Standard Review Projects and AB 1082/1083 Pilots

Evaluation Year 2022 (Year 2)

Third-Party Evaluation Report

October 2023

Prepared for
Southern California Edison
(on behalf of Pacific Gas & Electric,
San Diego Gas & Electric, and Liberty Utilities)
1201 K Street # 1810
Sacramento, CA 95814

Lead Authors
Cadmus Group
Energetics Incorporated

Contributing Authors
ZMassociates Environmental Corporation
National Renewable Energy Laboratory
DAV Energy Solutions Inc
Marshall Miller

Table of Contents

Tables

Figures

Acronym List

Acronym	Definition
AB	Assembly Bill
ACF	Advanced Clean Fleets
ACT	Advanced Clean Trucks
ADA	Americans with Disabilities Act
AMI	Advanced metering infrastructure
AR5	IPCC's published fifth assessment report
BEV	Battery electric vehicle
BTM	Behind the meter
CAISO	California Independent System Operator
CARB	California Air Resources Board
CB	Census block
CBG	Census block group
CCS	Combined charging system
CEC	California Energy Commission
CH_4	Methane
CNG	Compressed natural gas
CO	Carbon monoxide
COBRA	CO-Benefits Risk Assessment Health Impacts Screening and Mapping tool
CO_2	Carbon dioxide
CPUC	California Public Utilities Commission
CRT	Charge Ready Transport
CVUSD	Cajon Valley Union School District
DAC	Disadvantaged Community
DC	Direct current
DCFC	Direct current fast charging
DGE	Diesel gallons equivalent
DPR	Department of Parks and Recreation
ELRP	Emergency Load Reduction Program
EMFAC	EMissions FACtor model
EPA	U.S. Environmental Protection Agency
eTRU	Electric transportation refrigeration units
EV	Electric vehicle
EV-HP	Electric vehicle high-power
EVSE	Electric vehicle supply equipment
EVSP	Electric vehicle service provider
EY	Evaluation Year
GHG	Greenhouse gas, here including CO_2, CH_4, and N_2O
GWP	Global Warming Potentials
HVIP	Hybrid and Zero Emission Truck and Bus Voucher Incentive Project
ICE	Internal combustion engine
ICT	Innovative Clean Transit
IOU	Investor-owned utility
IPCC	Intergovernmental Panel on Climate Change
IV-2SLS	Instrumental variable two-stage least squares
L1	Level 1
L2	Level 2
LCFS	Low Carbon Fuel Standard

Acronym	Definition
LDV	Light-duty vehicle
MDHD	Medium- and heavy-duty
ME&O	Marketing, education, and outreach
MT	Metric ton
N_2O	Nitrous oxide
NO_3	Ammonia
NO_x	Oxides of nitrogen
NPV	Net present value
OEM	Original equipment manufacturer
OLS	Ordinary least squares
ORION	Off-Road Inventory ONline
PAC	Program Advisory Committee
PG&E	Pacific Gas & Electric
PHEV	Plug-in hybrid electric vehicle
PM	Particulate matter
PYDFF	Power Your Drive for Fleets
ROG	Reactive organic gases
SB	Senate Bill
SCE	Southern California Edison
SDG&E	San Diego Gas & Electric
SO_2	Sulfur dioxide
SO_x	Oxides of sulfur
SRP	Standard Review Projects
TCO	Total cost of ownership
TE	Transportation electrification
TEF	Transportation Electrification Framework
TTM	To-the-meter
VALE	Voluntary Airport Low Emission
VAP	Vehicle Acquisition Plans
VOCs	Volatile organic compounds
VMT	Vehicle miles traveled
V2G	Vehicle-to-grid
V2GEL	V2G Equipment List
ZEV	Zero-emission vehicle

1. Executive Summary

This report summarizes findings and lessons learned from an independent evaluation of 14 programs to build electric vehicle (EV) charging infrastructure for light-, medium-, and heavy-duty vehicles, administered by four California Utilities. These programs were authorized under California Public Utilities Commission (CPUC) decisions in 2018 and 2019 and support TE goals in Senate Bill (SB) 350 Clean Energy and Pollution Reduction Act of 2015 and Assembly Bills (AB) 1082 and 1083. This report builds on last year's Evaluation Year (EY) 2021 report[1] with new findings and lessons learned for EY2022.

Table 1 summarizes the 14 transportation electrification (TE) programs and their authorized budgets.

Table 1. Summary of Utility Programs

Utility	Program	Description	Budget
Southern California Edison (SCE)	Charge Ready Transport (CRT)	Public and private fleet MDHD make-ready and customer infrastructure.	$342.6M
	Schools Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at K–12 schools, community colleges, and universities.	$9.9M
	Parks Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at public parks and beaches.	$9.9M
Pacific Gas & Electric (PG&E)	EV Fleet	Public and private fleet medium- and heavy-duty (MDHD) make-ready and customer infrastructure.	$236.3M
	Schools Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at K–12 schools, community colleges, and universities.	$5.8M
	Parks Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at public parks and beaches.	$5.5M
	EV Fast Charge	Installation of Utility-owned direct current fast charge (DCFC) chargers.	$22.4M
San Diego Gas & Electric (SDG&E)	Power Your Drive for Fleets (PYDFF)	Public and private fleet MDHD make-ready and customer infrastructure.	$107M
	Vehicle to Grid (V2G) Pilot	Pilot to test electric school buses and bi-directional charging equipment.	$1.7M
	Schools Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at K–12 schools, community colleges, and universities.	$9.9M
	Parks Pilot	Direct installation of make-ready infrastructure and chargers at public parks and beaches.	$8.8M
Liberty Utilities	EV Bus Infrastructure	Depot charging stations for Tahoe Transportation District to install.	$0.22M
	Schools Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at K–12 schools, community colleges, and universities.	$3.9M
	Parks Pilot	Direct installation of and incentives for make-ready infrastructure and chargers at public parks and beaches.	$0.78M

[1] For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

A charging site is a single geographic location at which a Utility customer has charging stations and ports installed as part of one of the 14 Utility programs. This evaluation uses the following conventions to describe the status of those sites as they advance towards activation and use:

- **Utility Construction Completed:** Sites where the Utility has completed their scope either: to-the-meter (TTM), behind-the-meter (BTM), turnkey installation
- **Activated:** Sites with charging stations installed and available for use
- **Operational:** Sites where advanced metering infrastructure (AMI) and/or electric vehicle service provider (EVSP) energy usage data were received from the Utility or EVSP
- **Closed Out:** Sites where financial documentation has been finalized by the Utility and rebates for the installed chargers have been paid[2]

Table 2 summarizes site counts denoted in this evaluation for EY2022 and program to date (PTD). The difference between the two columns were the number of sites included in the EY2021 Evaluation Report. EY2022 sites, shown in white columns, include sites that reached a given site status (such as Activated) between January 1, 2022 and December 31, 2022. PTD sites, shown in green columns, include all sites since the launch of the program that reached a given site status as of December 31, 2022.

Table 2. Site Counts for EY2022 Sites and Program-to-Date (PTD) Sites

Utility	Program	Utility Construction Completed		Activated		Operational		Closed Out	
		EY2022 Sites	PTD Sites	EY2022 Sites	PTD Sites	EY2022 Sites	PTD Sites	EY2022 Sites	PTD Sites
SCE	CRT	15	42	15	39	20	39	15	16
	Schools	12	13	12	13	8	9	1	1
	Parks	0	0	0	0	0	0	0	0
PG&E	EV Fleet	18	46	14	42	15	41	9	32
	Schools	1	1	1	1	1	1	0	0
	Parks	0	0	0	0	0	0	0	0
	EV Fast Charge	8	12	5	9	5	9	2	6
SDG&E	PYDFF	11	13	12	13	12	13	3	4
	Schools	8	9	6	7	6	7	1	1
	Parks	3	8	4	8	4	8	5	5
	V2G	0	1	0	1	0	1	0	0
Liberty	EV Bus Infrastructure	0	1	0	1	0	1	1	1
	Schools	0	0	0	0	0	0	0	0
	Parks	0	0	0	0	0	0	0	0
Total		**76**	**146**	**69**	**134**	**71**	**129**	**37**	**66**

Counts in Table 2 are not additive between the four site statuses (e.g., Activated, Operational, etc.). In general, counts in the Closed Out column are a subset of sites in the Operational column, which is a subset of sites in the Activated column, which is a subset of sites in the Utility Construction Completed

[2] At some closed out sites, the Utilities still plan to pay rebates for future chargers.

column. The four MDHD programs had the most sites reach Utility Construction Complete (58), followed by the Parks Pilot (five), EV Fast Charge (four), and the Schools Pilot (two).

1.1. Findings

This section summarizes program findings. For simplicity, programs are grouped into three program bundles based on similarities in program design:

- **MDHD Bundle:** Liberty EV Bus Infrastructure, PG&E EV Fleet, SCE CRT, and SDG&E PYDFF
- **Public Charging Bundle:** Liberty Schools and Parks, PG&E EV Fast Charge, PG&E Schools and Parks, SCE Schools and Parks, and SDG&E Schools and Parks
- **V2G Pilot:** SDG&E V2G

Table 3 summarizes the program impacts, by bundle, for EY2022.

Table 3. EY2022 Program Impacts by Bundle

Impact Parameter	MDHD Bundle	Public Charging Bundle	V2G Bundle
Population of Activated Sites in EY2022 (#)	41	27	1
Ports Installed in Analyzed Sites (#)	745	200	0
EVs Supported (#) [a]	906	N/A	0
Electric Energy Consumption (MWh)	5,536	445	0
Petroleum Displacement (diesel gallons equivalent [DGE])	525,711	36,688	0
Greenhouse Gas (GHG) Emission Reduction (metric ton [MT] GHG) [b]	4,346	283	0
Oxides of Nitrogen (NO_x) Reduction (kg)	3,975	N/A	0
Particulate Matter (PM_{10}) Reduction (kg)	27	1.5	0
Particulate Matter ($PM_{2.5}$) Reduction (kg)	25	1.3	0
Reactive Organic Gases (ROG) Reduction (kg)	761	23.3	0
Carbon Monoxide (CO) Reduction (kg)	59,176	762	0

[a] The team derived the EVs supported value for MDHD programs from applicants' vehicle acquisition plans (VAP). This value represents the maximum number of vehicles expected to be supported by the charging infrastructure.

[b] GHGs include carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) multiplied by their respective Global Warming Potentials (GWP) as defined by the Intergovernmental Panel on Climate Change (IPCC) published fifth assessment (AR5; see the *Methodology* section for more details).

1.2. Lessons Learned

Preliminary lessons learned supported by findings are provided below by bundle. Note that these lessons and findings were derived from a limited number of program participants across most but not all market sectors. Additional insights will be gained as more sites are completed in the coming years.

1.2.1. Medium-Duty Heavy-Duty Bundle

The Utility programs are progressing well toward their goals for number of EVs but are lagging behind in their goals for number of sites.

Across Utility programs in EY2022 a total of 41 new project sites were activated to support 906 vehicles. This brings the total activated sites across the Utility programs to 94, with support for 1,435 additional electrified vehicles according to customer VAPs. These sites are distributed across eight market sectors: medium duty vehicles, heavy duty vehicles, forklifts, eTRU, airport GSE, school buses, transit buses, and TSE.

As of the end of 2022, the SCE CRT program has a total of 108 contracts to date to support 2,344 vehicles, which would meet 12% of the programmatic site goal and 28% of the vehicles supported goal. The PG&E EV Fleet program has a total of 158 contracts to support 3,050 vehicles, which would meet 23% of the site goal and 47% of the vehicles supported goal. The SDG&E PYDFF program has a total of 22 contracts to support 554 vehicles, which would meet 7% of the site goal and 18% of the vehicles supported goal.

Staff at the three large Utilities have expressed concern about reaching site goals and reported that program requirements are a challenge for small fleets, as some customers do not own their sites and/or are unable to meet the requirements for number of vehicles per site, limiting participation.

Overall program spending is ramping up slowly across Utilities; however, spending in disadvantaged communities (DACs) exceeds targets for most programs.

As of the end of EY2022, $70 million has been spent across the four Utility programs, or 10% of the available funding budget of $686 million. SCE has spent $22 million of the $342.6 million approved program budget, or 6.4% of available funding. Across financially closed out sites, 58% of program spending has been on DAC sites, exceeding the 40% program target. PG&E has spent $35.9 million of the $236.3 million approved program budget, or 15% of available funding. Across financially closed out sites, 39% of program spending has been on DAC sites, exceeding the 25% program target. SDG&E has spent $11.02 million of the $107 million approved budget, or 10% of available funding. SDG&E has a requirement that 30% of the infrastructure budget is spent on sites in DACs; however, none of the contracted sites are in a DAC.

TTM and BTM infrastructure costs continue to vary widely across project sites and Utility infrastructure incentives continue to be necessary to overcome incremental costs.

Across 20 PG&E and 16 SCE sites, Utility spending resulted in an average infrastructure cost of $212,525 per project site, $1,611 per kilowatt, and $19,011 per vehicle, when including TTM and BTM infrastructure but excluding EVSE cost. The approved decision budgets and programmatic goals would result in an average of $221,498 per project site and $23,024 per electrified vehicle.

Utility spending resulted in an average spend of $195,420 per project site and $25,180 per vehicle for the SCE CRT program across the 16 financially closed out sites. For the PG&E EV Fleet program to date, utility spending resulted in an average spend of $226,209 per project site and $14,076 per vehicle across the 20 financially closed out school bus sites.[3]

Program timelines were longer than expected, and site costs and supply chain delays continued to be a challenge.

The median start-to-finish duration for all 41 sites activated in the Utility programs in EY2022 is 715 days and is 649 days for all 94 activated sites in the program to date. Design and Permitting is the longest phase in the program to date with a median of 231 days, followed by Construction Complete with a median of 97 days.

SCE had originally estimated in its program materials, site activation to take between 11.5 months and 14.5 months. The median start-to-finish duration for all sites activated in the CRT program in EY2022 is 841 days (28 months) and is 722 days (24 months) for all activated sites in the program to date. Design and Permitting is the longest phase in the program to date, with a median of 205 days, followed by Construction Complete with a median of 133 days.

PG&E's EV Fleet program had initially estimated its process to take 13 to 19 months. The median start-to-finish duration for all sites activated in EY2022 is 784 days (26 months) and is 557 days (18.5 months) for all activated sites in the program to date. Design and Permitting is the longest phase in the program to date, with a median of 265 days.

The median time to complete all six phases of the SDG&E PYDFF program in EY2022 was 654 days (24 months), greater than the original program estimate of 11 to 16 months. The Design and Permitting phase contributed the largest share of this timeline, taking an average of 316 days.

Across all programs, EVSPs, Utility staff, and customers reported that the acquisition of switchgear is a primary driver for delays, with timelines extending to 50 to 70 weeks. Utility staff also reported that delays during the Design and Permitting phase are often driven by the customer design schedule, rather than by Utility action.

Across all Utility programs, significant new charging capacity was installed in EY2022 but is underutilized. The majority of fleet operators are not actively employing load management, and many are not tracking their charging costs.

Over 23,500 kW of new charging capacity was added at activated sites in EY2022 across Utility programs, bringing total installed capacity to over 31,500 kW. However, peak daily demand did not exceed 20% of available capacity for any Utility program, highlighting underutilization. Many fleet

[3] Detailed cost breakdown is included in the TCO findings sections of the Utility chapters.

operators reported that they had not yet received some or all of their vehicles, leading to chargers being underutilized. It is also expected that chargers at activated sites will have higher usage as vehicles are received and integrated into fleet operations at higher rates.

Across all Utilities, only nine of the 94 observed sites in the program to date exhibit the use of load management, shown by sharp increases in load beginning after 9 PM, when the highest cost period ends, while between 20% and 37% of all fleet charging took place between 4 PM and 9 PM on a monthly basis, resulting in negative impacts on operational costs and grid congestion. However, between 30% and 40% of all charging sessions have enough flexibility to avoid charging during that peak rate time period, offering significant opportunity for cost savings.

Not all EVSPs offer load management programs, and Utility bills may not be made available to allow fleet operators to understand the cost impacts of time of use. During site visits, many fleet operators reported it being the first time they had seen their own usage information, and almost every operator had a disconnect between what they expected the electricity to cost versus actual historical costs. However, most fleet operators are aware of time-of-use pricing, regardless of not being aware of their own usage trends and costs. Based on site visits, successful load management occurred when the EVSP was financially responsible for its application.

> **Recommendation: IOUs should review current processes around communicating load management to ensure customers are maximizing monetary and emissions savings.**
>
> The Evaluation Team identified several challenges to the implementation of load management in this report related to awareness, operational constraints, knowledge of rate structure, and organizational capacity. Following site energization, Utilities should review customer usage data over six to 12 months of operations and follow up with sites that exhibit opportunities for better load management. The Evaluation Team's interactive dashboard (a Utility-facing tool not publicly accessible) provides key metrics on customer load management performance that can be leveraged to highlight site-level charging behavior and opportunities for monetary and emissions savings.

Fleet programs are having a measurable and increasing impact on petroleum reduction, GHG emission reductions, criteria pollutant emission reduction, and health benefits.

In EY2022 a total of 41 new sites were activated across Utility programs, which results in a total annualized impact of over 500,000 gallons of petroleum displaced. Over a 10-year time period all sites in the program to date are expected to displace over 9.5 million gallons of petroleum. Across all programs in EY2022, annualized reductions in GHG emissions relative to counterfactual vehicles are estimated to be 4,346 MT, with 34% of reductions occurring in DACs. All sites in the program to date are expected to reduce GHG emissions by 80,475 MT over a 10-year period. The estimated total value of health benefits resulting from emissions reductions in the program to date is between $345,127 and $775,630. Across all Utility programs, there is an opportunity for improve emissions impacts through the use of greater load management, specifically by enabling vehicles to avoid charging during peak periods while taking advantage of periods with a higher mix of renewable generation.

The 15 activated sites in the SCE CRT program in EY2022 achieved an annualized impact of over 200,000 gallons of petroleum displaced, and program to date sites are expected to displace over 4,000,000 gallons of petroleum over a 10-year period. EY2022 activated sites resulted in an 80% reduction in GHG emissions relative to the counterfactual vehicles, while program to date sites achieved a 75% reduction. Annualized GHG emissions reductions from EY2022 sites was 1,739 MT with 47% in DACs.

The 14 activated sites in the PG&E EV Fleet program in EY2022 achieved an annualized impact of over 200,000 gallons of petroleum displaced, and program to date sites are expected to displace nearly 4,400,000 gallons of petroleum over a 10-year period. EY2022 activated sites resulted in an 84% reduction in GHG emissions relative to counterfactual vehicles, while program to date sites achieved an 85% reduction. Annualized GHG emissions reductions from EY2022 sites was 1,660 MT with 39% in DACs.

The 12 activated sites in the SDG&E PYDFF program in EY2022 achieved an annualized impact of over 100,000 gallons of petroleum displaced. These 12 sites resulted in an 84% reduction in GHG emissions relative to counterfactual vehicles, or 947 MT on an annualized basis.

In EY2022, Utilities continued to expand and improve customer education efforts to strengthen the number and quality of applications received, including increased outreach to DACs.

Through the TEAS program, SCE provided fact sheets, webinars, and other educational materials to assist its customers. SCE also provided grant writing and review assistance to smaller fleets to enhance their participation in the CRT program, as well as EV readiness studies including one-on-one conversations with customers about the electrification process. Based on the evaluation survey, three of the four responding fleet managers heard about the program directly from SCE, and all were highly satisfied with program communication.

PG&E provides several market sectors with specific informational resources to appeal to and educate potential fleet customers, including program materials, information on incentives and rebates per vehicle and charger, eligibility requirements, and tools such as an EV Fleet Charging Guidebook and a fuel switching rate calculator. Four of the six surveyed fleet managers reported hearing about the program directly from PG&E, and five out of five responding fleet managers were *very satisfied* with their experience working with PG&E staff. PG&E staff also reported that onboarding specialists have been the most effective outreach method for potential applicants and additional onboarding specialist support is planned for 2023.

SDG&E undertook significant efforts to increase outreach to DACs in 2022. Marketing, education, and outreach (ME&O) materials included a dedicated webpage titled “Electrification for Fleets Operating in Disadvantaged Communities,” a general fact sheet for fleets in DACs, a TCO fact sheet for fleets in DACs, a fact sheet on the benefits of SDG&E’s EV High Power pricing plan with DAC-specific information, and a fact sheet on funding opportunities and incentives with DAC-specific information.

There was general consensus among market experts that the EV market share for transit bus and delivery vehicles will increase over time, and that Utility programs are critical to meet deployment targets.

The market forecast for electric transit bus market share in California aligns with the Innovative Clean Transit (ICT) requirements through 2025 but falls short of 100% by 2030. The increased availability of funding is expected to be the primary driver for transportation agencies to meet purchase requirements. Experts forecasted the electric delivery vehicle market share to fall short of Advanced Clean Fleets (ACF) sales requirements in 2025, driven by high infrastructure costs, battery market competition, and limited product availability. EVSPs and fleet operators both identified Utility incentives as a key mechanism to reduce the barrier to electrification presented by high EV costs and the high cost of installing EV charging infrastructure.

1.2.2. Public Charging Bundle

All Public Charging Programs

The Schools and Parks Pilots' sites, as well as EV Fast Charge program sites, are promoting EV adoption.

The SDG&E Schools and Parks Pilots, SCE Schools Pilot, and PG&E EV Fast Charge program positively influenced EV adoption in households neighboring the infrastructure. SDG&E's investments in the Schools Pilot and Parks Pilot public charging infrastructure had a significant and economically meaningful impact on EV ownership in EY2022, leading to an increase of 19 EVs and 14 EVs, respectively, for households neighboring the infrastructure. The impact of the SDG&E Schools Pilot was larger than the impact of the SDG&E Parks Pilot, as there were more charging facilities and the site locations and chargers are easier for the public to access than the site locations and chargers for Parks Pilot sites. The SCE Schools Pilot and the PG&E EV Fast Charge program also positively influenced EV adoption in households neighboring the infrastructure, relative to baseline registrations. The impacts from the SCE and PG&E programs were modest, potentially because of the location of charging stations in nonresidential areas, resulting in limited impacts for neighboring homes.

The Schools and Parks Pilots' sites, as well as the EV Fast Charge program sites, are helping to displace petroleum, reduce GHG and local emissions, and achieve nominal health impacts overall and within DACs.

Combined, the EY2022 sites have displaced more than 36,000 gallons of petroleum, and the programs are forecasted to displace over 525,000 gallons over a 10-year period. More specifically, the SCE Schools Pilot accounted for an annualized impact of 4,000 gallons of petroleum (40,000 gallons over a 10-year period), with 16% within DACs. The SDG&E Schools and Parks Pilots accounted for an annualized impact of over 12,000 gallons of petroleum (190,000 gallons over a 10-year period), with 67% of the impact within DACs. The PG&E EV Fast Charge program sites accounted for an annualized impact of over 20,000 gallons of petroleum (295,000 gallons over a 10-year period), with 7% of the impact within DACs.

In addition, the SCE Schools Pilot achieved an 80% reduction of GHG, and the SDG&E Schools and Parks Pilots and PG&E EV Fast Charge program resulted in an 81% and 80% reduction of GHGs, respectively, with 16% occurring within DACs for SCE, 67% within DACs for SDG&E, and 7% within DACs for PG&E. These sites all positively contributed to lowering local emissions, with CO impacts being the most prominent, achieving a reduction of 732 kg in EY2022 and a forecasted reduction of nearly 14,000 kg over a 10-year period.

Overall, the sites accounted for between 14% and 21% of the health benefits in DACs with the annual monetary health benefits ranging from $103 (SCE Schools) to $3,007 (PG&E EV Fast Charge).

Schools Pilot and Parks Pilot

Long-term engagement with customers, like those interested in the Schools and Parks Pilots, lends itself to positive relationship building, increased awareness, increased understanding of barriers, and promotes interest and participation in TE opportunities.

In both the Schools and Parks Pilots, SDG&E staff have now been working closely with some customers for well over one calendar year. Over the course of implementing the Pilots, SDG&E staff have learned where there is flexibility in the design to make the Pilot as appealing to customers as possible (for example, allowing K–12 schools that are concerned with student safety to keep their chargers private). In addition, because these chargers are Utility owned, SDG&E staff continue to have a relationship with Pilot participants even after EVSE is installed as they address maintenance concerns or questions that arise along the way. Through this long-term engagement, staff have not only built positive, stable relationships with these customer segments, but can also now directly connect these customers with other SDG&E programs or products of interest.

Over the course of implementing the Schools Pilot, Liberty staff have struggled with disinterest in the Pilot from nearly all eligible customers, while simultaneously seeing interest in other TE opportunities, such as for bus, DCFC, and other electrification programs. Even though this interest may not result in participation in the Schools Pilot, over the past year Liberty has learned what schools need and want out of TE. As the electrification market accelerates, Liberty will be better positioned to support school customers when other opportunities arise.

Market conditions contribute to higher-than-expected site costs.

The Schools and Parks Pilots began during the COVID-19 pandemic, which had unprecedented economic impacts across nearly every market, driving up costs for materials and labor and disrupting supply chains. These changes were so significant that the estimates the Utilities had created for Decision 19-11-017 (which set the Schools and Parks Pilots funding levels) did not reflect the actual costs for implementation. In some cases, these elevated costs created an unexpectedly high number of cost flags to trigger during the application review process, ultimately reducing the number of sites that made it through the desktop review process. These struggles continued to impact sites in EY2022 as inflation impacted material costs across the region. In addition, these struggles were compounded by additional design-driven delays. For example, the Utilities had limited construction time, as schools only allowed construction during breaks and permit approval took an exceptionally long time. (SCE and PG&E can only apply this lesson to the Schools Pilot, as they had limited engagement in the EY2022 Parks Pilot. This lesson does not apply to Liberty, as it did not secure any Pilot sites in EY2022.)

Schools Pilot Only

As the School Pilots mature, Utility staff are improving coordination with and approvals from schools.

In EY2021, Pilot implementation was slower than anticipated as SCE staff started to learn about the schools' complex decision-making structures. For example, staff learned that approval must often come from the school board (which, in some cases, means the site may be open to scrutiny and public comment) or from specific personnel who may not work at the site. These multiple layers add complication and time to the enrollment and implementation processes. Though SCE staff began forming strategies and adaptations to navigate these complex structures in EY2021, the lack of clarity and variability between districts meant that the planning for each project took significantly more time than expected. However, in EY2022, with their growing expertise, SCE staff were more easily able to maneuver these complex decision-making structures. For example, SCE staff are better able to anticipate and address concerns (such as for student safety if chargers were accessible to the public) of newly enrolling schools.

Parks Pilot Only

Sufficient time must be built into Parks Pilot implementation planning when anticipating contract negotiations between two or more large organizations.

To maximize efficiencies, SCE, SDG&E, and PG&E worked together throughout EY2021 to develop a collective participation agreement with the Department of Parks and Recreation (DPR). Given staff constraints during this time, Liberty stayed in a holding pattern with the intention of joining the final agreed-upon master agreements. However, ultimately three of the legal teams were not comfortable with the terms of the final draft of the master agreement that had been developed for joint use (specifically the terms around responsibilities for certain costs, liabilities, and risks). This disagreement led to delays, which was further compounded by DPR staff turnover, which meant pausing negotiations while new DPR staff were oriented to the status of the agreement documents.

In EY2022, the Utilities separated their efforts and set out to establish independent agreements with the DPR. While SCE was able to successfully finalize a Master Participation Agreement with the DPR and officially begin planning individual parks sites during EY2022, SDG&E, PG&E, and Liberty are continuing to work toward finalizing their own master agreements. Staff across these three Utilities are hopeful for a completed agreement in EY2023.

PG&E EV Fast Charge

Market conditions and program requirements resulted in higher-than-expected site costs for the EV Fast Charge program. While these have limited participation so far, program design flexibility may be key to ensuring that PG&E can meet the program participation goals.

PG&E began the EV Fast Charge program just as the COVID-19 pandemic started. COVID-19 had unprecedented economic impacts across nearly every market, driving up costs for materials and labor and disrupting supply chains. These changes were so significant that the estimates PG&E had created for Decision 18-05-040 (which mandated program funding levels) did not reflect the actual costs for implementing EV Fast Charge. Though PG&E staff conducted research ahead of program design, these expenses were then compounded by inadvertent inaccuracies in site design estimations. Because of this, and despite increasing its cost threshold, PG&E has had to turn many sites away from the program for being cost-prohibitive. In EY2022, after discussions with staff in the CPUC Energy Division, PG&E staff shifted the program design to allow partnering site hosts to contribute to project costs if the costs exceeded the program funding limits, thus expanding the pool of eligible site hosts. Furthermore, staff added more phone screening steps to try to mitigate the attrition of site hosts during later stages in the application process.

Coordination and training with EVSPs who partner with the EV Fast Charge program is key to minimizing the number of sites that are screened out early in the application process.

PG&E designed the program so that all site hosts would have to apply through an approved EVSP, who would lead the complex application completion. At the beginning of the program, PG&E provided training to help EVSPs become knowledgeable about the application. However, as the program was implemented, PG&E staff had to turn away many applications because of projected issues with cost-effectiveness. After conducting an exercise where PG&E staff and the participating EVSPs ranked submitted sites from most to least ideal, it was clear that EVSPs were misunderstanding PG&E's priorities in site selection or were not on the same page regarding the pilot requirements.

1.2.3. V2G Bundle

EV battery degradation impacts are of high concern to vehicle and battery manufacturers.

Battery state of health and warranty concerns resulted in the implementation of battery charge and discharge throttling for vehicles in the V2G Pilot. Additional research and data collection is necessary to understand optimal V2G operation on battery health. The V2G Pilot team is working to understand the impacts, how to mitigate risks to the site host and vehicle manufacturers, and potentially remove the V2G limitations.

Interoperability between V2G-capable EVSE and V2G-capable EVs is not guaranteed.

A difficult and protracted experience of having to retrofit the AC unidirectional electric school buses selected for the V2G Pilot has led SDG&E to recommend that fleet customers who want to pursue V2G should procure new EVs with off-the-lot direct current (DC) bidirectional capability and choose EVSE with demonstrated interoperability to the selected vehicles, such as from the California Energy Commission's (CEC) V2GEL (V2G equipment list).

1.3. Structure of Report

The evaluation report is organized into the following sections:

- **Chapter 1.** Executive Summary
- **Chapter 2.** Introduction
- **Chapter 3.** SCE Programs: CRT, Schools and Parks Pilots
- **Chapter 4.** PG&E Programs: EV Fleet, Schools and Parks Pilots, EV Fast Charge
- **Chapter 5.** SDG&E Programs: PYDFF, Schools and Parks Pilots, Vehicle-to-Grid (V2G) Pilot
- **Chapter 6.** Liberty Utilities Programs: EV Bus Infrastructure, Schools and Parks Pilots

- **Appendix A**. Methodology
- **Appendix B**. Deep Dives
- **Appendix C**. Data Collection Instruments

Each of the 14 program-specific sections in Chapters 3 to 6 contain the same three subsections:

- **Overview:** Describes the evaluation objectives, logic model, theory of program impacts, and research questions.
- **Findings:** Details results from the program materials review, market research, in-depth interviews, surveys, analyses, or other methods.
- **Lessons Learned:** Varies, as appropriate, according to the needs of each evaluation bundle.

2. Introduction

In support of the TE goals of the SB 350 Clean Energy and Pollution Reduction Act of 2015 and ABs 1082 and 1083, the CPUC issued major decisions in 2018 and 2019 authorizing investment in 14 Utility programs. This report evaluates these 14 programs. Through these programs, outlined in Table 4, the Utilities invest in charging infrastructure to help spur light-, medium-, and heavy-duty EV adoption among fleets and households. Additional detail on program design is provided in subsequent chapters.

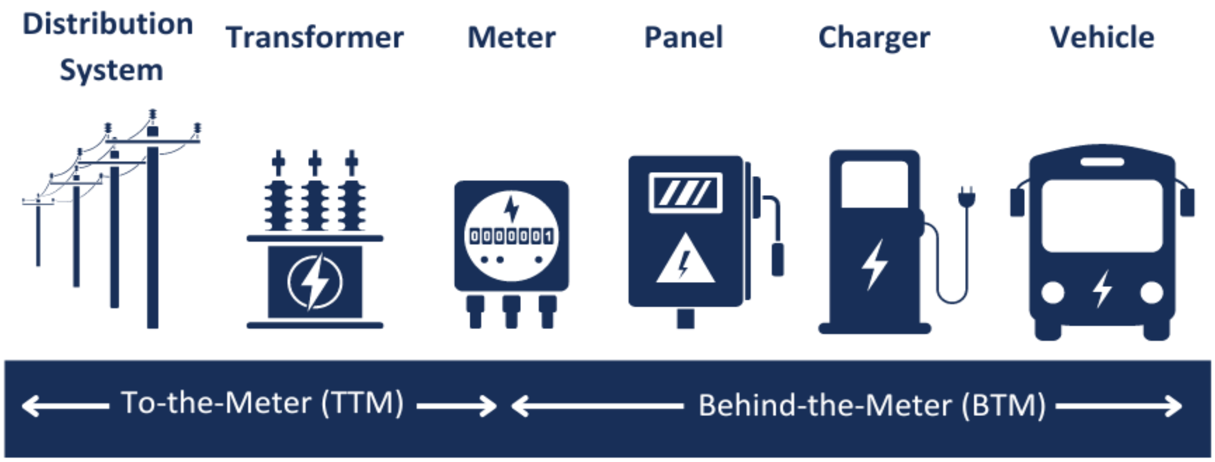
Table 4. Summary of Utility Programs

Utility	Program	Description	Decision [a]
SCE	CRT Program	$342.6M for TTM and some or all of the BTM infrastructure up to the charging station for MDHD fleets. Additional rebates for charging stations are available for certain fleets.	1
	Schools Pilot	$9.9M for installation of approximately 250 Level 1 (L1) and Level 2 (L2) charging ports at 40 K–12 schools.	2
	Parks Pilot	$9.9M for installation of approximately 120 L2 charging stations, 10 DCFC charging ports, and an optional 15 mobile stations across 27 state parks and beaches.	2
PG&E	EV Fleet Program	$236.3M for TTM and some or all BTM infrastructure up to the charging station for MDHD fleets. Additional rebates for charging stations are available for certain fleets.	1
	Schools Pilot	$5.8M for installation of four or six L2 charging ports at 22 schools.	2
	Parks Pilot	$5.5M for installation of L2 and DCFC charging ports at state parks and beaches.	2
	EV Fast Charge Program	$22.4M for make-ready infrastructure of 52 DCFC and rebates for EVSE.	1
SDG&E	PYDFF Program	$107M for TTM and some or all BTM infrastructure up to the charging station for MDHD fleets. Additional rebates for charging stations are available for certain fleets.	3
	Schools Pilot	$9.9M for installation of and incentives for installing 184 L2 and 12 DCFC charging ports at 30 schools and educational institutions.	2
	Parks Pilot	$8.8M for installation of 74 light-duty public charging ports in 12 state parks and beaches within SDG&E's service territory and 66 light-duty public charging ports at 10 city and county park sites.	2
	Vehicle to Grid (V2G) Pilot	$1.7M for installation of V2G-capable chargers for school buses at the Cajon Valley Union School District (CVUSD).	3
Liberty Utilities	EV Bus Infrastructure Program	$0.22M for TTM and BTM infrastructure for electric transit bus.	4
	Schools Pilot	$3.9M for up to 56 L2 and DCFC charging ports at 17 schools.	2
	Parks Pilot	$0.78M for five dual-pedestal EVSE at three sites.	2

[a] 1. Decision 18-05-040; 2. Decision 19-11-017; 3. Decision 19-08-026; 4. Decision 18-09-034

The programs support EV infrastructure, typically categorized as TTM and BTM (Figure 1). Across Utility programs, the Utilities pay for and own 100% of the TTM infrastructure. BTM infrastructure funding varies by program and includes up to 100% of BTM costs in some programs. BTM ownership also varies by program, and includes utility ownership, private sector ownership, and government sector ownership.

Figure 1. Illustration of To-the-Meter and Behind-the-Meter Infrastructure



2.1. Market Landscape

This section summarizes market changes occurring in calendar year 2022. The Cadmus team summarized the market landscape in the previous EY2021 evaluation report.[4]

2.1.1. EV Share of New Vehicles

The EV market in the United States continued to grow in 2022 in California and nationally. EVs increased their share of new, light-duty vehicles (LDVs) sold in the United States market from 3.2% in 2021 to 5.8% in 2022.[5] In California, total electric vehicle market share was 19% in 2022, with battery electric vehicles (BEVs) accounting for 16% of LDV sales and plug-in hybrids (PHEV) accounting for 3%, compared to 9% and 3% in 2021.[6]

Figure 2 shows the trend of EV adoption in California. The CEC estimates that the light-duty EV fleet in California was approximately 1.1 million vehicles at the end of 2022, representing 4% of the overall LDV fleet.

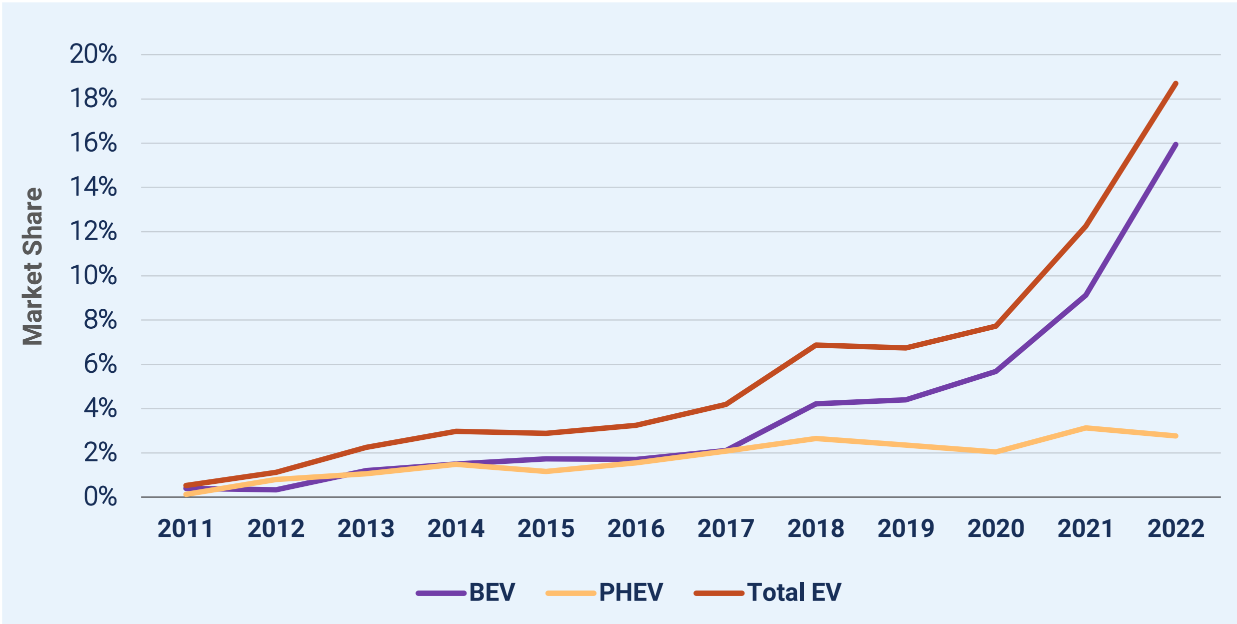
---

4 Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

5 Colias, M. January 6, 2023. "U.S. EV Sales Jolted Higher in 2022 as Newcomers Target Tesla." *The Wall Street Journal*.

6 California Energy Commission. Last updated January 18, 2023. "New ZEV Sales in California." https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/new-zev-sales

Figure 2. EV New Light-Duty Vehicle Market Share California, 2011-2022



The electric MDHD market is significantly smaller than the light-duty EV market. Electric MDHDs accounted for 2,320 vehicles of Class 3 through 8 by 2022 year end, primarily composed of bus (950 transit bus, 556 school buses, and 189 coach bus).[7] There were 340 vans (189 Step-vans and 151 delivery vans) as well as 272 electric trucks (108 tractor trucks, 84 terminal tractors, and 40 chassis & cab, and 37 straight trucks). There were also 13 incomplete bus-chassis, two flatbed/platform, and one garbage truck. These numbers do not include pickup trucks, although some electric pickup trucks fall into the Class 2b category and are therefore medium-duty (as detailed in Section 2.1.2 below).

2.1.2. EV Models

Several new EV models entered the market in 2022. One new market entrant, the Ford F-150 Lightning, is the all-electric version of what has been the best-selling LDV in the U.S. for 41 consecutive years (with over 640,000 units of Ford F-series truck sales in 2022).[8]

Another electric pickup truck, the Rivian R1T, had its first deliveries in late 2021 and increased production in 2022. Per the CEC, there were 2,233 vehicle registrations for the Ford F-150 Lightning and 3,604 for the Rivian R1T in 2022.[9] The Rivian R1T and the Ford F-150 Lightning Extended Range both

7 California Energy Commission. 2023. "Medium- and Heavy-Duty Zero-Emission Vehicles in California." https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/medium-and-heavy

8 Ford Motor Company. January 3, 2023. "Still On Top: Ford F-Series Retains Title of Best-Selling Truck for 46th Consecutive Year; Overall Best-Seller For 41st." Press release.

9 California Energy Commission. 2023. *New ZEV Sales in California.* https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/new-zev-sales

have a gross vehicle weight rating (the sum of the curb weight and the payload capacity) in excess of 8,500 pounds.[10] Pickup trucks with a gross vehicle weight rating between 8,501 and 10,000 pounds are Class 2b trucks, which fall under the Advanced Clean Trucks (ACT) and ACF requirements. The 3,604 Rivian R1T trucks registered in EY2022 in California alone outnumber the estimated MDHD zero emission vehicle (ZEV) fleets reported for the state.

The Hyundai IONIQ 5 and Chevy Bolt EUV were popular new market entrants in California in 2022, both achieving sales of over 7,500 vehicles. As shown in Table 5, the market leaders are—by a very wide margin—the Tesla Model 3 and the Tesla Model Y. Tesla accounts for 62% of all EV sales in California, or 73% of BEV sales. Other data exists with slightly different values,[11] but that dataset also shows the Model Y and the Model 3 as the best-selling LDVs *overall* in the state (not just the best-selling EVs).

Table 5. Top 10 EVs in California, 2022 (all EV sales: 343,244)

Make	Model	Type	Sales
Tesla	Model 3	BEV	94,683
Tesla	Model Y	BEV	93,872
Tesla	Model X	BEV	13,319
Tesla	Model S	BEV	10,712
Ford	Mustang Mach-E	BEV	9,860
Chevy	Bolt EUV	BEV	8,709
Hyundai	IONIQ 5	BEV	7,519
Toyota	Prius Prime	Plug-in hybrid electric vehicle (PHEV)	6,711
Jeep	Wrangler Unlimited [a]	PHEV	6,396
VW	ID4	BEV	5,089

[a] The CEC refers to the Wrangler Unlimited in its EV sales database; presumably, this is the “4xe” PHEV version.

Excluding the Class 2b trucks, the MDHD ZEV fleet (2,320 vehicles through the end of EY2022) is approximately 0.2% the size of the LDV segment (1.1 million vehicles through the end of EY2022).

The MDHD segment features an increasing diversity of options. Data from CALSTART shows 201 models of MDHD ZEVs available in the U.S. and Canada in 2022, a 25% increase over 2021.[12] Of these, 193 models were battery electric.

---

10 The Rivian R1T has a gross vehicle weight rating of 8,532 pounds (“R1T Owner’s Guide.” https://rivian.com/support/article/r1t-owners-guide). The Ford F-150 Lightning (Extended Range) has a gross vehicle weight rating of 8,550 pounds (“2022 Electric Vehicles.” Brochure. https://www.fleet.ford.com/content/dam/aem_fleet/en_us/fleet/brochures/order/general-information/2021_EV_Roadshow.pdf).

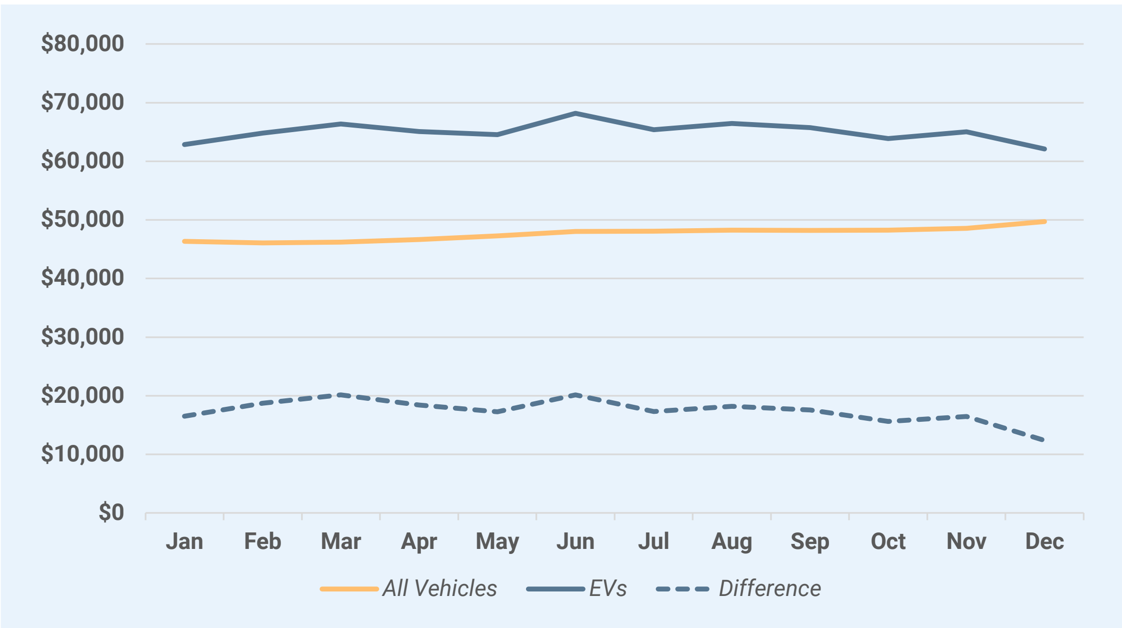
11 California New Car Dealers Association. February 2023. *California Auto Outlook* (Volume 19, Number 1). https://www.cncda.org/wp-content/uploads/Cal-Covering-4Q-22_FINAL.pdf

12 CALSTART. 2022. *Drive to Zero: Zero-Emission Technology Inventory Data Explorer.* Version 1.0. https://globaldrivetozero.org/zeti-data-explorer/

2.1.3. Electric Vehicle Prices

EVs remained significantly more expensive than conventional vehicles. While some lower-priced models do exist, they did not sell in very large volumes. Nationally, the average price for a new EV throughout 2022 was approximately $17,400 higher than the average price for a new internal combustion engine (ICE) vehicle, as shown in Figure 3. Comparable statistics of the average transaction price for MDHD EVs are not available.

Figure 3. Average Transaction Price for New Vehicles



Source: Kelley Blue Book. *Average Transaction Prices Report*. https://www.kbb.com/

EV price reductions, combined with fuel savings and various incentives, may lead to EVs having a lower total cost of ownership (TCO) than conventional ICE vehicles in some cases. Even with a higher upfront cost, the EV may achieve a lower TCO through operating cost savings. Achieving a net TCO reduction depends heavily on annual driving distance, the cost of EVSE installation, the frequency of public DCFC use, and other factors.

2.1.4. Charging Infrastructure

According to the U.S. Department of Energy's Alternative Fuels Data Center, California has the most EV chargers of any state in the U.S., with 36,787 ports across 13,443 public charging stations as of December 31, 2022.[13] In 2022, California added 7,536 charging ports across 2,633 stations. Of these, 5,613 were L2 ports, 1,922 were DCFC ports, and 1 was a public L1 port. The 2022 installations represented a decrease from the number of installed L2 ports in 2021, but a slight increase in the number of installed DCFC ports in 2021.

The CEC reports project costs for L2 and DCFC ports in the state, across different size sites. For L2 sites in

---

13 Alternative Fuels Data Center. 2023. "Alternative Fueling Station Locator." https://afdc.energy.gov/states/ca

California, the average total project cost per connector was $9,992 for the projects with one to four connectors, $8,768 for sites with five to seven connectors, and $9,139 for sites with eight or more connectors. For DCFC sites in California, the average total project cost per connector was $114,674 for the projects with two connectors, $117,659 for the projects with three connectors, and $104,443 for the projects with four or more connectors.

The number of EV charging stations installed by year in California is illustrated in Figure 4. Comparable estimates of the number of fleet chargers (both for government and private fleets) is not available.

Figure 4. Public EV Charging Ports in California by Year of Installation

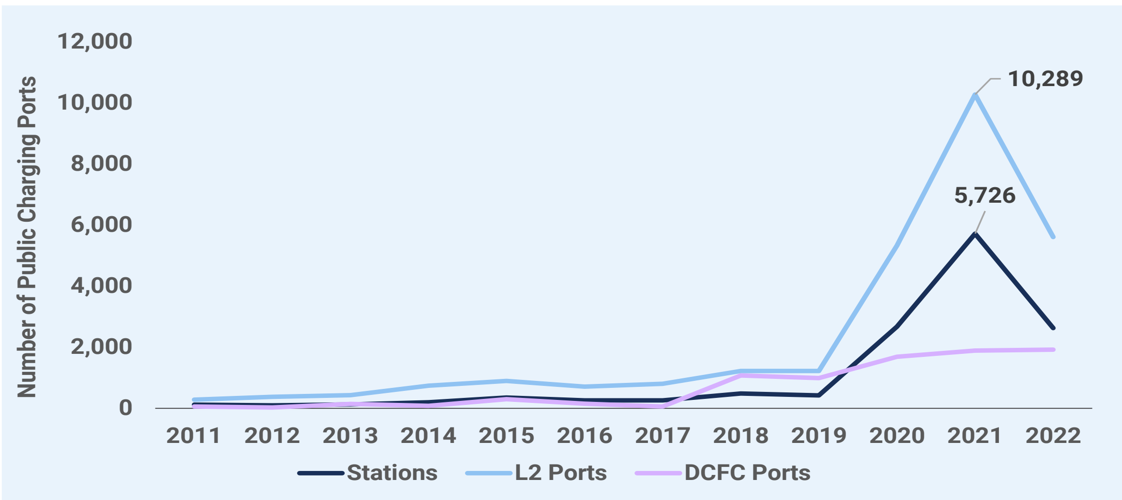
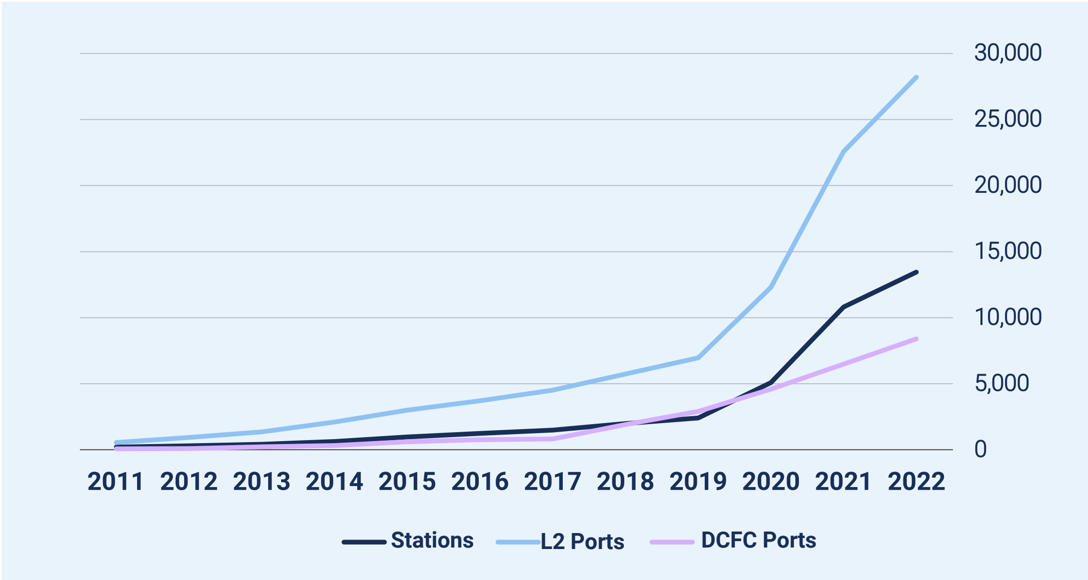


Figure 5 shows the cumulative total of public EV charging ports in California, excluding stations that are no longer functional.

Figure 5. Cumulative Total of Public EV Charging Ports in California



2.2. Policy Landscape

The 14 Utility programs exist within a larger policy ecosystem aimed at spurring EV adoption through regulation, incentives, and other instruments. This section describes major policy changes at the federal and state levels in 2022. The EY2021 Evaluation Report[14] describes other policies enacted before 2022.

2.2.1. Federal Policy

At the federal level, the Bipartisan Infrastructure Law, enacted as the Infrastructure Investment and Jobs Act, provides California with $384 million in formula funding for EV charging under the National Electric Vehicle Infrastructure Formula Program. Accessing this funding requires meeting the Federal Highway Administration's criteria for designation in its Alternative Fuel Corridor program.[15] California submitted its Electric Vehicle Infrastructure Deployment Plan[16] in August 2022, which was approved on September 14, 2022. California will also have the opportunity to apply for grants out of the $2.5 billion available for the discretionary Charging and Fueling Infrastructure program administered by the Federal Highway

---

14 Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

15 Federal Highway Administration. February 2023. FACT SHEET: Biden-Harris Administration Announces New Standards and Major Progress for a Made-in-America National Network of Electric Vehicle Chargers. https://www.whitehouse.gov/briefing-room/statements-releases/2023/02/15/fact-sheet-biden-harris-administration-announces-new-standards-and-major-progress-for-a-made-in-america-national-network-of-electric-vehicle-chargers/

16 Caltrans and California Energy Commission. August 2022. *California's Deployment Plan for the National Electric Vehicle Infrastructure Program.* https://www.fhwa.dot.gov/environment/nevi/ev_deployment_plans/ca_nevi_plan.pdf

Administration. Additionally, the Bipartisan Infrastructure Law provides up to $5 billion in funding for electric school busses and low emission busses, as well as $500 million for electric or low-emission ferries.

The Inflation Reduction Act of 2022 was signed into law on August 16, 2022. This act: extended the $7,500 tax credit for EVs (potentially higher for commercial vehicles) through 2023; restored the tax credit for manufacturers that had exhausted their available credits; imposed restrictions for non-commercial vehicles on vehicle price, purchaser income, vehicle assembly location, and material sourcing; and added two distinct provisions to allow expanded utilization of the EV tax credits:

1. The Transfer of Credit provision (Sec. 13401 (g), "Transfer of Credit") converts the Section 30D tax credit to a point-of-sale rebate for taxpayers without enough tax liability to benefit from the full credit.
2. The Qualified Commercial Clean Vehicles provision (Sec. 13404 "Credit for Qualified Commercial Clean Vehicles") modifies section 45W of Chapter 26 of the U.S. Code (26 USC 45W). Section 13801 of the bill enables tax-exempt entities to receive a direct payment from the Internal Revenue Service equivalent to the tax credit they would have received if they were taxable entities.

2.2.2. State Policy

Within California, TE programs range widely in design and objective. The state-run website driveclean.ca.gov provides location-specific information about incentives within the state.

In January 2022, Governor Newsom announced that the 2022 budget would contain an additional $6.1 billion for ZEVs.[17] This funding is allocated among a range of programs including personal vehicles, commercial vehicles, transit vehicles, and demonstration projects.

Other key state policies and programs advanced in 2022 include:

- **Transportation Electrification Framework (TEF).** In November 2022, the CPUC adopted the TEF under Decision 22-11-040.[18] This establishes a five-year (2025 through 2029) TE program, funded at $1 billion by the Utilities. The initial phase, Funding Cycle 1, has a budget of $600 million, of which at least 65% is reserved for underserved communities. In the TEF, overall, 70% of program expenditures will support MDHD EV charging and 30% will support LDV EV charging at or near multi-unit dwellings. The TEF will support BTM infrastructure, with TTM infrastructure covered by AB 841 (see below).

---

17 State of California. January 16, 2022. "Governor Newsom Outlines Historic $10 Billion Zero-Emission Vehicle Package to Lead the World's Transition to Clean Energy, Combat Climate Change." Press release. https://www.gov.ca.gov/2022/01/26/governor-newsom-outlines-historic-10-billion-zero-emission-vehicle-package-to-lead-the-worlds-transition-to-clean-energy-combat-climate-change/

18 California Public Utilities Commission. November 17, 2022. *Rulemaking 18-12-006, Decision 22-11-040.* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M499/K005/499005805.PDF

- **Electric Transport Refrigeration Units (TRU) mandate.** In February 2022, the California Air Resources Board (CARB) amended its rule for TRUs.[19] The amendments contain numerous regulations impacting TRUs, including a requirement that, beginning December 31, 2023, TRU owners shall turnover at least 15% of their fleet to zero-emission technology each year for seven years. All truck TRUs operating in California shall be zero-emission by December 31, 2029.
- **AB 841.** This legislation requires Utilities to fully pay for Utility-side make-ready costs for nonresidential EV charging infrastructure up to the electrical meter. In October 2021, the CPUC approved new Utility Electric Vehicle Infrastructure Rules that were developed pursuant to the 2022 AB 841. The new process for funding TTM infrastructure is designated as Rule 29 for PG&E and SCE and Rule 45 for SDG&E. Under these rules, TTM costs are covered by the Utilities then recouped through the Utilities' General Rate Case proceedings. In December 2022, the CPUC approved modifications to the timeline for project energization under the Electric Vehicle Infrastructure Rules.[20] The interim timeline is an average of 125 business days for events that are within the Utilities' control.
- **Advanced Clean Cars II**. CARB issued the Advanced Clean Cars II regulation on August 25, 2022. This policy requires major automakers to sell an increasing fraction of light-duty ZEVs over time, ramping up from approximately 35% of all new passenger vehicles in 2026, to 100% in 2035. The regulation applies to passenger cars and light-duty trucks (including SUVs).
- **Submetering.** In August 2022, the CPUC adopted and required the Utilities to implement a submetering protocol. As the CPUC notes, "The protocol reduces the cost of electric vehicle charging; consumers can avoid having to install a separate Utility meter and can instead use the technology to have their electric vehicle charging measured and billed separately from their primary Utility meter."[21]
- **AB 2622.** This legislation extends the partial state sales and use tax exemption for zero-emission transit bus through 2025.
- **SB 922.** This legislation extends the limited exemption of ZEV bus projects from the California Environmental Quality Act review through 2030.
- **AB 2061.** This legislation requires the CEC, in consultation with the CPUC, to develop uptime recordkeeping and reporting standards for EV chargers and charging stations by January 1, 2024. Uptime records will be kept for all publicly supported EVSE installed on or after January 1, 2024, and the CEC will assess these records every two years beginning in 2025.

---

19 California Air Resources Board. March 17, 2022. "2022 Amendments to the TRU ATCM." https://ww2.arb.ca.gov/resources/fact-sheets/2022-amendments-tru-atcm

20 Public Utilities Commission of the State of California. December 15, 2022. *Resolution E-5247.* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M500/K043/500043680.PDF

21 California Public Utilities Commission. August 4, 2022 *Rulemaking 18-12-006: Decision Adopting Plug-In Electric Vehicle Submetering Protocol and Electric Vehicle Supply Equipment Communication Protocols.* https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M496/K405/496405751.PDF

The following are noteworthy policy and program changes in 2023. Although they are not included in the EY2022 Evaluation Report time horizon, these changes may have influenced decision making around EVs and EV infrastructure during 2022.

- **California Green Building Code.** As of January 1, 2023, the California Green Building Code requires EV charging for publicly accessible parking lots. The requirements differ by the building type and the size of the parking lot, but can include EV-capable spots (with conduit and panel capacity), EV-ready spots (fully wired, with at least a receptacle), or EVSE spots (with a L2 EV charging station). For a residential building with 100 parking spaces, 10 spaces need to be EV-capable, 25 need to be EV-ready, and five need to have EVSE. For a nonresidential building, 17 spaces need to be EV-capable, with four of those having EVSE (13 are EV-capable and four are EVSE-equipped). The nonresidential section enumerates EVSE-equipped spots as a subset of EV-capable spots while the residential section enumerates each category separately.
- **ACF**. State officials held nine public meetings in 2022 for the ACF. CARB issued the Final Regulation Order for the ACF regulation in April 2023. This builds off of CARB's ACT regulation with additional requirements for certain fleets of trucks, vans, and bus that are well-suited for electrification. These requirements apply to all fleets, businesses, and public entities that own or direct the operation of MDHD vehicles in California to transition to ZEV fleets by 2045 where feasible, with specific requirements by fleet type:

  100% zero-emission drayage trucks, last mile delivery, and government fleets by 2035

  100% zero-emission refuse trucks and local bus by 2040

  100% zero-emission capable Utility fleets by 2040

The EY2021 Evaluation Report describes previously-enacted policies and programs, including:

- **California Electric Vehicle Infrastructure Project Charging Grants.** CARB provides grants for L2 and DCFC installations.
- **Low Carbon Fuel Standard (LCFS).** Through this standard, CARB provides funding for low carbon fuel providers, including EV charging refueling station owners.
- **ICT.** This regulation requires that 100% of new bus for public transit agencies be ZEV by 2029 and 100% of the fleets be ZEV by 2040.
- **Hybrid and Zero Emission Truck and Bus Voucher Incentive Project (HVIP).** CARB provides fleets vouchers to reduce the incremental cost of qualified electric, hybrid, or natural gas trucks and bus at the time of purchase.
- **Electric Vehicle Charging Station Financing Program**. Through this program, the California Pollution Control Financing Authority provides loans for the design, development, purchase, and installation of EV charging stations at small business locations in California.
- **Clean Vehicle Rebate Program.** CARB provides consumers with up to $7,500 to purchase or lease a new PHEV, BEV, or fuel cell EV.
- **ACT.** CARB issued the ACT regulation in March 2021. ACT requires manufacturers for Class 2b through Class 8 vehicles to sell zero-emission trucks as an increasing percentage of their annual

California sales from 2024 to 2035. Large companies and regulated fleets (50 or more trucks) have reporting requirements to ensure that fleets are purchasing zero-emission trucks and placing them into service where suitable. The ACT regulation specifies a gradual shift using calendar year purchase requirements (with a certain percentage of all new vehicle purchases that must be zero-emission), which differ by vehicle weight class.

3. Southern California Edison Programs

3.1. Charge Ready Transport Program

3.1.1. Overview

This overview provides a detailed description of the SCE CRT program, as well as summaries of the program implementation process; performance metrics, program materials, and budget summary; and a major milestone timeline. Following the overview, this section presents the EY2022 findings, highlights, and lessons learned.

Program Description

Per Decision 18-05-040, SCE's CRT program provides infrastructure for fleet electrification at a low or no cost to participants who procure or convert at least two medium- or heavy-duty (MDHD) EVs. Launched in May 2019, SCE designed CRT to accelerate the adoption of MDHD EVs by lowering the TCO for fleets, assist businesses in reducing emissions, offer an avenue for customers to take advantage of current incentives, and enable enjoyable experiences for drivers.[22] CRT has an approved budget of $342.6 million and a target to enroll and support a minimum of 870 sites with 8,490 EVs procured or converted to electric.[23]

CRT Program Target

Achieve a minimum of 870 sites with 8,490 MDHD EVs procured or converted.

Through the CRT program, SCE covers the cost of most or all of the distribution charging infrastructure needed up to the first point of connection with a participant's charging stations. Participants can choose Utility ownership or customer ownership of BTM infrastructure. If SCE owns both the Utility-side and customer-side of the meter infrastructure, then SCE pays to design, construct, own, and maintain all infrastructure up to the charging station. The participant will then pay to install, own, and maintain the charging station. If the participant decides to own the BTM infrastructure, then SCE will pay to design, construct, own, and maintain all TTM infrastructure and the participant will pay to design, construct, own, and maintain all BTM infrastructure and receive a rebate for up to 80% of what it would otherwise have cost SCE to perform the BTM work or the participant's actual installation costs, whichever is less. Additional charger rebates are available for transit and school bus deployments and for fleets located in DACs that are not operated by Fortune 1000 companies.

CRT Program Design Goal

Accelerate the adoption of MDHD EVs by lowering the TCO for fleets, assisting businesses in reducing emissions, offering an avenue for customers to take advantage of current incentives, and enabling enjoyable experiences for drivers.

22 Southern California Edison. Accessed April 2022. "Charge Ready Transport Program."

23 This amount does not include the budget for the evaluation.

To participate in CRT, fleets must meet specific criteria. The program requires participating customers to lease, purchase, or convert at least two MDHD EVs. MDHD EVs include various categories of eligible vehicle and transportation equipment types: medium-duty vehicles, heavy-duty vehicles, transit bus, school bus, forklifts, airport ground support equipment, port cargo trucks, and transport refrigeration units, among others. Program-eligible vehicles include commercial plug-in EVs approved by SCE for use in the outlined market sectors, as well as on-road vehicles with a gross vehicle weight rating exceeding 8,500 pounds (Class 2b through Class 8) and non-road vehicles. Additionally, fleets must own or lease the property, operate and maintain the infrastructure for 10 years, provide monthly data related to EV usage for five years, and use approved vendors for the electric vehicle supply equipment (EVSE), among other requirements. Pursuant to the SB 350 Decision, CRT's infrastructure budget should spend a minimum of 15% for transit agencies, a maximum of 10% for forklifts, a minimum of 25% for ports and warehouses in SCE's territory, and a minimum of 40% of the infrastructure should result in installations in DACs in SCE's territory.

SCE offers EV-specific TOU rates to support commercial EV fleet customers (TOU-EV-7, -8, and -9), which includes demand charge relief.[24] In D.22-08-001, SCE received approval for an extension of the demand charge holiday for TOU-EV 8 and TOU-EV 9. The specific charge paid by the customer includes a monthly fixed customer charge, an energy charge (per kWh), and a demand charge, calculated using the highest recorded demand during each monthly billing period.

SCE implemented several changes to improve the program in 2022. First, parallel processing of CRT applications is now permitted for customers who have select equipment that is still undergoing Nationally Recognized Testing Laboratory (NRTL) certification. This accelerates the review process and is more efficient than undergoing the NRTL certification and the CRT application process sequentially.

SCE has also started to require that chargers be installed as soon as infrastructure is installed and requires a one-to-one port-to-EV minimum, to ensure procurement of EVs and EVSEs. SCE has also started to consider the number of remote dispensers, in addition to power cabinets, when determining rebates. Other program changes are discussed in the *Program Materials Summary* section.

---

24 Southern California Edison. 2018. "Business Rate Basics: Rate Schedules TOU-EV-7, TOU-EV-8, TOU-EV-9 for Business Customers Charging Electric Vehicles." https://www.sce.com/sites/default/files/inline-files/TOU-EV-7_8_9_Rate_Fact_Sheet_WCAG.pdf

Implementation

Figure 6 shows the key steps in the CRT program implementation process.

Figure 6. SCE CRT Program Implementation Process

FUNDING REQUEST

1. *Customers submit program enrollment applications and EV acquisition plans to SCE*

RESERVE FUNDING

1. *SCE screens and prioritizes applications*
2. *SCE conducts a project site evaluation*
3. *SCE and customer develop conceptual infrastructure design*
4. *SCE conducts cost analysis to ensure that applications do not exceed cost thresholds*
5. *Parties sign program participation agreement*

PRE-CONSTRUCTION COMMITMENTS

1. *Customer provides proof of electric vehicle acquisition*
2. *Customer provides proof of charging equipment acquisition*
3. *SCE assigns rebate*

DESIGN & BUILD

1. *SCE or customer performs detailed site design work*
2. *Customer grants final easement*
3. *SCE or customer requests and secures permits*
4. *SCE or customer constructs infrastructure*
5. *Customer installs charging equipment*

ISSUE REBATES

1. *SCE verifies charging equipment installation*
2. *SCE reviews documentation and issue rebates*
3. *Customer completes program survey*

VERIFY COMPLIANCE

1. *Customer completes planned EV acquisition*
2. *Customer complies with five-year port-level data sharing commitment*
3. *Customer complies with 10-year operation of charging equipment*

Program Performance Metrics

The Evaluation Team reviewed the sites participating in SCE's CRT program and analyzed them by program status. Table 6 provides the count of sites in the CRT program by completion status as of December 31, 2022.[25]

Table 6. SCE CRT Program Complete Site Count by Status

Site Status	EY2021	EY2022
Utility Construction Complete	27	15
Activated	24	15
Operational	19	20
Closed Out	1	15

Note: For different site status categories site counts reported for EY2022 may include sites from EY2021. For example, a site activated in EY2022 could have been reported as construction completed in the EY2021 Evaluation Report.

In EY2022, SCE's CRT program received an additional 108 applications, signed contracts with 45 sites, and activated 15 sites that supported 456 vehicles across five market sectors. This raises the total number of applications received to date by SCE's CRT program to 211 and the total number of contracts executed to date to 108.[26] As shown in Table 7, 80% of sites activated in EY2022 (or 12 of 15) are located in a DAC and 69% of activated sites to date (or 27 of 39) are in a DAC.

Table 7. SCE CRT Program Activated Site Summary by Market Sector

Market Sector	EY2022 Number of Sites in DAC	EY2022 Number of Sites in Non-DAC	Program-to-Date Number of Sites in DAC	Program-to-Date Number of Sites in Non-DAC
Heavy-Duty Vehicles	-	1	4	1
Medium-Duty Vehicles	-	1	0	4
School Bus	9	1	16	7
Transit Bus	1	-	5	-
eTRU	2	-	2	-
Total	**12**	**3**	**27**	**12**

SCE's EY2022 CRT program had the highest participation rate from school bus fleets, which made up 67% of the year's activated sites. The next most common market sector is eTRU, accounting for 13% of activated sites. The transit bus, medium-duty vehicle, and heavy-duty vehicle market sectors each had only one activated site in EY2022.

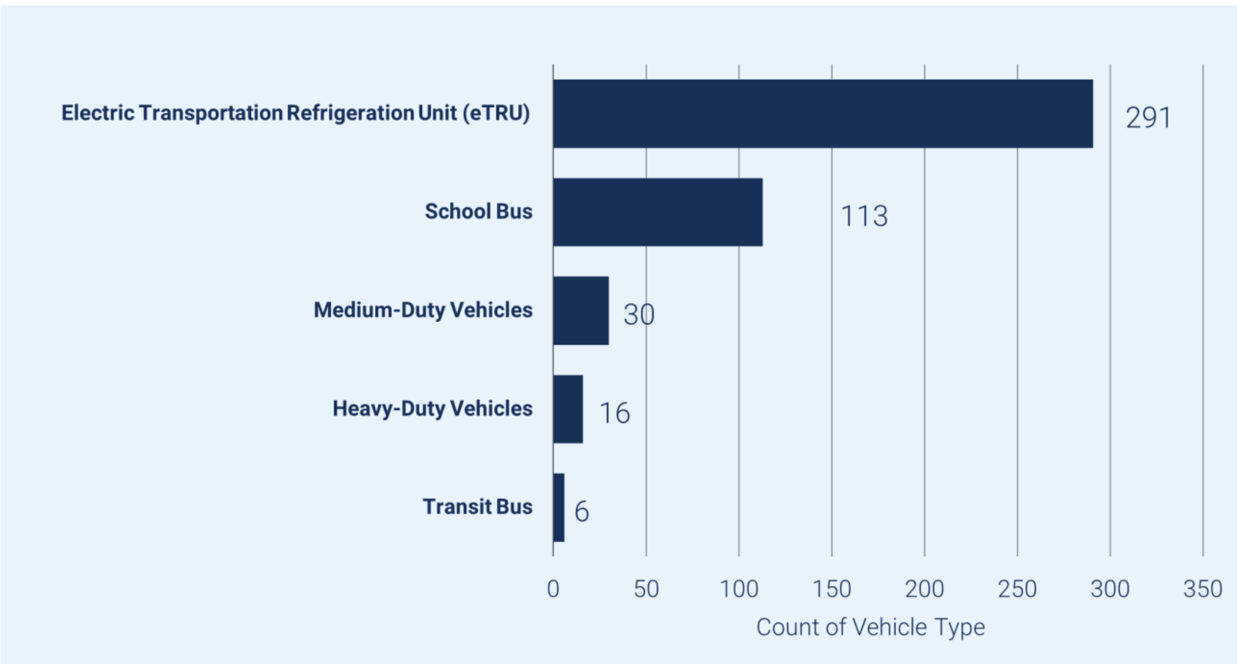
25 Note that these numbers are not additive and apply only for the evaluation year indicated; for example, in EY2022, 15 new sites in the SCE CRT program were activated (12 constructed in EY2022 and three from EY2021), 20 new sites became operational (12 constructed and activated in EY2022, three constructed in EY2021 and activated in EY2022, and five constructed and activated in EY2021), and 15 sites were financially closed out.

26 The application and contract totals do not include applications that were withdrawn, rejected, or put on hold.

To date in the CRT program, school bus fleets represent nearly 60% of all activated sites. Transit bus and heavy-duty vehicle sites are the next most common market sectors to date, each accounting for roughly 13% of all activated sites. The medium-duty vehicle and eTRU market sectors are the least represented in the CRT program, with only 10% and 5% of all activated sites, respectively.

As shown in Figure 7, through CRT, SCE installed charging infrastructure to support a planned 456 MDHD vehicles across five market sectors in EY2022 based on 10-year VAPs submitted by the customers at time of application. This brings the cumulative number of MDHD vehicles electrified in CRT to 747.[27] Despite only two activated sites, eTRUs comprise the largest market sector (291, or 64%) of MDHD vehicles electrified within the program, followed by school buses (113, or 25% of MDHD vehicles). The next most commonly electrified MDHD sectors are medium-duty vehicles (30, or 7%) and heavy-duty vehicles (16, or 4%). The transit bus market sector registers the lowest number of vehicles, with six, or 1% of MDHD vehicles electrified in the program.

Figure 7. SCE CRT Program Vehicles Supported by Market Sector, EY2022 Sites



The CPUC established six phases in the program timeline per the SB 350 reporting template. As presented in Table 8, as of December 31, 2022, most (54%) customer applications were either under review or undergoing design and permitting. The majority of the remaining applications were in the Site Assessment or Activation phase of the program, comprising 36% of all customer applications. Collectively, the applications in these four phases represent 87% of all vehicles in the CRT program to date.

27 The Evaluation Team calculated vehicle counts per customer applications' VAPs. Not all vehicles shown in the figure were delivered and operational as of December 31, 2022.

Table 8. SCE CRT Program Sites and Vehicles by Program Phase, as of December 31, 2022

Program Phase	Number of Sites	Total Number of EVs Supported [a]
Application Reviewal	58	1,200
Site Assessment	37	602
Contract Issuance [b]	13	292
Design and Permitting	56	1,114
Construction Complete	8	283
Activation [c]	39	747

[a] Vehicle counts were derived from customer applications' VAP. Totals include customer applications without the vehicle market sector(s) being specified.

[b] Contract issuance only includes projects with agreements out for signature.

[c] Sites in the Activation phase are those that have completed this sixth phase (39 sites to date). There are three additional sites in the Activation phase that are not yet complete and therefore have been excluded from this total and included in the count of sites for the fifth program phase.

By the end of 2022, the SCE CRT program had 39 activated sites to support the electrification of 747 MDHD vehicles per customers' VAPs. The 108 contracts signed in the CRT program meet 12% of the program's *per se reasonableness* goal of 870 sites and support 2,344 MDHD vehicles meeting 28% of the program's *per se reasonableness* goal of 8,490 additional vehicles electrified. The total of 211 customer applications could satisfy approximately 24% of the program's site goal and would support the roughly 4,200 MDHD vehicles, which could satisfy 50% of the program's electrified vehicles goal.

Table 9 displays the median durations per program phase (measured in calendar days). The column labeled EY2021 Sites refers to sites included in the 2021 Evaluation Report.[28] The column labeled EY2022 Sites refers to sites activated during Calendar Year 2022. Program-to-Date refers to all sites activated since the initiation of the program to December 31, 2022. Values in Table 9 are used as a representative indicator of project phase length trends over time. Note, sites in each column did not necessarily pass through each phase in the same calendar year. For example, some sites in the EY2022 Sites column may have passed through Design and Permitting in 2021 while others passed through in 2022. For this reason, the columns capture different moments in the Utility program's lifecycle and may not be directly comparable. Across all program phases, Contract Issuance has the shortest median duration, while Design and Permitting has the longest median duration.

Note that these median durations vary by market sector. For instance, for sites activated in EY2022 the median calendar days for Contract Issuance was 21 days; however, the heavy-duty vehicle applications took 141 days to pass through this program phase. Similarly, the transit bus applications spent significantly longer in the Application Reviewal and Activation phases compared to the overall median durations.

---

[28] https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/sb-350-te/sb-350-standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

Table 9. SCE CRT Program Median Calendar Days Per Phase

Program Phase	EY2021 Sites (Median Calendar Days)	EY2022 Sites (Median Calendar Days)	Program-to-Date Sites (Median Calendar Days)
Application Reviewal	59	90	71
Site Assessment	27	34	33
Contract Issuance	7	21	11
Design and Permitting	208	202	205
Construction Complete	109	155	133
Activation	52	28	50
Number of Activated Sites	**24**	**15**	**39**

Note: This table only includes data from activated sites.

The analysis of program phase durations is expanded upon in Figure 8, which displays the average number of calendar days per phase (denoted by X), as well as calendar day median (middle line inside of box), the 1st quartile (bottom of box), 3rd quartile (top of box), minimum (bottom tail), maximum (top tail), and outliers (dots). Based on the calendar day distributions, applicants experienced the highest degree of variation in completion time within the Design and Permitting phase, which requires external review and involves substantial back-and-forth with customers to finalize project layout and design. This was followed by Application Reviewal, which displayed high variation in the number of days to complete and requires significant communication with customers to solidify the project scope and ensure that applications met program requirements. Customer applications in the Site Assessment and Contract Issuance phases experienced the lowest mean and variance in calendar days among all the program phases.

Figure 8. SCE CRT Program Durations of Applications for EY2022 Sites, by CPUC Phase

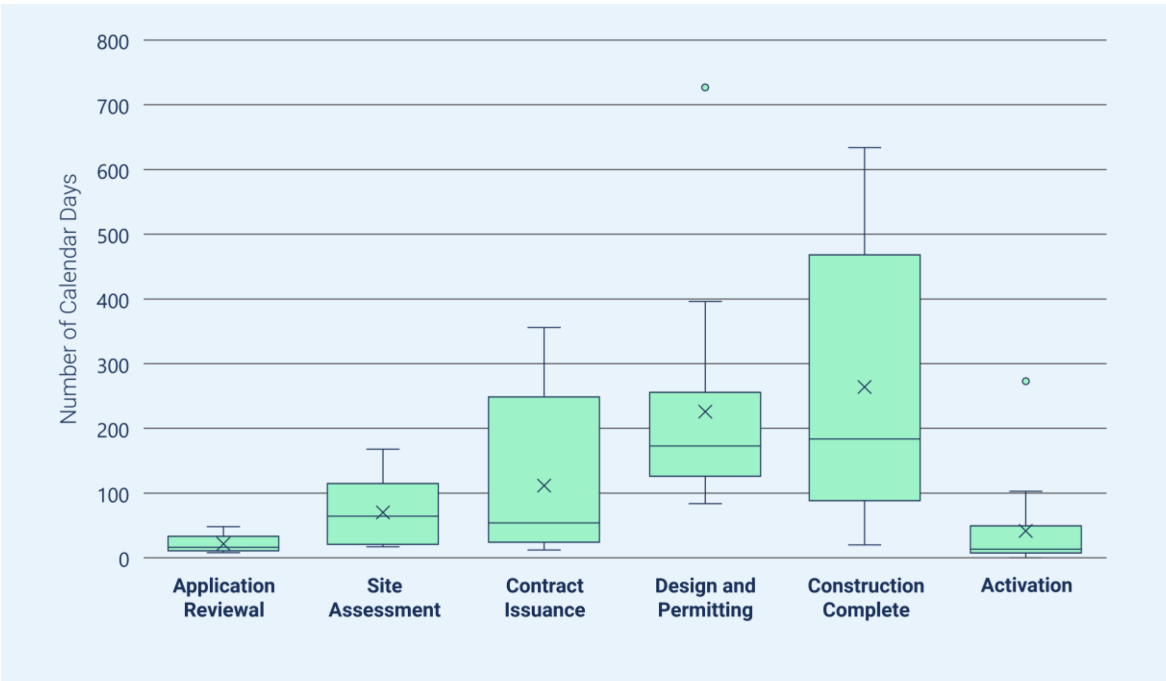


Table 10 displays the median quantity of calendar days that CRT program participants took from program start-to-finish (Application Reviewal to Activation) for 15 activated sites across five market sectors in EY2022, as well as the median for the program to date. The overall median start-to-finish timeline for site activation for these sites was 841 calendar days, up 172 days from the median in EY2021 (669 days).[29] As displayed in Table 10, median start-to-finish durations varied widely across market sectors from 603 calendar days or over 1,000 calendar days.

Table 10. SCE CRT Program Median Duration for Site Activation, by Market Sector

Market Sector	EY2022 Sites		Program-to-Date Sites	
	Median Start-to-Finish Activation (Calendar Days)	Number of Activated Sites	Median Start-to-Finish Activation (Calendar Days)	Number of Activated Sites
Heavy-Duty Vehicles	603	1	668	5
eTRU	728	2	728	2
School Bus	848	10	666	23
Transit Bus	973	1	769	5
Medium-Duty Vehicles	1,032	1	729	4
All Market Sectors	**841**	**15**	**722**	**39**

Program Materials Summary

This section highlights findings from the review of program material and ME&O activities conducted by SCE in EY2022. SCE expanded outreach, education, and support for CRT customers in three ways:

- **Expanding the Transportation Electrification Advisory Services (TEAS) program.** Through TEAS, SCE provides outreach, education, and information on grants, rebates, tax incentives, and details of how stackable incentives work. In addition, TEAS educational materials and programming includes fact sheets and webinars on EV topics.
- **Offering grant writing and grant package review assistance.** The TEAS program began providing grant writing assistance and grant package review support to help smaller and mid-sized fleets that are less familiar with grants to access funding for the purchase of electric MDHD vehicles (SCE also provides grant package review services for large and small fleet customers). Grant assistance has helped fleet owners understand the eligibility and compliance requirements for the various grant funding opportunities and allows them to avoid confusion down the road, such as those related to scrappage requirements. SCE's TEAS website advertises its grant writing webinars for fleets, a grant writing assistance program, and a grant package review assistance program.

[29] Median start-to-finish durations will not equal the sum of median calendar days per each phase due to gaps in the timeline between the completion of one phase and the start of another phase.

- **Introducing EV Readiness Studies**. SCE staff also began providing EV Readiness Studies in EY2022, which include one-on-one conversations with customers to assess customer readiness, along with a checklist of issues to cover including the electrification process, rates, and funding opportunities. These meetings include advice about site planning, looking at the site via Google Maps, identifying transformer locations, and potentially introducing customers to other items such as V2G technologies. SCE's TEAS site also advertises EV Readiness Studies for prospective fleets, including advertising support for developing a business case and an electrification plan.[30]

Figure 9 shows the TEAS fact sheet. SCE also made additional efforts to educate fleet customers on TOU rates and load management, pursuant to findings from the EY2021 Evaluation Report. For example, CRT staff developed and shared a YouTube video[31] on load management with CRT program participants via email, explaining the concept of TOU rates and encouraging participants to manage their charging to reduce their electric fuel costs and impact on the grid and the environment. The video discusses the monthly customer charge and TOU charge for TOU customers, as well as the planned phase-in of facilities-related demand charges. The video also discusses the reasoning for TOU pricing, the surge in demand beginning at 4 PM, and strategies for peak shaving (to reduce power consumption at high demand times). Peak shaving strategies include manually scheduling charging for off-peak periods and automated load management.

Figure 9. SCE CRT Program TEAS Fact Sheet

EDISON

TRANSPORTATION ELECTRIFICATION ADVISORY SERVICES

Planning services toward the acquisition and implementation of electric vehicle charging equipment.

Transportation Electrification (TE) Advisory Services supports business and property owners in preparing for the potential deployment of electric vehicle (EV) charging equipment at their commercial business locations or multi-family properties.

Our expert representatives are available to provide education, awareness, and support through our services, including custom EV Readiness Studies, grant writing assistance, webinars, and in-person events. With TE Advisory Services, property owners and businesses can now confidently implement the clean-energy technologies they desire to support the needs of their EV fleets, customers, and/or tenants.

Through comprehensive planning and professional deployment, those interested in adopting electric vehicle charging equipment and achieving their clean energy goals can do so with expert advice. TE Advisory Services are ideal for:

- Medium- and heavy-duty fleet owners (buses, trucks, shuttles, off-road vehicles, etc.)
- Multi-family properties (apartments, retirement communities, etc.)
- Small businesses
- Large businesses (located in Disadvantaged Communities)
- Commercial locations (hospitals, shopping centers, schools, etc.)

Requirements
To utilize TE Advisory Services, customers must have:
1. An active SCE customer account; and
2. A proposed project site within SCE's service territory

EV Readiness Studies

We develop site-specific EV Readiness Studies that help determine the feasibility of a proposed electrification project. We offer two types of EV Readiness Studies: Fleet & Site, available for medium- and heavy-duty vehicle (MDHD) fleet customers, and Site Only, available for multi-family properties and commercial business customers.

Grant Assistance

There are many funding opportunities for zero-emission vehicles that vary in both form and complexity, especially in California. We currently offer grant writing webinars where customers can engage directly with our experts, receive help toward writing more effective grant applications, and learn about EV funding opportunities.

Beginning in 2022, TE Advisory Services will be available to assist qualified customers secure grants through grant writing assistance and grant package review.

Educational Webinars & Workshops

TE Advisory Services will host quarterly, one-hour webinars on various technical topics for all commercial and multi-family dwelling stakeholders. Our customized webinars examine the unique needs, concerns, and challenges organizations face when considering transportation electrification.

In-Person Events

Beginning in 2022, our team will host events throughout SCE's service area to give customers an opportunity to ask questions, meet with electrification experts, and test new technology.

Learn More
For additional information, please visit sce.com/TEAS.

SCE shared an email message with a link to the aforementioned video with 34 participants whom had reached construction complete in 2022. SCE will continue to share this important message of TOU benefits as sites are completed in addition to sending out a bi-annual reminder with the video link.

Budget Summary

As shown in Figure 10, from program inception in 2019 through December 31, 2022, SCE spent $22.0 million of $342.6 million (constant dollars) of the approved CRT program budget. In EY2022, program spending was $10.3 million. Figure 10 does not include spending on sites that were not fully

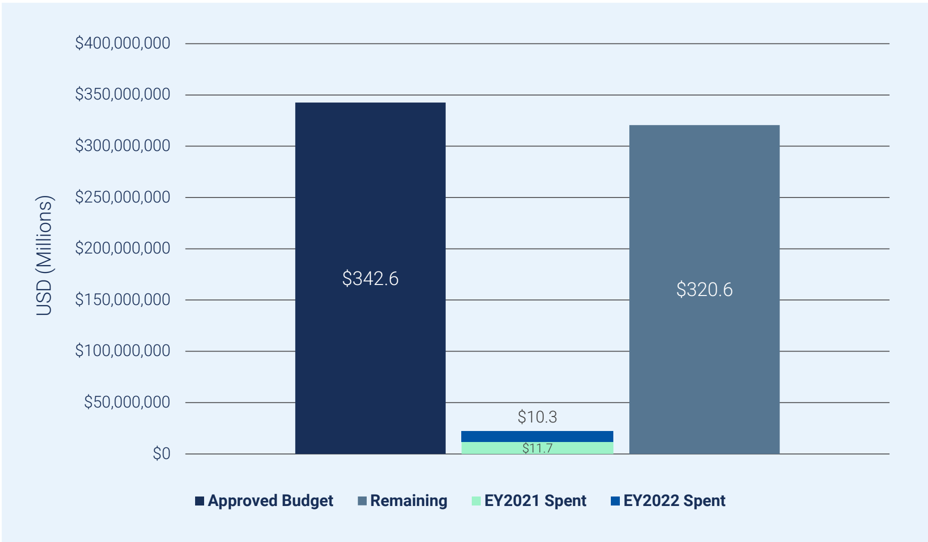
---

30 Southern California Edison. Last updated 2023. "TE Advisory Services Webinars." https://cloud.sce.com/teas#ed-webinars

31 Southern California Edison. February 14, 2023. "Energy Management: Charge Ready Rate Training." https://www.youtube.com/watch?v=r2dD7P6PtGg

closed out as of December 31, 2022. Fifty-eight percent[32] of SCE CRT program spending on infrastructure for financially closed out sites to date has been on DAC sites, exceeding the 40% program target.

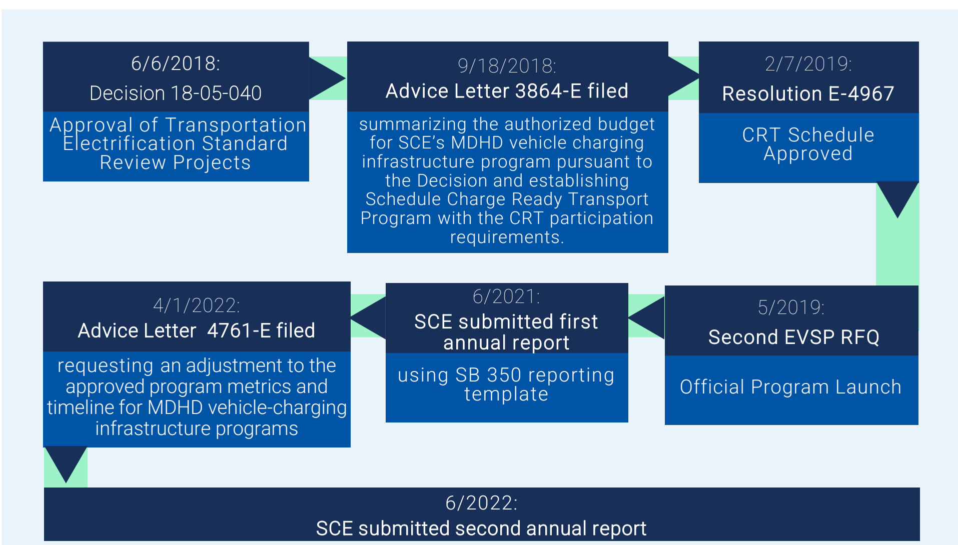
Figure 10. SCE CRT Program Budget Summary as of December 31, 2022



Timeline

Since the beginning of the program SCE has filed two advice letters. In 2022, SCE filed Advice Letter 4761 jointly with PG&E, requesting to adjust the program metrics and timeline. Figure 11 shows all major milestones since the beginning of the program.

Figure 11. SCE CRT Program Key Charge Ready Transport Milestones



---

32 Calculated by summing utility TTM and BTM costs (for sites with customer constructed BTM, rebate for customer side infrastructure is used).

3.1.2. Findings

The following sections provide findings from the Utility staff and vendor interviews, as well as from surveys and site visits. In addition, the Evaluation Team provide insights from the co-benefits and co-cost analysis, as well as the deep dive analysis, TCO, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health, and net impacts.

Table 11 summarizes key impact parameters for EY2022 Sites as well as for the program to date. Annual estimates of impacts are provided for metrics calculated as part of the impact evaluation. Additionally, the table provides estimates of impacts across all sites included in the program population through the end of 2022.[33]

Table 11. SCE CRT Program Impacts Summary

Impact Parameter	EY2021 Sites[a]	EY2022 Sites[a]	EY2022 Sites Percentage in DAC	Program-to-Date Sites Actuals	Program-to-Date Sites Actuals Percentage in DAC
Population of Activated Sites (#)	24	15	80%	39	69%
Sites Included in Analysis (#)	16	15	80%	39	69%
Ports Installed in Analyzed Sites (#)	63	432	87%	590	81%
EVs Supported (#) [b]	184	456	88%	747	75%
Electric Energy Consumption (MWh)	1,029	2,432	43%	4,113	63%
Petroleum Displacement (DGE)	99,699	208,972	47%	396,073	66%
GHG Emission Reduction (MT GHG) [c]	723	1,739	47%	2,985	66%
NO_x Reduction (kg)	278	2,114	78%	1,347	81%
PM_{10} Reduction (kg)	1.32	16.0	74%	9.7	73%
$PM_{2.5}$ Reduction (kg)	1.25	14.9	74%	9.1	73%
ROG Reduction (kg)	14.2	656	98%	372	97%
CO Reduction (kg)	7,055	36,191	96%	35,610	96%

[a] Energy consumption, petroleum displacement, emission reductions, and health benefits are based on annualized data. Program-to-date results in the table are based on actual data (see the *Methodology* section for more details).
[b] The team derived the EVs supported value from applicants' VAPs. This value represents the maximum number of vehicles expected to be supported by the charging infrastructure.
[c] GHGs include CO_2, CH_4, and N_2O multiplied by their respective GWP as defined by IPCC AR5 (see the *Methodology* section for more details).

Utility Staff Insights

The Evaluation Team interviewed SCE CRT program staff in October 2022 to discuss program challenges and successes. Program staff identified several program challenges:

- **Costs.** In terms of fleet electrification costs, the cost of EV procurement is significant and likely one of the largest factors in a customer's decision to electrify their fleet, as opposed to the

33 For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

charging infrastructure. MDHD EVs continue to have higher upfront retail costs than comparable diesel, gasoline, and natural gas trucks, which continues to pose a barrier to customers without substantial capital to be able to demonstrate the necessary vehicle commitment required to participate in CRT. Civil engineering work is expensive, and switchgear costs have continued to increase since last year.

- **Supply chain delays.** SCE staff continued to experience delays due to supply chain issues (such as long lead times for switchgear), an issue that was also mentioned by the EVSPs (see the *Vendor Interviews* section for details).
- **Limited vehicle options.** Suitable EVs are not yet available for all market sectors.
- **Limiting program design requirements.** Smaller fleets, which represent more of the SCE customer base, often do not meet the CRT program requirements of owning or leasing their sites and meeting vehicle requirements per site. At the time of the interview, SCE staff indicated that although the program was on track to meet its goal of 8,490 vehicles, it may have challenges meeting its goal of 870 sites, which staff attributed in part to the tradeoff between meeting vehicle goals with larger sites that have lower per-vehicle cost and meeting site goals with a larger number of smaller sites that have higher per-vehicle costs and strain the program budget. To address this challenge, SCE submitted Advice Letter 4761, asking for a range for site goals as a design adjustment that would allow them to better meet the overall program targets.

Staff noted that Rule 29, which offers customers an alternative to CRT by paying for the extension of electric service lines to the meter, and went into effect in April 2022,[34] could result in reduced participation in CRT. This is because a single site cannot be part of both the Rule 29 process and CRT at the same time. However, SCE program staff reported that they have not noticed a change in CRT participation since Rule 29.

SCE staff also report notable successes in EY2022:

- **Expanded vehicles included.** Staff reported that the participation of new market sectors in EY2022 contributed to program growth and a diversified customer base.
- **Flexibility and Adaptability.** In EY2022, SCE staff received more applications for drayage vehicles and warehouse sites with delivery vehicles (or eTRU). As a result, SCE staff had to quickly learn about and adapt their processes to serve new vehicle vocations and higher-powered equipment, such as large power cabinets with remote dispensers.
- **Program design enhancements**. SCE staff implemented several changes to improve the program in EY2022, including process improvements to speed up the application process and to require that chargers be installed as soon as infrastructure is installed and requiring a one-to-one port-to-EV minimum.

---

34 SCE. Accessed May 2022. “Electric Vehicle (EV) Infrastructure Rule 29.” https://www.sce.com/sites/2022-07/EV%20Rule%2029%20Fact%20Sheet%200622_WCAG%20(V2).pdf

- **Expanded Outreach.** As noted in the *Program Materials Summary* section, SCE staff took additional efforts to educate fleet customers on TOU rates and load management. Staff also expanded the TEAS outreach, education, and support for CRT customers including introducing EV readiness studies and grant writing assistance to help small- and mid-sized fleets that are less familiar with grants to access vehicle grant funding. As a result of these expanded TEAS services, SCE staff began communicating with customers via text and other channels, which increased outreach effectiveness, and they began offering advisory services in other languages. These communications introduce potential customers to grants, rebates, tax incentives, and stackable incentive opportunities. Text and email campaigns help SCE to communicate more effectively with customers when funding streams become available. SCE has also seen benefits from TEAS services, including educating customers so they can be proactive and showing customers fueling cost estimates, so they understand the implication of their decision. Staff reported that TEAS also speeds up the application timeline, as customers will have already received a TEAS consultation and report prior to applying. The SCE TEAS team is considering having more one-on-one meetings throughout the process, as well as providing additional webinars and fact sheets and offering a fueling cost calculator. They already calculate the LCFS credit value for customers and have provided webinars on the topic of LCFS credit monetization. They consult with participants after project implementation to ensure compliance and optimize their investment through education on topics like route optimization and load management.

Highlights

- Participation from new market sectors is expanding and diversifying the participating customer base.
- As site construction continued in EY2022, site costs and supply chain delays continued to be a challenge.
- Some customer markets may be limited by current vehicle selection and program design requirements, such as the two-vehicle minimum.
- Flexibility and adaptability in staff and processes paired with expanded outreach through TEAS and program design enhancements reduced process timelines, supported project scope and budget, and led to additional customer outreach, education, and support.

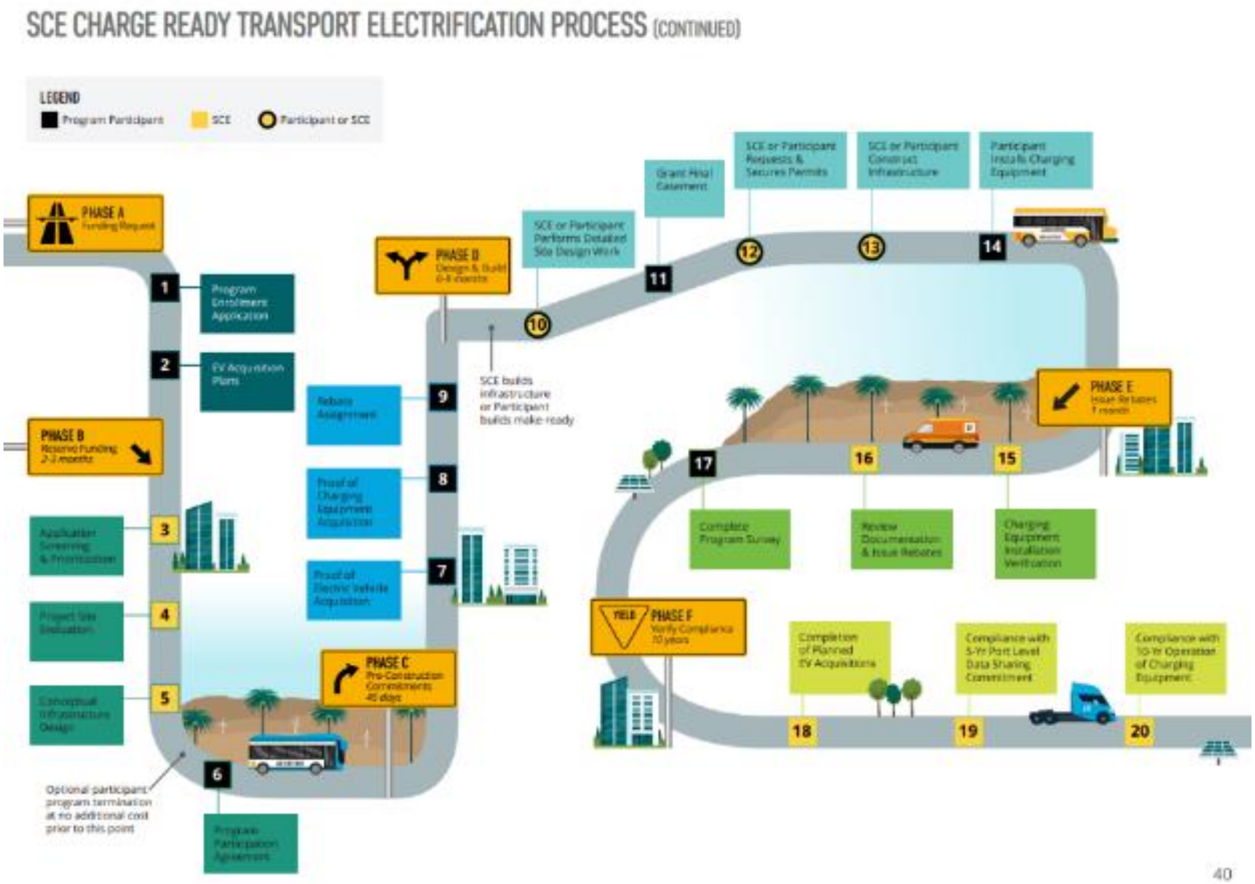
Vendor Interviews

The Evaluation Team interviewed representatives from four charging providers, known as EV service providers (EVSPs), to explore their program experience including Utility engagement; project installation; perceived insights from fleet owners, site hosts, and drivers; data collection and load management; barriers to electrification; overall market outlook; and suggestions for program improvement. Many of these findings are similar or identical to those reported for the PG&E program (Chapter 3) and the SDG&E program (Chapter 4), as EVSPs tended to offer observations on the Utility programs as a whole, rarely mentioning specific programs for praise or criticism.

Utility Engagement

Generally, the four interviewed EVSPs were strongly complimentary toward and supportive of Utility engagement through the CRT program. For example, one EVSP highlighted SCE's flow chart (Figure 12) as a useful tool for explaining the program clearly so the site host knows what to expect. In addition, three EVSPs reported that SCE staff involvement in the make-ready infrastructure process was a very important element in accelerating EVSE deployment. However, two of the four representatives said the Utilities (SCE, PG&E, and SDG&E) would benefit from additional staffing to expedite the analysis and accommodate the increased load attributable to EVSE.

Figure 12. SCE CRT Program Diagram from SCE Fleet Electrification Guidebook



Source: Southern California Edison. n.d. "TAKE CHARGE: A Guidebook to Fleet Electrification and Infrastructure." https://www.sce.com/sites/default/files/2020-07/Electrification%20%26%20Infrastructure%20Guidebook-Final_06.29.20.pdf

Installation

EVSP representatives provided insights regarding installation challenges, interoperability, and installation cost differences:

- ***Installation challenges***. The EVSPs reported several challenges with EVSE installation: (1) long lead times for vehicle and equipment availability, (2) labor shortages among installation contractors, and (3) long timelines for permitting approval at the city or state levels. For example, one EVSP noted that the Service Level Agreements with Utilities can require product delivery within 21 days, which can be difficult under current market conditions; however, the EVSP did not specify which Utilities had such challenging and inflexible Service Level Agreements. Three EVSPs also noted that permitting had previously been a problem (not simply with the CRT program but with EVSE installation generally) but indicated that these challenges had largely been resolved (and attributed the remaining permitting challenges to staff shortages at the permitting entities). However, one EVSP reported that local permitting remained a barrier, with previously expected timelines of 12 months becoming 18 months. One EVSP also noted that EVSE installation at schools could be delayed by the need to secure approval from the Division of the State Architect.

EVSPs identified additional challenges such as inconsistent processes for setting up right-of-way agreements for Utility-owned infrastructure across the three different Utilities (n=1), lack of readily available grid capacity information (n=1), and inconsistent responses from Utility staff about the eligibility of V2G-capable chargers for rebates and installation incentives (n=1).

- ***Interoperability.*** When asked about interoperability as a challenge, three EVSPs reported that interoperability issues between EVSE and specific vehicles were sporadic and rapidly rectified, generally through over-the-air software updates. As opposed to on-site software updates requiring a service call by a technician or engineer, over-the-air updates can be implemented remotely and therefore quickly.

  Additionally, one EVSP noted that more significant effort is now required to correct interoperability issues: while they have engineers working to better integrate their software with the vehicle software, a "plug and play" solution is about one year away.
- ***Installation costs.*** All four EVSPs reported that cost differences in the installation of comparable EVSE at different sites arise primarily from the status of the existing infrastructure on the site, such as the available load on the transformer, capacity of the distribution panel, need for facility upgrades, need for trenching, type of surface material, and distance from the meter to the EVSE. In addition, the EVSPs noted other factors including the quality of product installed (which materials and components are used), the quality and availability of software, and the desired EVSE functionality.

Fleet Owner, Site Host, and Driver Perspectives

All four EVSPs noted that there was extensive interest from customers in electrifying their fleets and good alignment between what Utilities can provide and what customers need.

EVSPs noted several key aspects of CRT for customers:

- ***Capital funding.*** All four EVSPs reported that program incentives for both the infrastructure and the vehicles is extremely important for accelerating customer EV adoption. In addition, the EVSPs agreed that there is sufficient demand from fleet owners to warrant expanding the CRT program with additional technical assistance and incentive funds. Furthermore, all four EVSPs indicated that the current Utility incentive levels per site are adequate, although one noted that there could be benefits in helping customers (especially schools) to identify and access grant funding opportunities.

- ***Site analysis*.** One EVSP described SCE's fleet team as providing a very rigorous analysis for potential fleet customers, including site assessment and vehicle options.
- ***Identified products.*** One EVSP noted that the qualified products list supports fleet owners by removing some of the guesswork involved in fleet electrification.[35]

From the EVSP perspective, challenges for fleet owners include the rapid pace of changes in the MDHD EV industry. For example, a customer's needs may have changed since they developed their VAP or recommendations from the feasibility study may have lost some relevance by the time the fleet is ready to implement the plan. EVSPs expressed a desire for Utilities to offer greater flexibility to program participants in modifying their EVSE and vehicle plans, especially for schools.

EVSPs reported mixed perceptions from fleet drivers regarding EVs. One EVSP attributed uncertainty regarding EVs to a lack of knowledge about the vehicles, citing that some drivers worried about plugging in a vehicle to charge while it was raining, fearing the risk of electrocution.

Data Collection

The four EVSPs were generally supportive of the data collection required for CRT. However, one EVSP said the data collection process carries a cost, and that individual EVSPs can be at a disadvantage if they invest in providing a large volume of high-quality data while some of their competitors provide lower-quality data. This EVSP recommended clear standards and requirements for the quality of data collection. SCE has provided directions and requirements for EVSP data reporting. The degree of EVSP compliance to these requirements should be considered in future funding decisions.

Load Management

Load management capabilities can reduce EVSE installation costs by avoiding the need for infrastructure upgrades, and they can reduce operational costs by reducing demand charges. However, one EVSP noted that uptake of the load management capabilities could be constrained by a fleet's operational needs. For example, some fleets require charging during peak hours, and not all loads can be shifted. One EVSP noted that they did not yet have fully operational load management capabilities but was in the process of developing such features. Three EVSPs reported that the use of load management often requires customized support that factors in each customer's unique operations and charging needs. One EVSP also noted some difficulty in calibrating load management systems to particularly complicated Utility tariffs, especially when it was not clear which tariff would apply to a vehicle (such as when a vehicle can charge at multiple locations).

Barriers to Electrification

The most common barrier to fleet electrification reported by EVSPs was component supply, specifically transformers and switchgear. One EVSP noted that custom switchgear can have a 48-month timeline to

---

[35] The CRT program Approved Product List is available at https://www.sce.com/APL.

delivery, but also recognized that Utilities had been receptive to recommendations from the EVSP on addressing supply chain issues.

Market Outlook

Forthcoming technological advances that could accelerate fleet electrification include plug-and-charge capability, V2G or bidirectional charging, wireless charging, and billing management through the vehicle's system. Additionally, two EVSPs noted that extensive grid communication strategies are in development, which one of these EVSPs plans to integrate with home energy management technologies.

All four EVSPs noted that the Utilities in general were good partners in deploying infrastructure, emphasizing that Utility engagement was vital and that the sector is not yet mature enough for a self-sustaining market if Utilities were to disengage. Compared to the light-duty market, the EVSP reflected that the MDHD market is at a much earlier stage of development. For example, one EVSP suggested that the transition in this market sector may take another decade. This same EVSP noted that, while early adopters may have the financial means to make the shift today, there will be broader demand in five years, and those customers may also need Utility support. One EVSP said, "These are really great programs for everybody involved. They help the capital cost burden for early adopters. This is something that Utilities should continue to support going forward."

Suggestions for Improvement

The EVSPs had some suggestions for improving the CRT program:

- Revise the timeline in the Service Level Agreements to reflect market realities and longer lead times for equipment
- Communicate major program changes more promptly to key partners such as EVSPs
- Shorten the load analysis timelines

Highlights

- EVSPs agree that the CRT program is beneficial and well-implemented but said SCE could benefit from additional staffing to expedite the analysis and accommodate the increased load attributable to EVSE.
- Interoperability issues are relatively minor and are resolved quickly, generally through over-the-air software updates.
- Supply chain constraints continue to be a concern and impact installation timelines, particularly for custom switchgear.
- Utilities are good partners in deploying infrastructure and EVSPs emphasized the need for Utilities to stay involved, as the sector is not yet mature enough for a self-sustaining market.

Survey Results

The Evaluation Team surveyed four fleet managers[36] who participated in CRT about their motivations for and barriers to electrification, program satisfaction and awareness, experience with EVs and charging infrastructure, the impact of the program on fleet electrification, and their perspective on the industry. Of these four fleet managers, three were from the school bus sector and one was from the medium-duty sector (Table 12).

In addition, the subsections below provide insights from two fleet managers who withdrew from the program (known as withdrawn fleet managers).

Table 12. SCE CRT Program Fleet Manager Survey Sample, EY2022

Survey Type	Sector	Number of Surveys Sent	Number of Partial Surveys	Number of Completed Surveys
Participating Fleet Managers	Airport GSE	0	0	0
	Medium-Duty	4	0	1
	Forklift	1[a]	0	0
	Port Cargo Trucks	1	0	0
	School Bus	8	0	3
	Transit Bus	0	0	0
Total Fleet Manager Participants	**-**	**14**	**0**	**4**
Withdrawn Fleet Managers	-	34	0	2

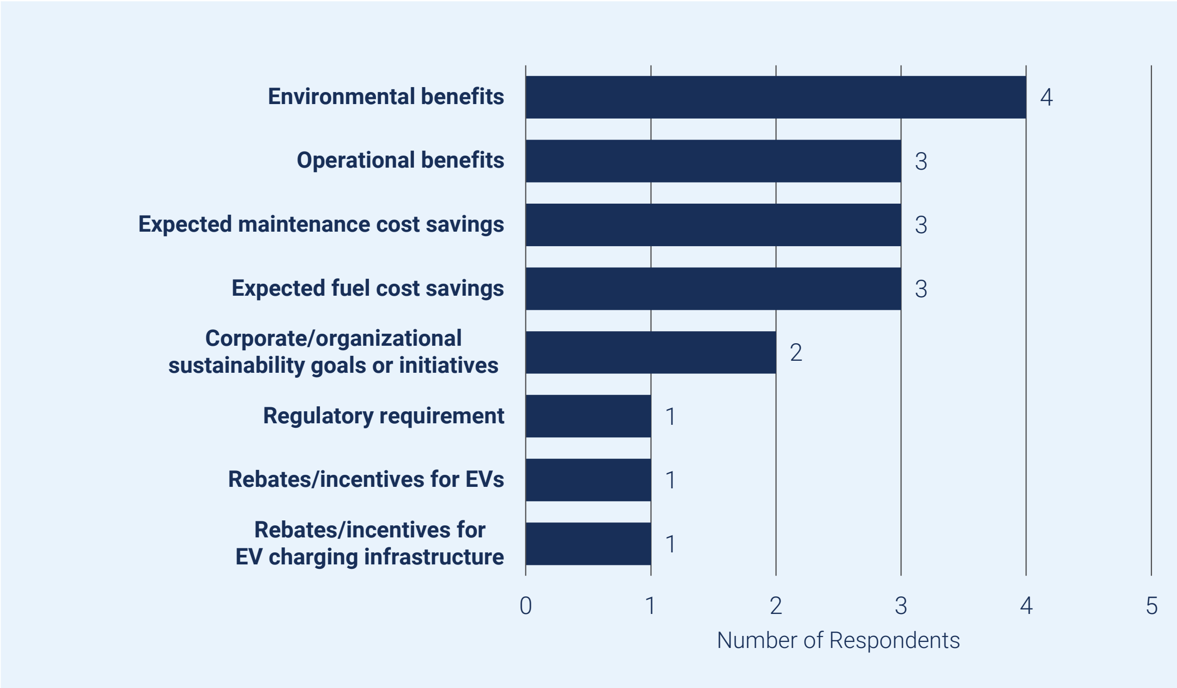
[a] forklift site was constructed in EY2022, but chargers were not installed by December 31, 2022. The team included this site in the fleet manager survey.

Electrification Motivators and Barriers

The Evaluation Team asked SCE fleet managers about their motivations for transitioning to EVs. As shown in Figure 13, all four fleet managers mentioned environmental benefits, while three each mentioned operational benefits, expected maintenance cost savings, and expected fuel cost savings.

36 In some cases, the number of responses to a question is greater or less than four. This is due to the inclusion of partial participants (those who answered some questions but did not complete the survey) and cases where not all respondents answered a question. Despite the Evaluation Team's efforts to improve the response rate through multiple rounds of outreach and increased survey incentives, the fleet manager survey did not reach the target response number, which limits the insights that can be gleaned from a smaller sample size.

Figure 13. SCE CRT Program Participant Motivators for Transitioning to EVs in EY2022

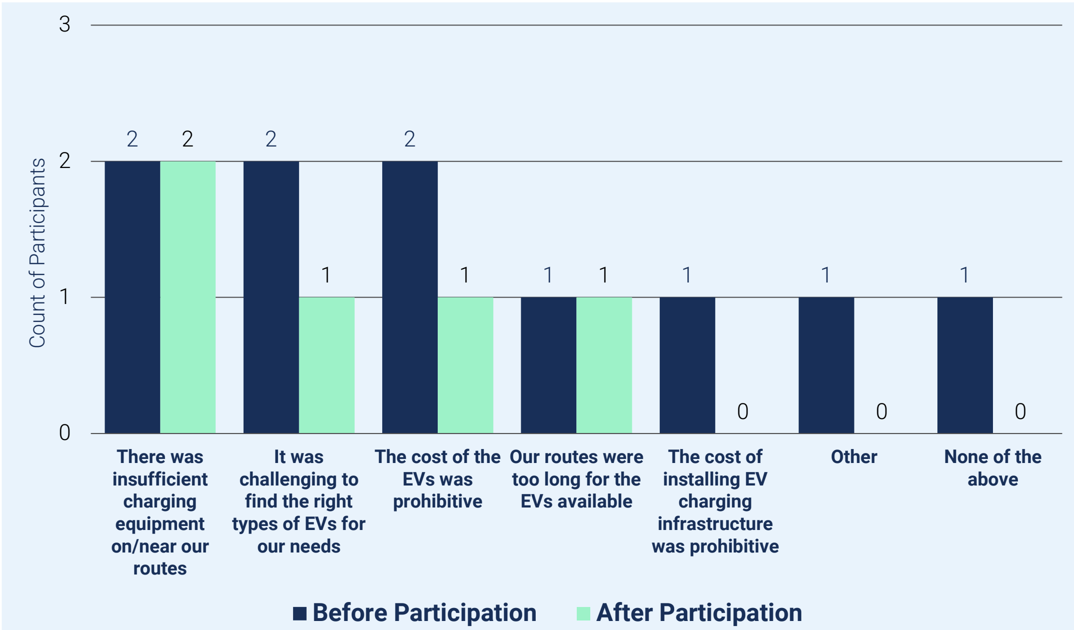


Source: Fleet Manager Survey Question C1. "Why did your fleet decide to transition to EVs? Select all that apply." (n=4; multiple responses allowed)

The Evaluation Team asked fleet managers which barriers to electrification their fleets faced before participation in the CRT program and what barriers remained after participation. As shown in Figure 14, two participating fleet managers each said the top barriers prior to electrification were insufficient charging equipment on or near routes, challenges with finding the right EVs to meet fleet needs, and the cost of EVs.

After participating in the program, the largest remaining barriers reported by participating fleet managers were insufficient charging equipment on or near routes (two respondents), difficulty finding the right EVs to meet fleet needs (one respondent), the cost of EVs (one respondent), and routes being too long for the EVs available (one respondent). These managers indicated that all other barriers were primarily addressed as part of program participation.

Figure 14. SCE CRT Program Barriers to Electrification before and after Program Participation in EY2022



Source: Fleet Manager Survey Questions F3 and F4. "Which of the following barriers to electrification did your fleet face before participating in the Charge Ready Transport program?" (n=4; multiple responses allowed) and "You mentioned that the following were barriers to electrification before participating in the Charge Ready Transport program. Do any of these barriers still exist after you participated in the program?" (n=4; multiple responses allowed)

Program Satisfaction

When asked to rank the likelihood of recommending the CRT program on a scale of 0 to 10, with 10 being the most likely to recommend, three of four fleet managers selected a 10, indicating that they would be extremely likely to recommend the program or had already recommended it. One fleet manager selected a 9. Together, these ratings led to a net promoter score of +100.[37]

Similarly, all four fleet managers rated themselves as *very satisfied* with the program overall. Fleet managers were pleased with their experience working with SCE staff, the benefits received, construction and installation process, and the application process. As shown in Figure 15, three of the four fleet managers rated themselves as *somewhat satisfied* with the meter infrastructure installation rebate amount, the charging equipment rebate amount, and the rebate process. When asked about aspects of the program they were particularly satisfied with, fleet managers in the school bus sector provided the following comments:

- "Communication was very good and transparent throughout the entire process."

---

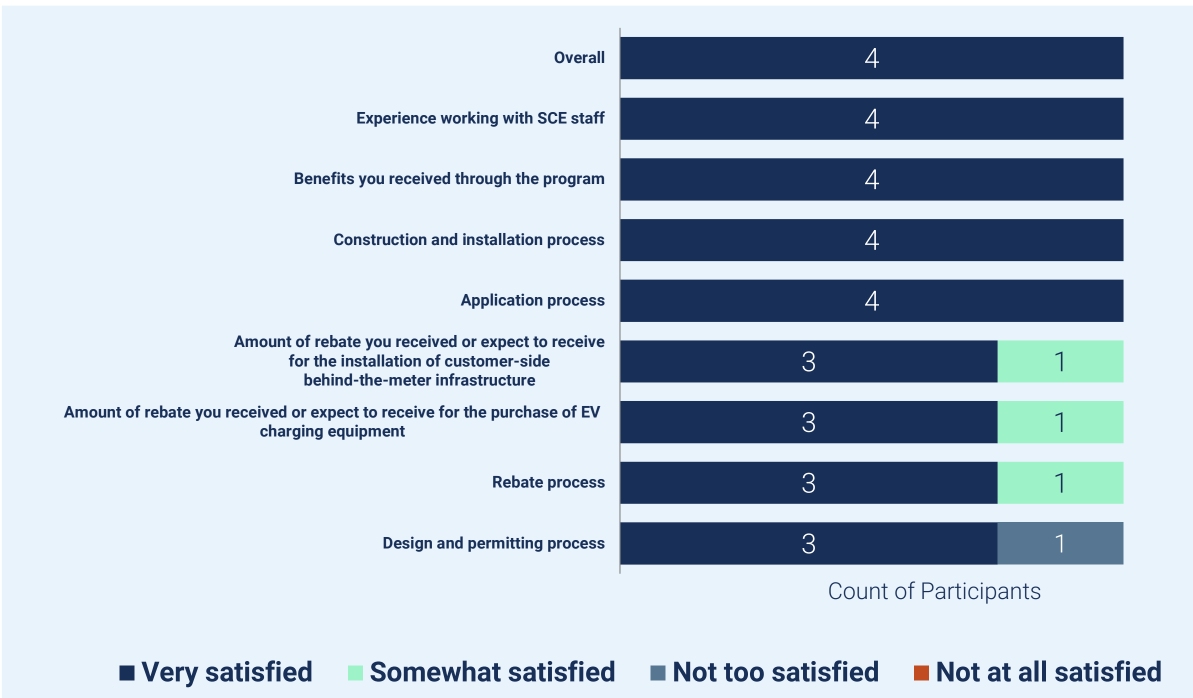
[37] The net promoter score is calculated by subtracting program detractors (those who rated their likelihood to recommend the program to others as a 0 through 6) from the program promoters (those who rated their likelihood to recommend the program as a 9 or 10). Those who give a rating of 7 or 8 are labeled as passives and do not impact the score.

- “Communication throughout the process and follow up has been outstanding.”
- “The whole process was great. “

The medium-duty fleet manager said, “the scope of the program is good and saved us a significant amount of money.”

The team asked fleet managers to provide comments about aspects of the program where they were particularly dissatisfied. One school bus fleet manager said, “the length of time it took from start to finish [was long].” The medium-duty fleet manager said, “the permitting and planning side of things takes a very long time.” The two remaining fleet managers said they did not have any dissatisfactions.

Figure 15. SCE CRT Program Satisfaction with SCE Program and Elements in EY2022



Source: Fleet Manager Survey Question B1. “Thinking about your experience with the Charge Ready Transport program, how satisfied are you with the following?” (n=4)
Note: No respondents provided a rating of *not at all satisfied* for any element.

When asked, fleet managers shared what they would have done differently if going through the program again. Two fleet managers would have started sooner, with one further explaining that they “would have been completed [the infrastructure] before receiving the [EVs].” Another fleet manager would have chosen a different piece of charging equipment.

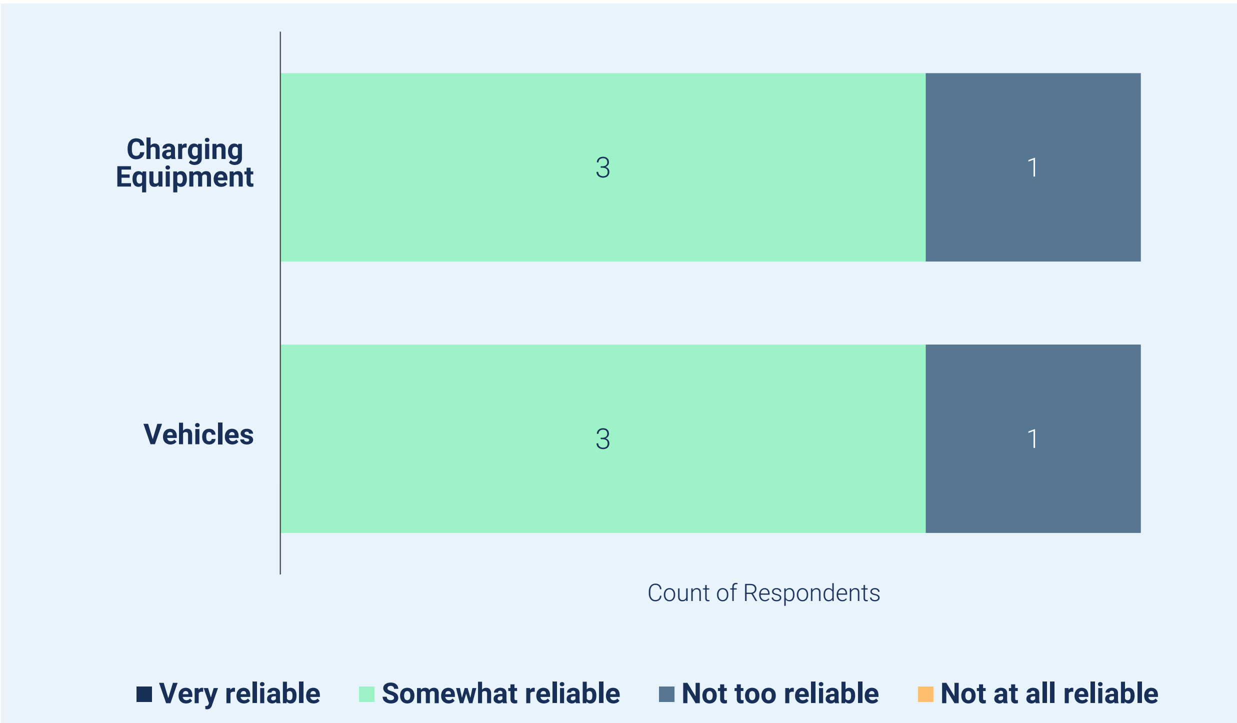
Program Awareness

The Evaluation Team asked fleet managers how they learned about the CRT program. Three of four fleet managers learned about the program from SCE, while one learned about it from an EV manufacturer or EV service equipment manufacturer. Prior to joining the program, three of the four fleet managers did not know that they needed to upgrade the electrical infrastructure from the Utility grid to their meter to charge EVs at their site, while the remaining manager understood what was needed.

Experience with EVs and Charging Infrastructure

When asked to rate the reliability and ease of using EVs and EV charging equipment, most fleet managers reported finding both technologies somewhat reliable and easy to use. As shown in Figure 16, three fleet managers each found the EV charging equipment and vehicles *somewhat reliable*, with one rating each as *not too reliable*.

Figure 16. SCE CRT Program Reliability of Vehicles and Charging Equipment in EY2022



Source: Fleet Manager Survey Questions C3 and C4. "How would you rate the reliability of the electric vehicles that are part of your fleet?" and "How would you rate the reliability of the electric vehicle charging equipment?" (n=4)

Note: No respondents provided a rating of *very reliable* or *not at all reliable* for either element.

Additionally, three of four fleet managers rated the charging equipment as *very easy to use*, with only one rated it as *somewhat easy to use*.

Impact of Program on Fleet Electrification

When asked if they plan to accelerate the procurement of EVs and EV-related equipment because of their experience with the program, all four fleet managers said their rate of procurement would remain unchanged. However, three fleet managers said they have electrification plans for a combined 40 school buses within the next 10 years, and the fourth manager said they will acquire an additional 10 medium-duty vehicles. When asked if there are other types of vehicles or equipment included in their organization's electrification plans within the next 10 years, one fleet manager mentioned "white fleet

EVs" such as sedans and vans. Another fleet manager mentioned "maintenance white fleet pick-up trucks with service bodies" such as a bobtail truck.

As a result of their experience with the CRT program and the infrastructure built through the program, two of four fleet managers said their company changed the number of EVs that were acquired or that they planned to acquire. One of these fleet managers acquired two bus and plans to acquire two more, while the other fleet manager was able to add extra infrastructure to their yard.

Industry Perspective

The Evaluation Team asked fleet managers how well their industry or sector is positioned for electrification (three school bus respondents and one medium-duty respondent). As shown in Table 13, the three fleet managers in the school bus sector each had a different perspective of their industry:

- One fleet manager selected *somewhat well-positioned* and said, "we have the necessary means to be able to expand in some areas."
- One fleet manager with a neutral outlook said, "we need a larger parking lot to accommodate more infrastructure and the Utilities may not be able to withstand the amount of vehicles we may need to procure over the years."
- One fleet manager selected *not too well-positioned* and said, "EV bus need greater range."

The medium-duty fleet manager reported their sector as *somewhat well-positioned,* stating, "final mile delivery is well-positioned to electrify from a technological point of view. However, the prevailing ownership model of commercial trucks (contractor model) makes it extremely difficult."

Table 13. SCE CRT Program Industry Positioning for Electrification among Program Participants in EY2022

Market Sector	Extremely Well-Positioned	Somewhat Well-Positioned	Neutral	Not Too Well-Positioned	Not at All Well-Positioned
School Bus	-	1	1	1	-
Medium-Duty	-	1	-	-	-

Source: Fleet Manager Survey Question F1. "How well-positioned do you think your industry/sector is for electrification?" (n=4)

Note: No respondents provided a rating of *extremely well-positioned.*

When asked about the availability of EV options in their sector, two of three fleet managers in the school bus sector said they were satisfied with the EV options available, while one was not satisfied. Two school bus sector fleet managers mentioned that the key limitation of EVs was range. The single fleet manager in the medium-duty sector was not satisfied with the current EV options in their sector and specifically mentioned that there are limited options with Class 4 and Class 5 vehicles.

The Evaluation Team asked fleet managers, given what they know or believe about requirements for fleets to purchase zero-emission MDHD vehicles, whether they believe electric, or diesel vehicles seem like a riskier purchase in the next three years and in the next 10 years. Three fleet managers (two school bus and one medium-duty sector respondents) said that diesel vehicles seem like a riskier purchasing decision than EVs, while one fleet manager in the school bus sector said EVs seem riskier. These responses were consistent across both the three-year and 10-year timeframes.

Withdrawn Fleet Managers

In addition to the fleet manager program participants, the Evaluation Team surveyed two fleet managers who withdrew from the program (known as withdrawn fleet managers). Both fleet managers provided a reason for withdrawing:

- One fleet manager withdrew due to reliability concerns with EVs or EV chargers.
- One fleet manager withdrew due to their inability to obtain easements; they said there were also other reasons but did not provide further details about those other reasons.

The team also asked these fleet managers about their satisfaction with the CRT program. One fleet manager rated themselves as *very satisfied* with the program overall, including the application process, application timeline, rebate amount, and experience working with SCE staff. The other fleet manager who withdrew from the program rated themselves as *somewhat satisfied* with the program overall. While they were *very satisfied* with the application process, application timeline, and working with SCE staff, this fleet manager was not aware of the program services offered (site planning, provision of TTM infrastructure) or the rebate amounts. When asked what would have enabled their continued participation in the program, this fleet manager indicated that lower costs or more rebates or incentives for vehicles and equipment would have increased the likelihood of their continued participation.

Highlights

Three of four respondent fleet managers became aware of CRT directly from SCE.

All four fleet managers rated themselves as *very satisfied* with CRT overall and said they were very likely to recommend the program to others.

Fleet managers were primarily motivated by operational benefits, environmental benefits, and expected maintenance and fuel cost savings.

Three of four fleet managers rated the EV charging equipment and vehicles as *somewhat reliable*.

While none of the fleet managers have plans to accelerate their procurement of EVs, three managers have electrification plans within the next 10 years and two of these fleet managers said they plan to acquire more EVs due to their participation in CRT.

Of two fleet managers who withdrew from the CRT program, one cited reliability concerns with EVs or EV chargers and one cited the inability to obtain easements.

Site Visit Findings

The Evaluation Team attempted to visit a census of activated project sites (n=15), and ultimately performed site visits of 14 sites in EY2022. This included MDHD vehicles, transit bus, school bus, and eTRU sites, ranging in fleet size from several vehicles to nearly 300 eTRU.

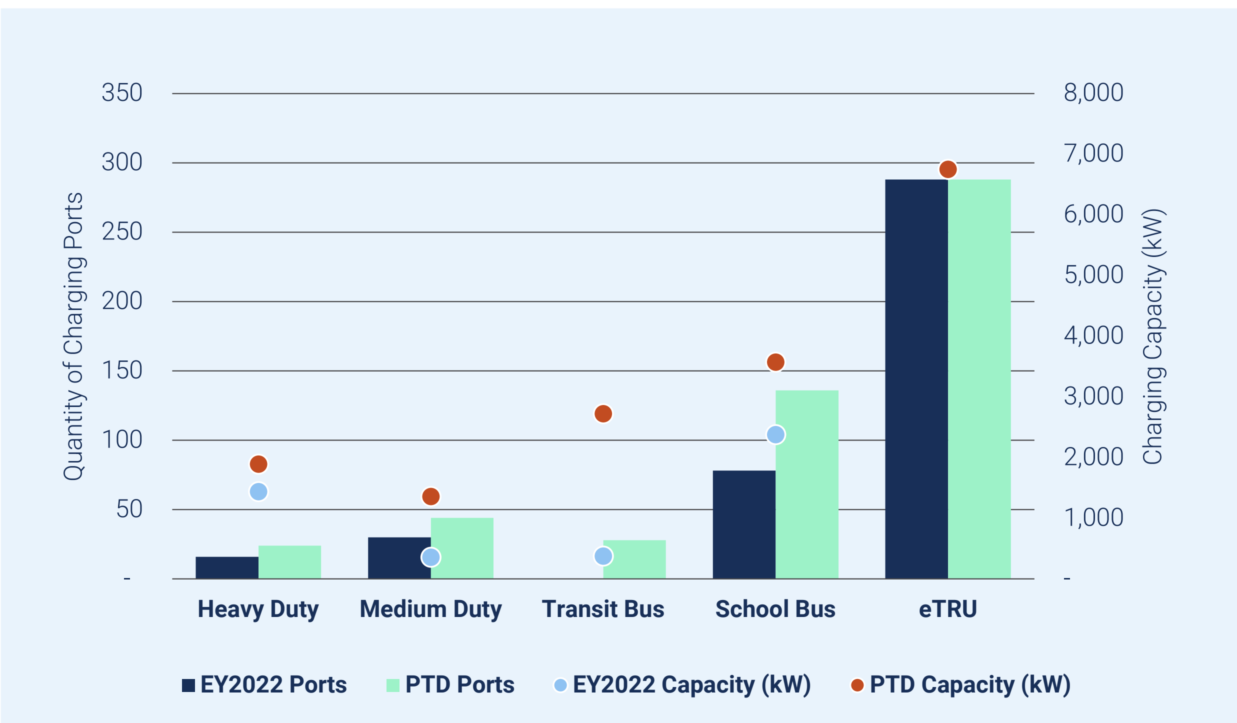
During the site visits, the team collected qualitative and quantitative information that provided us with an understanding of fleet composition and operations. The Evaluation Team used site visits to verify aspects such as the number of installed chargers, EVSPs used, types of EVs on the site or to be delivered, and physical influences on construction designs.

Table 14 provides a summary of charging site characteristics by market sector, including number of sites visited, number of L2 and DCFC charging ports, and total charging capacity. In total, the SCE CRT program added 429 charging ports with nearly 12 MW of EV charging capacity in EY2022. These additions bring the CRT program charger installations to nearly 600 charging ports with capacity over 16,000 kW as of December 31, 2022. Figure 17 presents a summary of L2 and DCFC charging port and charging capacity of CRT program site visit locations to date by market sector for EY2022.

Table 14. SCE CRT Program Site Visit Summary EY2022

Market Sector	Number of Sites	L2 Ports	DCFC Ports	Total Installed Charging Power Capacity (kW)
School Bus	9	67	22	2,775
Medium-Duty Vehicles	1	30	-	360
Heavy-Duty Vehicles	1	-	16	1,440
eTRU	2	288	-	6,750
Transit Bus	1	-	6	306

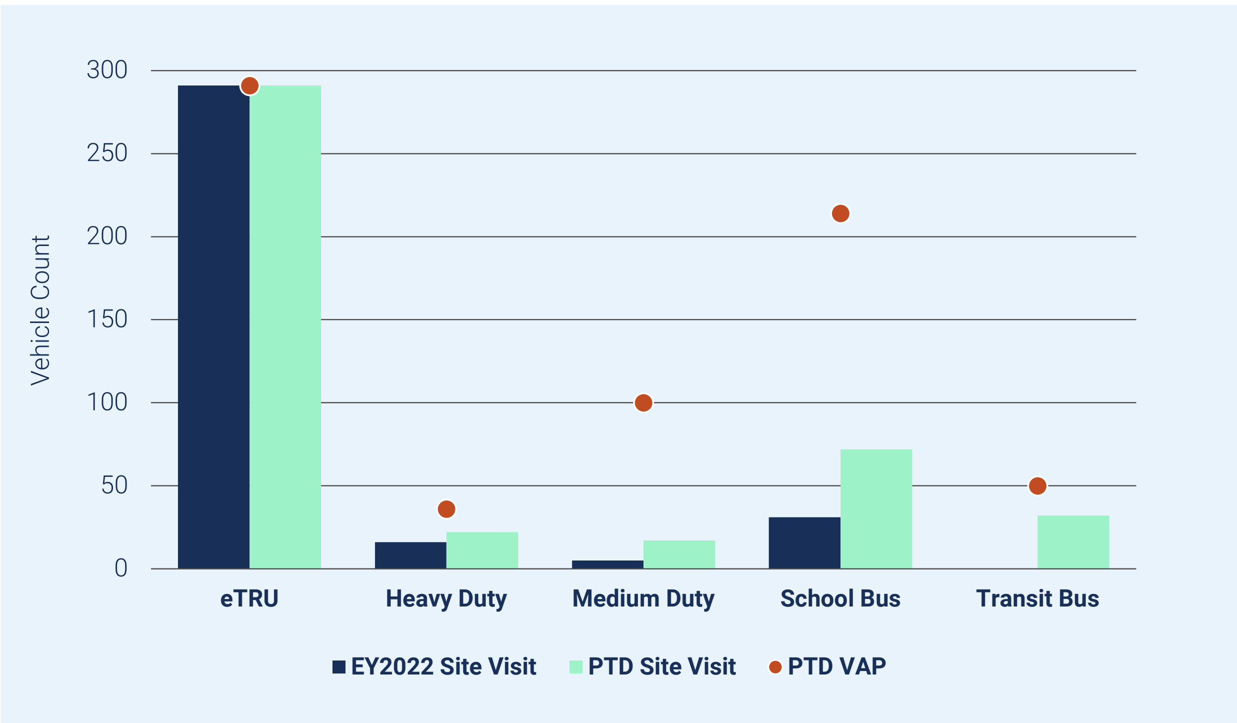
Figure 17. SCE CRT Program Summary of Site Characteristics by Market Sector, EY2022 and Program to Date



During site visits the Evaluation Team reviewed charge management capabilities, electrical infrastructure, future vehicle/equipment replacement plans (including future vehicle adoption), public funding sources, and the question of whether there was interest in on-site solar and/or battery storage. Site visits allowed us to obtain direct feedback from the individuals involved with operations and to identify EVSP points of contact to obtain charging session data.

Figure 18 shows a representation of vehicle data collected at the time of visits. Sites visited in EY2022 accounted for over 50 MDHD vehicles and nearly 300 eTRU, in contrast with about 90 vehicles in EY2021. The long-term VAP for all program to date sites visited accounts for an additional 700 vehicles. School bus and medium duty vehicles market sectors have the lowest ratio of vehicles delivered prior to our site visits to VAP with 30% and 20%, respectively.

Figure 18. SCE CRT Program Comparison of Long-Term VAP with Observed Site Visit Vehicles by Market Sector



The following sections provide a summary of key observations and data collected during site visits, organized by market sector.

eTRU

Figure 19. Electric Truck Refrigeration Unit Connector

In EY2022, the Evaluation Team conducted site visits of two eTRU projects. These were the first deployments in this market sector across all programs. The sector is notable as it represents over 67% of the total ports at sites visited in EY2022 and nearly half of all ports program to date. This may be attributed to sites being larger on average compared to other market sectors. For example, one of the two sites the Evaluation Team visited accounted for 258 ports, while the other accounted for 30 ports. This disparity reveals the range of project sizes that can be observed within a market sector.

The site with 258 ports is a good example of non-utility-based data metering. Due to the size of the facility, it was not feasible to meter the EV charging (eTRU) separately. Therefore, to meet the CRT program data collection requirements, the customer was required to provide a solution for aggregated 15-minute energy consumption data collection for all of the charging ports, which they achieved by installing a data logger on each port and aggregating the data before providing it to SCE monthly.

School Bus

The Evaluation Team visited nine school bus sites in EY2022, with a total of 22 DCFC and 67 L2 ports. As in EY2021, most chargers were L2, but three EY2022 sites installed DCFC, compared to only one site in EY2021. One of the school bus sites was a school bus dealership.

One school fleet manager explained that their partnership with the EVSP resulted in the EVSP setting up load management via their charger software in return for sharing the LCFS credits with the fleet. The site nearly perfectly managed charging to align with TOU periods, and therefore avoided high-cost energy, resulting in lower monthly energy costs. Another fleet manager mentioned a plan to set-up automated TOU-based load management in the future (it was not set up during initial station commissioning).

Public funding was a staple among school districts, for both vehicles and EV infrastructure. During the Evaluation Team's interviews, the school districts repeatedly told us that non-standard operations such as field trips could not currently be supported by their new EVs because of limitations on vehicle range and inadequate public charging infrastructure available along routes. However, at least one site expressed an interest in making their charging available to visiting schools if that could enable other districts to adopt EV bus. Procurement of additional vehicles is dependent on securing additional funding, which multiple school districts were actively pursuing.

Transit Bus

In EY2022, the Evaluation Team conducted a single transit bus project site visit. Notably, this was the third CRT transit operator that was participating in follow-up electrification projects at a new location.

This market sector uses among the largest EV batteries and maintains the longest routes which results in a significant continuous load on their charging equipment. Hardware reliability challenges encumbered this project, and other projects completed in EY2022, with issues that operators are still working through with their vendors. Additionally, multiple failures of AC-DC converters on electric bus led to lower-than-expected charger utilization.

Transit fleet operators reported that electric transit buses do not offer the range necessary for many routes that have been served by conventional ICE bus. During the site visit, the transit agency mentioned its continued interest in hydrogen bus as a means of reliably meeting its range requirements. This could create competition between EVs and hydrogen vehicles. The transit operator reported that additional stub-outs installed as part of their EV infrastructure project may never be used if its fleet should be shifted to hydrogen fueled vehicles.

Medium Duty Vehicles

In EY2022, the Evaluation Team visited the single completed medium-duty vehicle project site. This site currently serves five cargo vans (out of 30 vehicles listed in VAP) and has 30 installed L2 charging ports. Medium-duty package delivery was a new type of site in EY2022. Indeed, this was the first observed instance of a third-party owner and operator of vehicles charged at the site host property (a Utility customer). The site host and the vehicle operator both reported that they are awaiting more OEM options to purchase additional, larger electric delivery vehicles.

Heavy Duty Vehicles

The Evaluation Team visited a single heavy-duty vehicle site. This site had 16 DCFC ports completed in EY2022. The operator shared their plans to expand their electric truck fleet while relying on the existing charging stations. This would be a rare instance of more than one heavy-duty vehicle using a single charging port installed through the CRT program. As a result, load factors for the site are expected to increase substantially as more EVs are added.

Figure 20. Heavy-Duty Charging in Softscape

This site represents one of the few sites with a nearly ideal location, nearby Utility service with capacity and softscape (dirt) to install charging infrastructure. This contrasts with most sites across all market sectors that have had to trench through, and then repair, concrete or asphalt during construction.

The Evaluation Team analyzed charging session data for this site. The data revealed that over 90% of charging sessions ended with fully charged vehicles, and that most vehicles are using 70% or less of the vehicle's battery capacity. The operator benefits from consistent routes for planning purposes and does their best to operate the electric trucks on routes shorter than the truck's range on a single charge.

Common Site Visit Findings

Across market sectors, the Evaluation Team did not observe any RFID cards in use to enable charging, nor instances of vehicles being reliably assigned to specific parking spaces. As a result, fuel economy, fuel cost, and charging demand data is only available at the aggregate level and not at the vehicle or route level.

During site visits, three fleet operators discussed interest in distributed generation, including solar and energy storage. Operators also expressed interest in offsetting Utility billing costs and/or enhancing resiliency in the event of wildfires or other emergencies. These operators found that the current SB 350 Utility funding mechanisms impinged on their ability to include these elements in their transportation planning. Specifically, one site reported that they would be unable to tie into the Utility-owned BTM infrastructure to install a solar and battery storage project, which they could privately finance.

Highlights

- Public funding is critical for most school and transit fleet operators.
- Almost every operator experienced a disconnect between what they expected the electricity to cost based on planning and early marketing compared to actual bills received. Further support from Utility representatives could be helpful to ensure that customers are aware of energy costs.
- Fleet operators did not utilize RFID cards or assigned parking. As a result, fuel economy, fuel cost, and charging demand data is only available at the aggregate level and not at the vehicle or route level.
- School districts have the greatest ability to seek lower-cost energy and avoid high-cost periods and would therefore benefit from increased efforts to use load management.

Deep Dives

The Evaluation Team conducted deep dives for three CRT program sites in EY2022. The team selected sites from EY2021 for deep dives based on several criteria. These included sites with significant demand (kW), energy consumption (kWh), and/or installed charging capacity. The team was interested in sites that had some ability to expand EV infrastructure. The Evaluation Team was also interested in sites with load management, unique vehicles and/or charging equipment, a large fleet size, and/or a fleet manager who was willing to participate in the deep dive process.

For EY2022, the Evaluation Team examined three sites in the SCE territory: (1) a school district operating Type C school buses, (2) a transit district operating 35-foot transit buses and shuttle-type vans, and (3) a transit district operating 40-foot transit buses. The team conducted in-depth fleet manager interviews, analysis of AMI and EVSP data, and fleet driver surveys (only one of the three fleets was willing to participate in the driver surveys).

Findings presented in this section reflect results of the interviews, the Evaluation Team's data analysis, and driver survey feedback (where available). Refer to *Appendix B* for detailed case studies on each of these fleets.

School Bus Fleet

The Evaluation Team selected a school bus fleet that operated Type C buses for a deep dive analysis because of its early deployment of electric school buses, its high ratio of chargers to vehicles, and its potential for implementing load management.

The site charges its buses using more than two dozen L2 stations and follows a two-shift charging schedule. This means plugging in once when a bus returns from its morning routes at around 8:30 AM, and again when a bus returns from its afternoon routes at around 4:30 PM.

Given extremes in local weather at this site, vehicle and charger reliability has become a concern. The operator expressed concern about vehicle range suitability, particularly with the passenger cabin heater being turned on during the winter months. The chargers had initially experienced overheating and failure of internal electronics during the summer months, as well as difficulty establishing reliable authentication with the vehicles. After a software update, the initial problems became less frequent.

The charging patterns at the site indicate some potential to either slow or delay second shift charging sessions to further reduce the cost of electricity to charge these vehicles. The operator plans to implement load management to better avoid peak-rate-period charges.

Transit Fleet 1

The team selected a transit fleet operating 35-foot transit buses and shuttles for a deep dive. This choice was the result of several considerations: the site includes a two-pronged, high-power approach to vehicle charging and because of two deployments each day, the site has a 360 kW high-power DCFC system located along the route and 50 kW DCFCs at the site depot.

On average, depot charging kilowatt demand peaked at around 4 PM, and continued to taper off during the 4 PM to 9 PM period. Demand would typically increase again after the peak-rate-period, then begin to taper off again as midnight approached.

En route charging follows a two-shift charging schedule, peaking around noon and again at 7 PM. The site currently manages its depot charging manually, disconnecting and re-connecting vehicles to avoid charging during the peak-rate period. As expected, *en route* chargers do not employ load management. This is to ensure that, during their routes, vehicles always have access to the power required to complete their shifts.

This site expects to implement load management within the next several months, pending access to their EVSP's management functionality. Depot charger interoperability has not met expectations, with frequent errors and problems that require attention. The site operator replaced three shuttle vans with vehicles of another make due to issues with the shuttle bus batteries.

Transit Fleet 2

The team selected a transit fleet operating 40-foot transit buses for a deep dive because of their large deployment of full-size electric transit bus in a dense urban region, and because it installed a number of 62.5 kW DCFCs at their depot. There is no load management active at the site. Consequently, depot charging demand ramps up substantially during the 4 PM to 9 PM peak-rate period, with as much as 40% of monthly energy consumption occurring during this period. The operator has begun to shift vehicle charging away from the high-cost period, with recent months showing 25% of energy consumption occurring during that high-cost period.

The site operator plans to acquire more bus with larger batteries in the near term to more than double their EV fleet. Energy consumption patterns for this site are therefore expected to significantly increase. The addition of more bus and faster chargers will make managing charging to avoid peak-rate periods crucial to reducing the overall cost of fueling the vehicles, especially as demand charges come into effect in the near future. Additionally, because buses remain plugged into their chargers for a substantial period of time after the end of their charging sessions, the operator may have the flexibility to both delay and slow charging to take advantage of off-peak rates and to minimize demand charges.

Fleet Driver Surveys

As part of the deep dives, the Evaluation Team surveyed three fleet drivers from one of the participating deep dive sites about their experience driving an EV and using the program charging infrastructure. Overall, the three fleet drivers were satisfied with their experience of operating the vehicles and using the charging stations, and said the equipment was reliable. Nonetheless, they expressed concern with lack of storage on the bus, vehicle range, and charging issues.

Two of the three drivers were satisfied with the accuracy of the equipment's battery state of charge estimates, while one was *not too satisfied.* One fleet driver said there was miscommunication between the bus and the charger. The drivers said they typically need to charge their vehicles at least twice per day, with one reporting that it was necessary to charge more frequently. They all charge midday, and two of the three fleet drivers also charge overnight.

Two respondents said that operating and fueling an EV was no different than operating and fueling an ICE vehicle, while one said the EV was easier to use and refuel. The fleet drivers said the biggest change in their job due to EVs was that they experienced a quieter ride and had a better driving/operating experience yet had more concerns about the range of their vehicle.

Highlights

- All three deep dive sites experienced frequent issues with the charger-vehicle authentication process. One site placed the chargers into open access mode, while another has continued operations with the errors.
- The site operating school buses noted temperature-dependent issues with both its vehicles and chargers. Chargers were L2 models installed in direct sunlight. This combination of factors may exceed operating temperatures and reduce reliability.
- All sites appear to have the flexibility to shift their charging loads to better avoid the 4 PM to 9 PM peak-rate period. Depot chargers are reliably dispensing between 30% and 40% of their total energy usage during peak-rate periods. With charge management, this could likely decrease significantly.
- At one site, fleet drivers were satisfied with their experience operating the EVs but expressed concerns about vehicle range.

Co-Benefits and Co-Costs

Through fleet manager surveys, deep dive fleet manager interviews, deep dive fleet driver surveys, and site visits, the Evaluation Team identified several co-benefits and co-costs associated with the CRT program's vehicle electrification sites.

Fleet Manager Surveys

The fleet manager surveys included questions asking about co-benefits and co-costs, both aided (asking fleet managers if they have noticed a specific co-benefit or co-cost) and unaided (via an open-ended question).[38]

Table 15 shows that all four fleet managers expected to realize benefits for their community or fleet because of electrifying. Three of the four fleet managers expected *significant benefits* because of electrifying due to improved air quality and health, improved driver comfort and convenience, and reduced noise pollution. Additionally, all four managers expected *some benefits* from encouraging others to convert to EVs. Fleet managers were more divided on increased fleet flexibility, with two expecting *no benefits* and two expecting either *some benefits* or *significant benefits*. One fleet manager mentioned that "drivers, co-workers, and customers all feel good about the deployment of EVs." Two managers specifically cited improvements in noise and cleaner air and one mentioned cost savings and driver comfort.

38 The team received responses from four SCE fleet managers, but the sample size (n) denoted in the following tables and charts may differ because respondents could skip questions and response options. Despite the Evaluation Team's efforts to improve the response rate through multiple rounds of outreach and increased survey incentives, the fleet manager survey did not reach the target response number, which limits the insights that can be gleaned due to a smaller sample size.

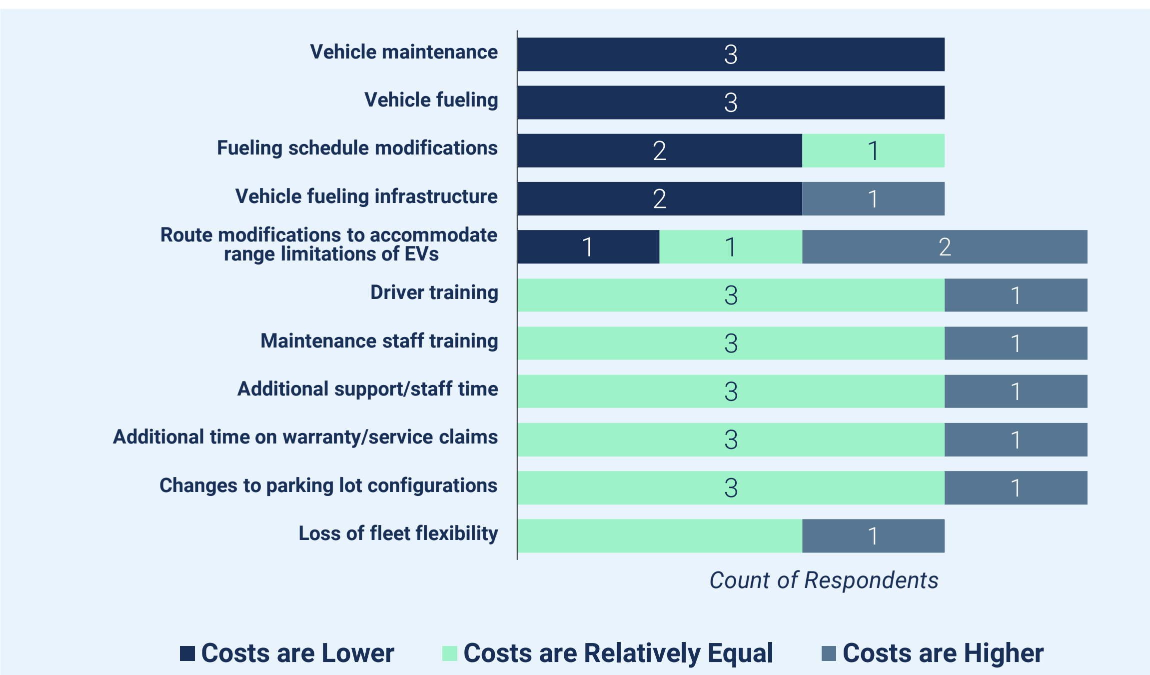
Table 15. SCE CRT Program Benefits Experienced from Electrification in EY2022

	Significant Benefits	Some Benefits	No Benefits
Improved air quality/health	3	1	-
Improved driver comfort/convenience	3	1	-
Reduction in noise pollution	3	1	-
Encourages other individuals/fleets to convert to EVs	-	4	-
Increased fleet flexibility	1	1	2

Source: Fleet Manager Survey Question D1. "What ancillary benefits do you think will be realized for your community/fleet as a result of electrifying?" (n=4)

Figure 21 shows the surveyed managers responses to questions on the observed costs associated with operating and maintaining EV fleets. The three respondents who reported on costs for vehicle maintenance and fueling all indicated those costs as *lower* since electrification. Two of three fleet managers also reported costs as *lower* for fuel schedule modifications and vehicle fueling infrastructure. One manager noted *lower* costs for route modifications due to EV range limitations, while two managers reported these costs as *higher* since electrification and one said the costs were *relatively equal*. One of the managers who reported route modifications costs as *higher* mentioned that because their electric bus does not have the range to operate for a full day, some drivers now need to complete "pre-trip" work for two buses per day.

Figure 21. SCE CRT Program Observed Cost Changes since Electrification in EY2022

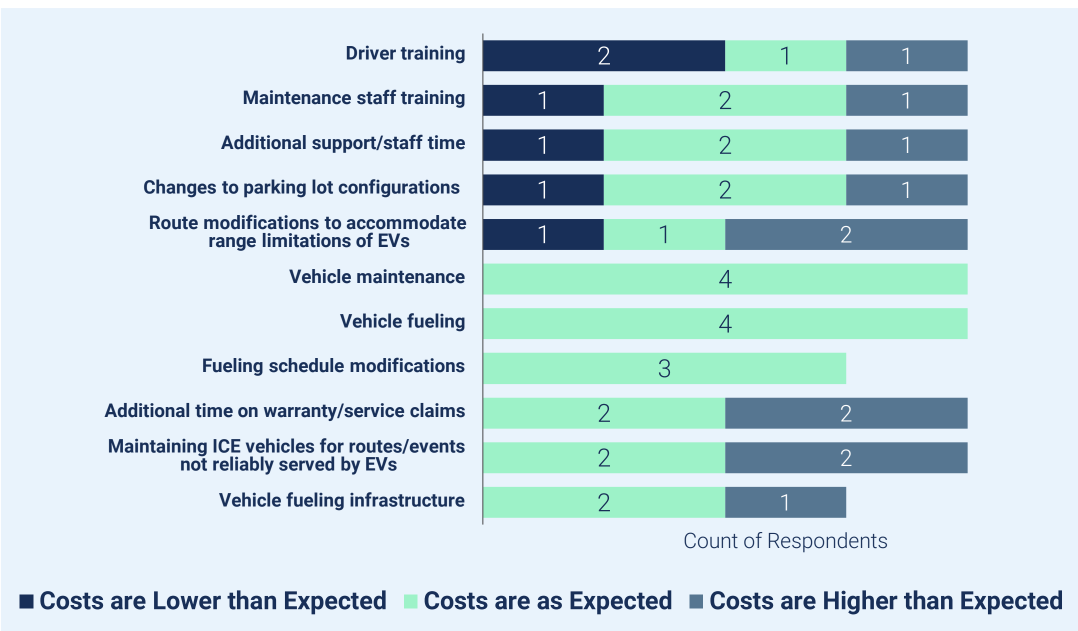


Source: Fleet Manager Survey Question E1. "Please think about all the costs associated with operating and maintaining your fleet. For each cost type, please estimate how much the cost has changed since transitioning your fleet to EVs."

Three of the four managers indicated several costs as being *relatively equal* since electrifying their fleets: driver and maintenance staff training, additional support time and time on warranty/service claims, and changes to parking lot configurations. Two of the three managers indicated costs as *relatively equal* for the loss of fleet flexibility. One manager mentioned the added cost of purchasing a new diesel bus due to EV range limitations, and another commented on added costs due to employee training. One manager noted that warranty issues had resulted in downtime, and one noted the impact or cost of "figuring out vehicle ownership."

The Evaluation Team also asked fleet managers about operational and maintenance cost changes. As shown in Figure 22, two of four managers reported *lower than expected* costs for driver training. Three of the four managers indicated costs as either *lower than expected* or *as expected* for maintenance staff training, additional support time, and changes to parking lot configurations. Most managers reported that cost changes *are as expected* for vehicle maintenance (four of four), fueling (four of four), fuel schedule modifications (three of three), and vehicle fueling infrastructure (two of three). For other cost categories, managers were more evenly split, with two of the four reporting *higher than expected* costs for time spent on warranty claims, route modifications due to EV range limitations, and having to maintain ICE vehicles for operations not well-served by EVs.

Figure 22. SCE CRT Program Difference in Electrification Cost Expectations in EY2022



Source: Fleet Manager Survey Question E2. "Have these operational and maintenance costs been what you expected?"

Deep Dive Fleet Manager Interviews

The Evaluation Team conducted deep dive interviews with three SCE fleet managers to assess the co-costs and co-benefits of transportation electrification for fleets and fleet drivers. During the interviews, fleet managers noted several costs:

- **Battery malfunctions.** One fleet manager experienced early growing pains because of battery malfunctions, specifically reporting that staff time was used to deal with battery recalls and warranties, and that they lost “a battery per week for the first two to three months” of EV operation. These issues were eventually resolved by the manufacturer. Another fleet manager said they maintain backup vehicles to replace EVs that are out-of-service due to battery pack malfunctions.

- **EV reliability.** One fleet manager is unable to keep their current fleet of EVs operational. Although funding is available for additional EVs, this fleet manager does not plan to procure additional EVs until the technology is proven to be more stable.
- **Charging failure**. Fleet managers also discussed challenges with charging equipment. One fleet manager had a charging unit failure and occasional malfunctions and said that the lack of charging authentication and parking space assignments has led to challenges with charging. Another manager reported challenges with EV and EVSE interoperability with smart managed charging systems, specifically noting that some vehicles in this fleet did not seem to be compatible and did not accept commands from the smart chargers. In addition, this manager noted that chargers programmed to avoid the 4 PM to 9 PM peak period would not resume charging after the peak period ended. To resolve this issue, fleet drivers and operators manually manage charging to avoid the peak hours by plugging in vehicles at the end of the day.

Two fleet managers expressed an overall positive experience with EVs while the third was dissatisfied. The two with a positive experience mentioned that the EV range has met expectations, although one fleet manager had to make operational adjustments to account for limited EV range. One fleet manager said that regenerative braking has helped to minimize brake and rotor wear and allows for one pedal driving. They also said that staff appreciate the quietness and smooth ride of EVs.

Deep Dive Fleet Driver Surveys

The Evaluation Team fielded surveys with participating fleet drivers as part of the deep dive effort and received three responses from one fleet. Drivers reported an improvement in comfort and convenience in operating an EV compared to a conventional ICE vehicle, specifically the air conditioning. Other benefits noted by the drivers included a smoother ride and less noise (n=1) and improved handling (n=1). The drivers did not indicate an improvement in air quality or health since operating an EV but noted that the EV requires charging more frequently than expected and that EVs have an insufficient range and reported difficulty locating charging sites outside of their main location.

Additional Insights from Site Visits

The Evaluation Team incorporated qualitative insights from the 17 EY2022 site visits to inform the co-costs and co-benefits findings. As shown in Figure 23, 10 fleet site contacts reported increased driver comfort, with one specifically mentioning improved air conditioning. Three fleet site contacts reported improved air quality, and two reported a reduction in noise pollution. One fleet site contact reported that converting their fleet to EVs would encourage other individuals or fleets to convert as well. Three site contacts reported *other* co-benefits, with one reporting that electrification has helped support company sustainability goals and another expecting lower costs, while the third did not provide additional context.

Figure 23. SCE CRT Program Benefits Identified during Site Visits

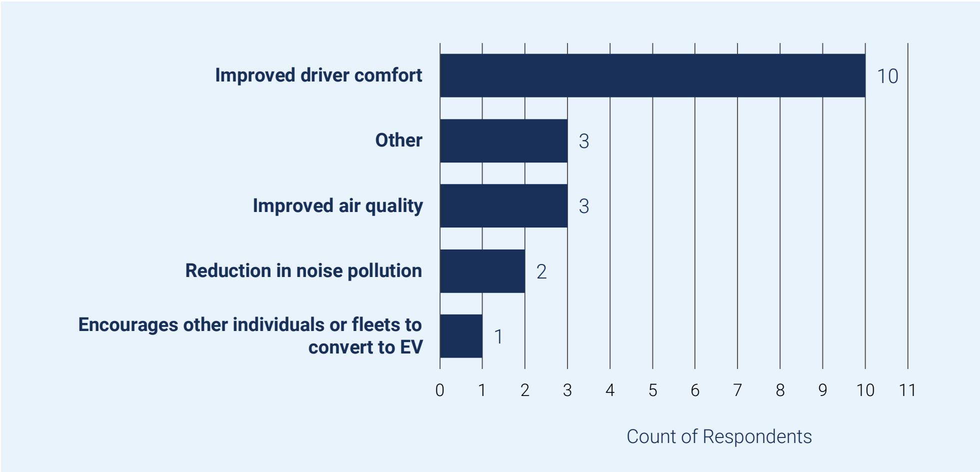
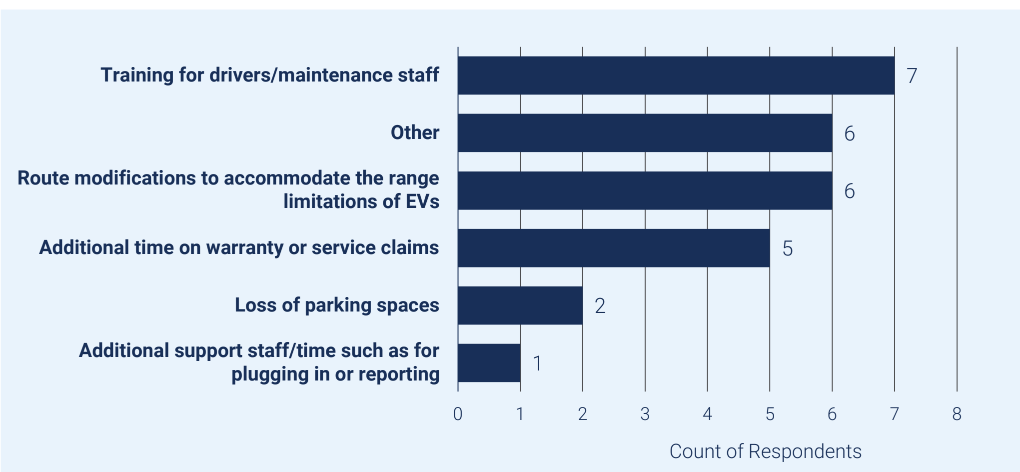


Figure 24 shows costs reported during site visits. The most reported observed co-costs were associated with training for drivers and maintenance staff (seven sites), route modifications to accommodate the range limitations of EVs (six sites), and additional time spent on warranty or service claims (five sites). Two site contacts also reported a loss of parking spaces, and one site contact reported the need for additional support staff and time. Six site contacts also reported *other* costs. Not all the costs mentioned were necessarily specific to EVs; for example, two site contacts specifically mentioned difficulties with driver shortages and a third cited complicated processes related to vehicle acquisition and contract drivers. The three *other* comments did mention specific EV-related costs, including the cost of potentially having to purchase a large generator as a backup power source to support charging in the event of a power outage, the need for increased EV range in rural areas, and incidental damage for charging infrastructure from driving vehicles while they were still connected.

Figure 24. SCE CRT Program Costs Identified during Site Visits



As some of the fleets from these site visits have only recently been electrified, two site contacts reported not yet having enough experience to determine co-benefits and one reported not yet being able to determine co-costs.

Highlights

- All four surveyed fleet managers cited benefits including improved air quality/health, improved driver comfort/convenience, reduced noise pollution, and encouraging other individuals/fleets to convert to EVs. During site visits, fleet drivers confirmed improved drive comfort as a key benefit.
- Three of three fleet managers said costs are lower for vehicle maintenance and vehicle fueling since transitioning their fleet to EVs.
- Two of four surveyed fleet managers said that costs of driver training are lower than expected; however, site visits revealed training as a key cost. Managers reported that fueling schedule modification, fueling, and maintenance all met their cost expectation.
- Fleet managers cited several costs to adapting to EV charging including battery malfunctions (2), reliability (1), and charging failures (2).

Total Cost of Ownership

The Evaluation Team conducted a cost analysis on 16 projects with fully closed out finances as of December 31, 2022, including EY2021 and EY2022 sites. Sites had a mix of L2 and DCFC ports, with an average of 224.5 kW installed capacity and 6.1 ports per site. The 16 projects included 10 school bus sites, three transit bus sites, two medium-duty sites, and one heavy-duty sites. Market sectors are presented together to meet customer confidentiality requirements. While this aggregation impedes findings for given market sectors, it still provides insights on relative magnitudes of costs faced by MDHD fleets. In future evaluation years, the Evaluation Team expects to have sufficient data points to disaggregate certain market sectors.

Figure 25 shows the distribution of site-level costs of the 16 sites. The horizontal lines of the boxes in Figure 25 show the 25th, 50th, and 75th percentile of sites. The “x” represents the mean site cost. The three panels in Figure 25 are defined as follows:

- **All-in Costs.** The total cost of capital and installation borne by SCE and the customer, calculated by summing actual TTM and BTM costs paid by SCE with the estimated EVSE costs shared between the customer and SCE.[39]
- **Ratepayer-Funded Costs.** All site costs borne by SCE, calculated by summing actual TTM and BTM cost with estimated EVSE rebate paid by SCE.[40]
- **Utility Infrastructure Costs.** Site costs borne by SCE for TTM and BTM.[41]

---

[39] EVSE equipment costs are estimated by doubling the EVSE rebate amount paid by SCE for sites receiving rebates and an assumed $3,000 for Level 2 chargers and $45,000 for DCFC chargers for sites not receiving rebates.

[40] SCE provides a Charging Equipment Rebate of up to 50 percent of EVSE costs to qualified participants deploying EVSEs that (1) support transit or school buses, or (2) are located in designated DACs where the participant is not a Fortune 1000 company.

[41] Values are the same as the Ratepayer-Funded Costs, without the inclusion of the EVSE rebates.

Figure 25. SCE CRT Program Costs Organized by Three Perspectives, Across 16 Sites

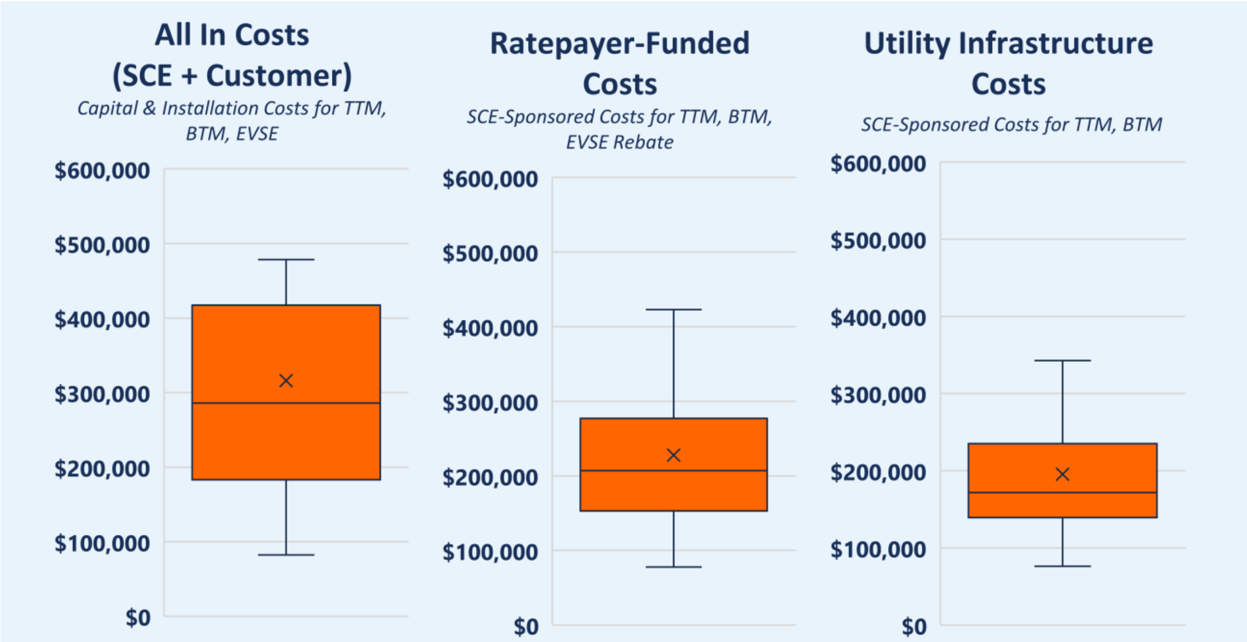
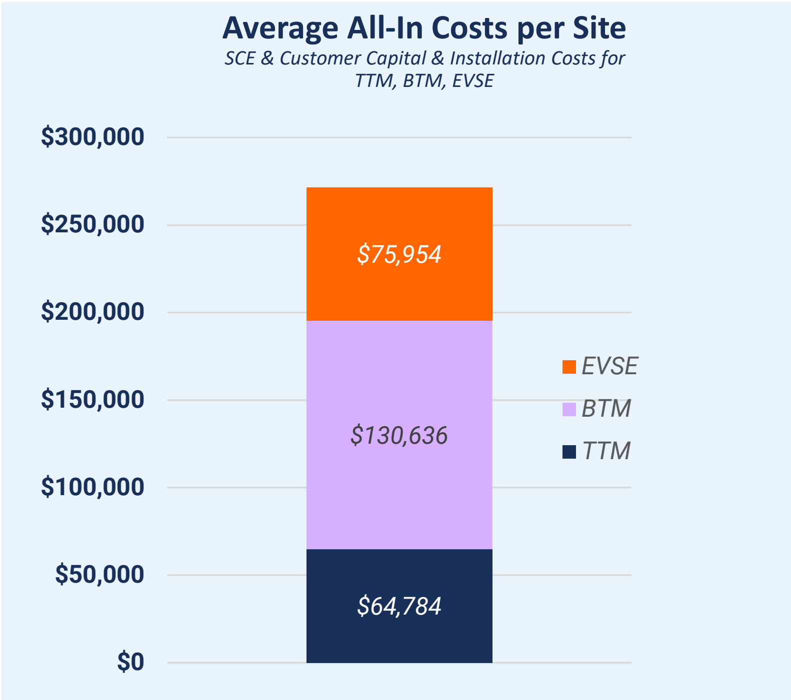


Figure 26 shows average all-in costs for the 16 sites. BTM is the largest cost across the sites, followed by EVSE, then TTM. Together, the average all-in TTM, BTM, and EVSE cost is $315,983.[42]

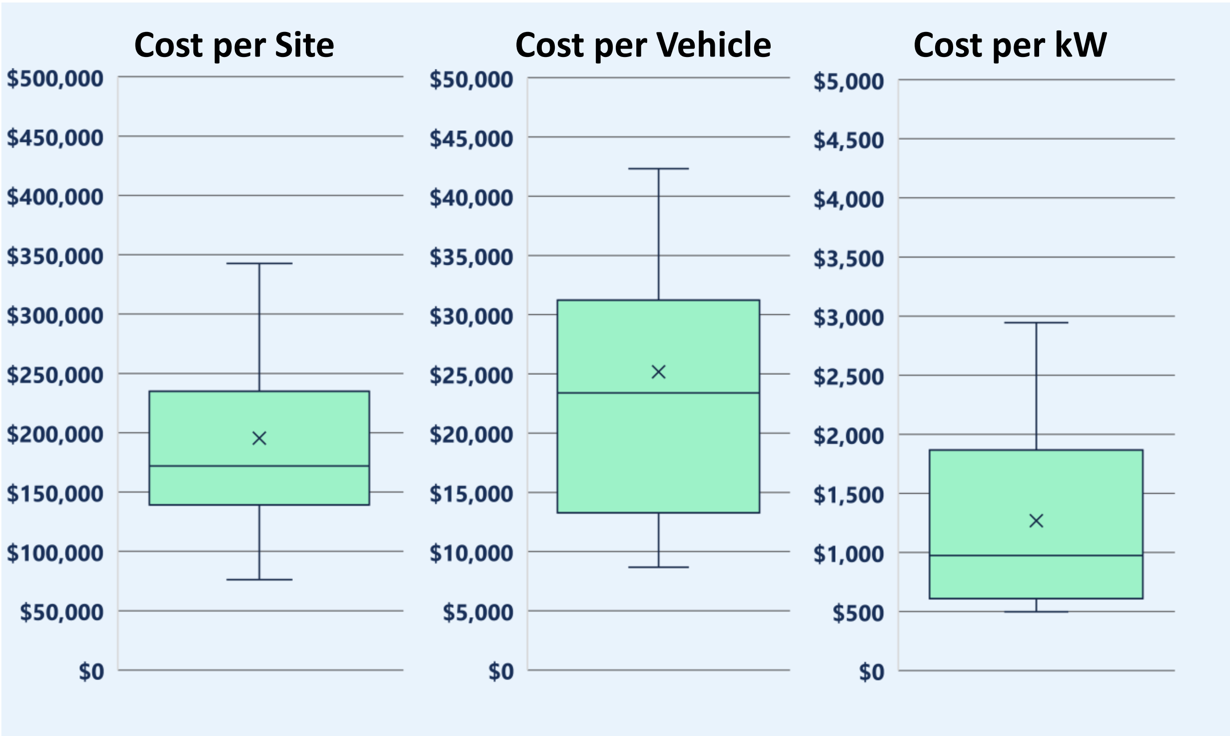
Figure 26. SCE CRT Program Average All-In Costs Across 16 Sites



[42] Calculated by summing all TTM, BTM, and EVSE costs borne by SCE and the customer, then dividing by 16 sites.

Figure 27 shows the distribution of utility infrastructure costs (corresponding to the far-right panel in Figure 25) presented per site, per vehicle, and per kW. The average utility infrastructure cost, including TTM and BTM borne by SCE, was $195,420 per site,[1] $25,180 per vehicle, [1] and $1,269 per kW.[1]

Figure 27. SCE CRT Program, Utility Infrastructure Cost per Site, per Vehicle, per kW for 16 Sites



Highlights

- All-in costs paid by the customer and SCE vary widely between sites, with an average of $271,375 per site.
- On average, BTM was the largest cost across the sites, followed by EVSE cost, then TTM cost.
- The average utility infrastructure cost, including TTM and BTM borne by SCE, was $195,420 per site, $25,180 per vehicle, and $1,269 per kW.

Grid Impacts

The team evaluated grid impacts for the CRT program based on the analysis of energy consumed by operational charging stations installed through the program in EY2022, combined with charging session data from the EVSPs. Table 16 presents a summary of the estimated CRT program grid impacts.

Table 16. SCE CRT Program Grid Impacts Summary

Impact Parameter	CY2022		Program-to-Date	
	Actual EY2022 + EY2021	Annualized EY2022	Actual PTD	10-Year Projection PTD
Operational Sites	39	15	39	39
Electric Energy Consumption, MWh	3,495	2,432	4,113	43,593
On-Peak MWh (4 PM to 9 PM) (and % of total)	924 (26.4%)	455 (18.5%)	1,114 (27.0%)	12,383 (24.7%)
Maximum Demand, kW (with date and time)	2,215 (9/6/22 10:15 PM)	1,414 (12/15/22 11:15 AM)	2,215 (9/6/22 10:15 PM)	N /A
Maximum On-Peak Demand, kW (with date and time)	1,992 (9/15/22 8:30 PM)	975 (2/2/22 4:30 PM)	1,992 (9/15/22 8:30 PM)	N /A

The remainder of this section offers detailed findings on actual monthly consumption and maximum demand load curves for calendar year 2022.

Figure 28 shows total monthly electricity consumption for 2021 and 2022 for all operational sites. A steep increase in energy consumption in the fall of 2022 is likely due to new school bus operations from sites built during the summer and corresponding to school re-openings. The relatively stable second half of the year is seemingly attributable to sites achieving steady-state operations (with all vehicles being on the site and reliably operating) or possibly stymied growth due to equipment issues encountered during early stages of deployment.

Figure 28. SCE CRT Program Monthly Electricity Consumption, Program-to-Date Sites

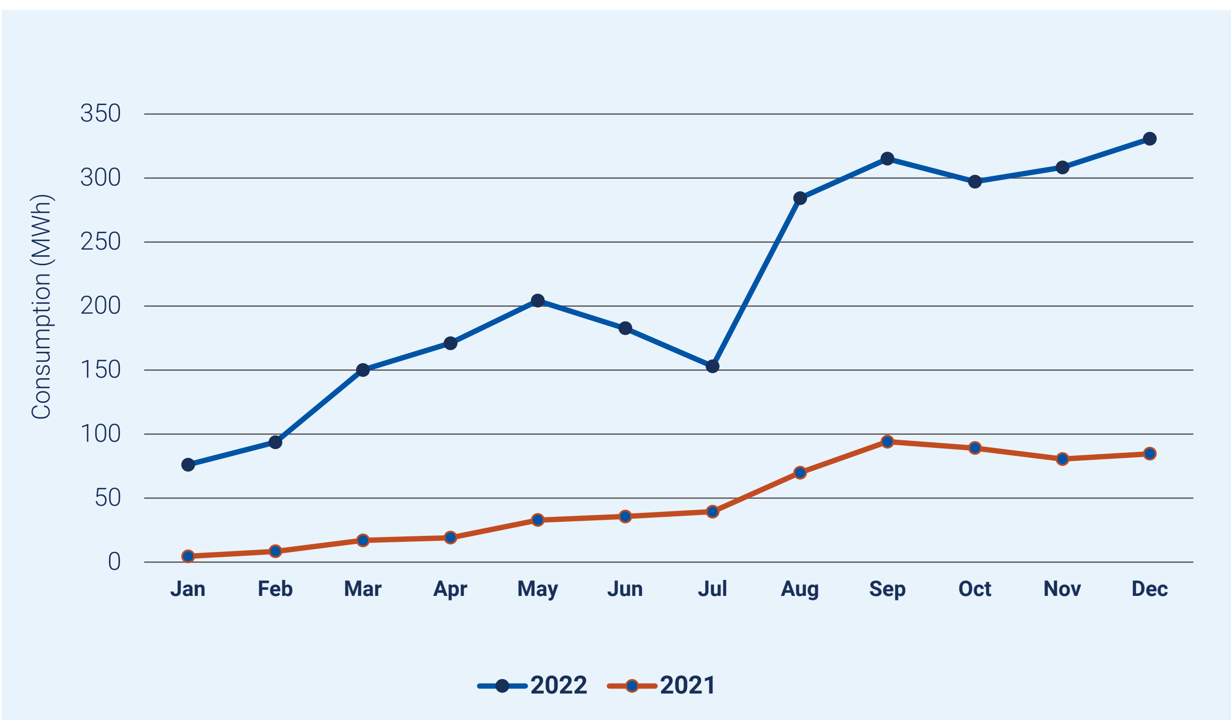
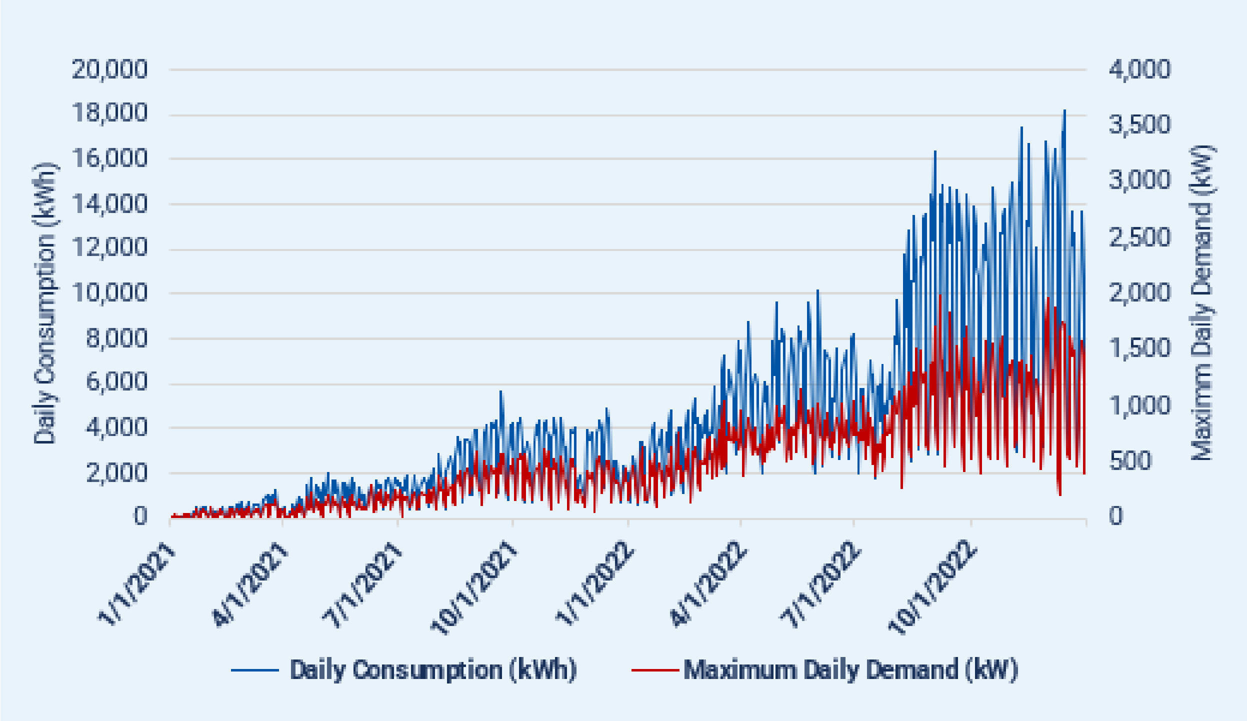


Figure 29 shows maximum daily demand in 2021 and 2022, as new customers came online, and older projects continued to operate. The team calculated load based on the average demand within a 15-minute interval of Utility meter data. The low marks typically represent reduced weekend operation. It is notable to compare the demand in early 2022 below 1,000 kW to the maximum throughout 2022 of 2,215 kW on September 6. This is more than double the load between January and December 2022. For comparison, approximately 16,000 kW of charging capacity has been installed at SCE CRT sites based on data collected from site visits.

Figure 29. SCE CRT Program Daily Maximum Demand and Consumption, Program-to-Date Sites



There were several other key observations:

- Not all planned vehicles have been delivered
- Among vehicles delivered, not all operated reliably
- Many sites are still conservatively operating vehicles so as not to run out of range
- Some sites installed charging capacity for anticipated vehicles (included in their VAP) they have not yet ordered

Figure 30 shows the average weekday load for all CRT sites in September 2022, which had the highest average use between 4 PM and 9 PM. Load during the 4 PM to 9 PM period grew by around 200 kW (25%) in 2022 compared to 2021. The highest demand times for the overall fleet was during or after that time period. Much of the maximum demand at night was due to non-school bus fleets, based on their operational profiles.

Figure 30. SCE CRT Program Average Weekday Load September 2022, Program-to-Date Sites

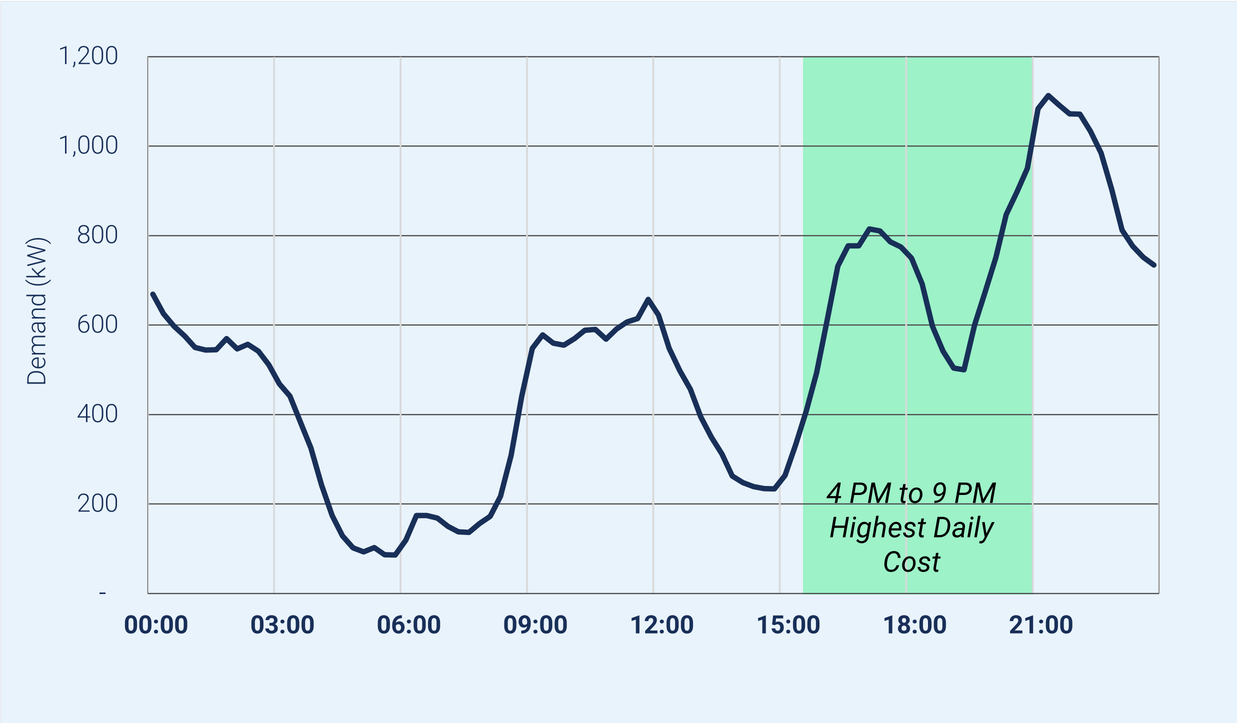
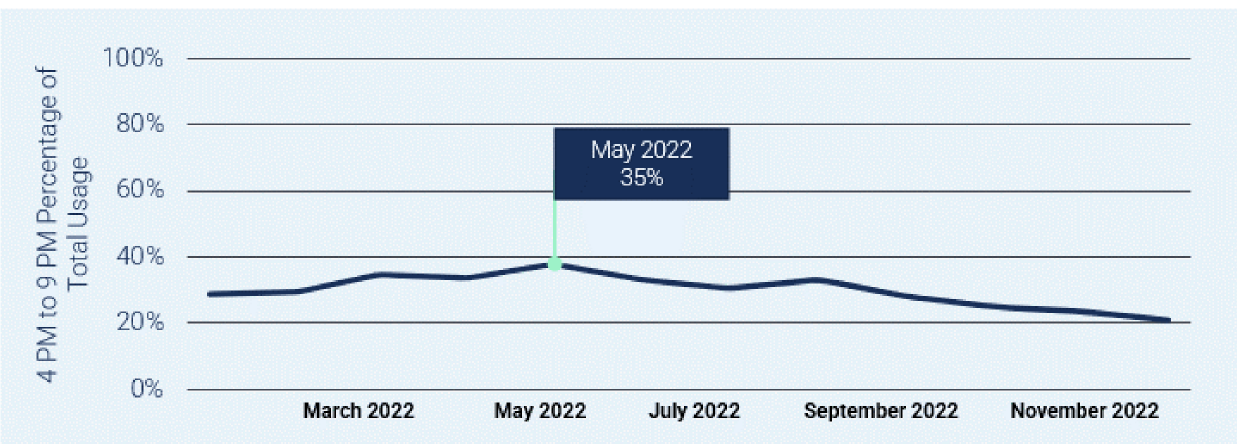


Figure 31 shows that overall consumption during the 4 PM to 9 PM peak-rate period ranged from 22% to 35% on average across all CRT program sites in 2021 and 2022. This means that several fleets have high usage at times that are detrimental to their costs, and further contribute to grid congestion.

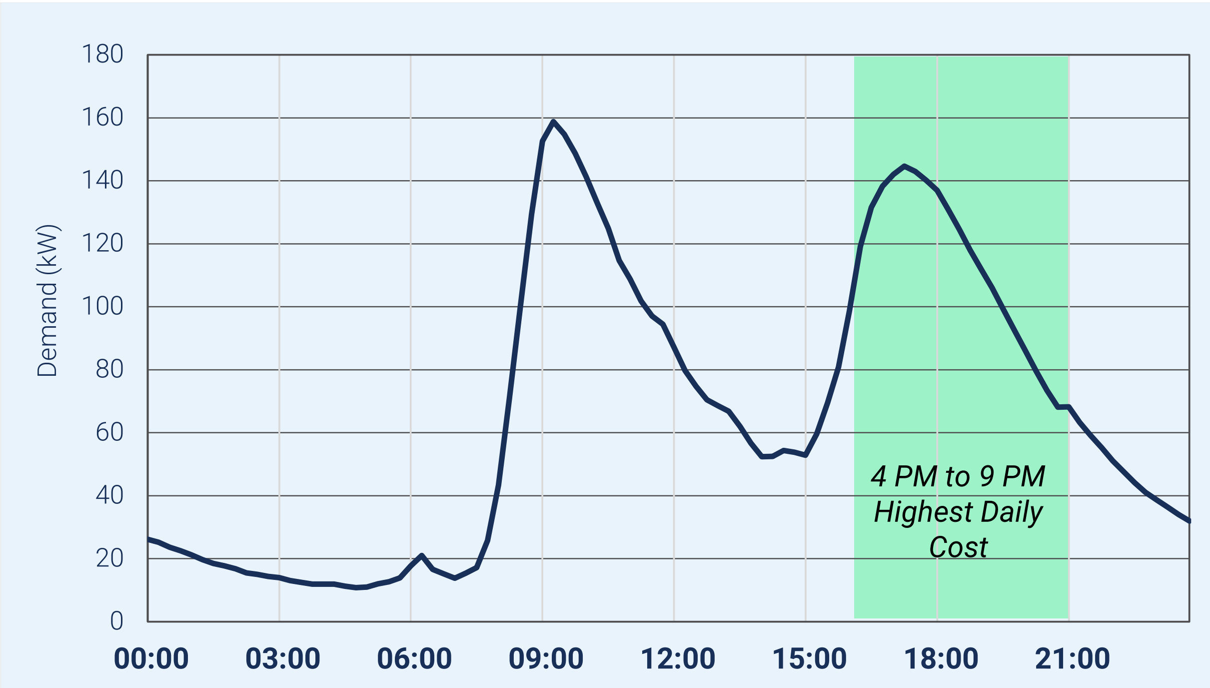
Figure 31. SCE CRT Program Monthly Proportion of Energy Use 4 PM to 9 PM, Program-to-Date Sites



School bus operations across the state shared many characteristics, such as similar duty cycles, similar EV battery capacities, and similar parking dwell times. This resulted in very similar load curves across sites. When isolating school bus charging, certain trends and opportunities appear.

Figure 32 shows that, on average, school bus charging reaches maximum demand in the morning, often coincident with least-cost and least-emission electricity. However, there is substantial and nearly equal demand taking place from 4 PM to 9 PM. This load shape likely represents unnecessary Utility costs adversely impacting the TCO for school bus operators.

Figure 32. SCE CRT Program School Bus Average Weekday Load, Program-to-Date Sites



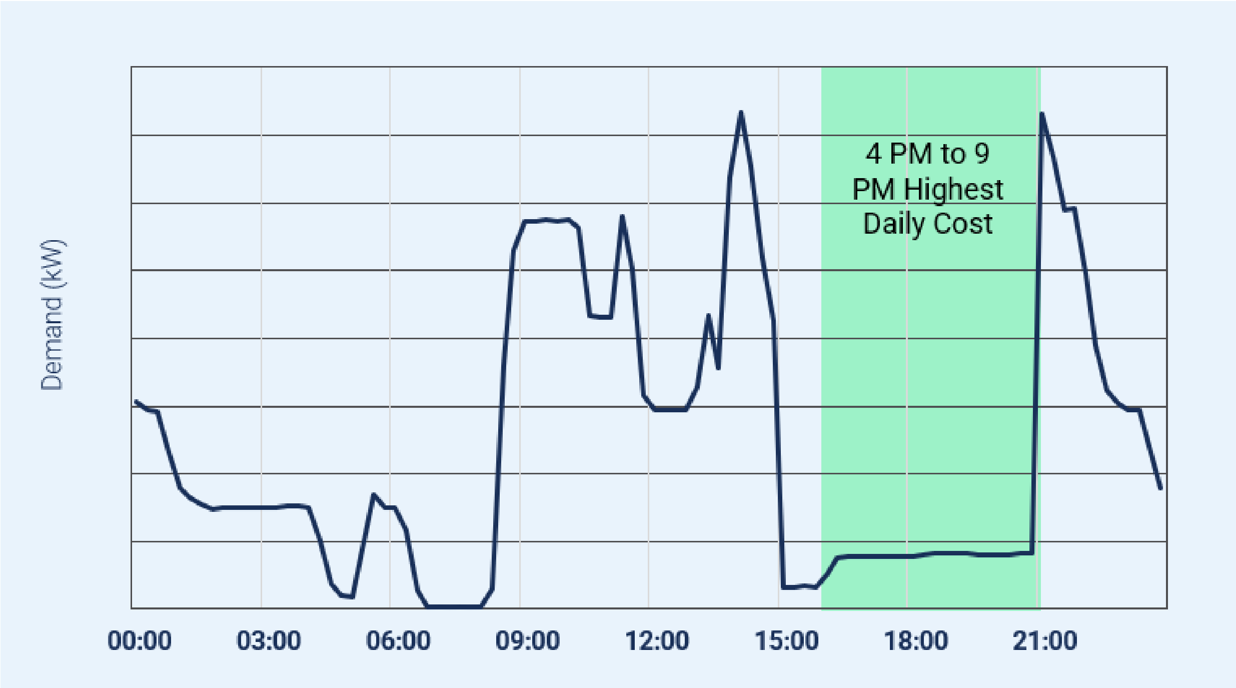
The Evaluation Team periodically reviews data on a site-by-site basis throughout the year to identify load managed sites. Visiting sites in person and speaking to fleet managers also provides context around load management intent. SCE is different from the other Utilities in that their EV tariff does not currently include demand-related costs. When accounting for demand-related costs, charging flexibility can also be used to estimate how much slower a vehicle can be charged.

Of the 39 sites operating vehicles across EY2021 and EY2022, three sites clearly exhibited the use of load management. This was evident in two ways:

- Load spiked quickly around 9 PM
- Low monthly proportion of energy used between 4 PM and 9 PM, often below 10%

Figure 33 shows the load profile of a CRT program site that exhibits the use of load management. In this example, load ramps up quickly between 1 PM and 2 PM, then drops precipitously for the period from 3 PM until 9 PM, and then rapidly ramps up to a similar load exhibited at 2 PM.

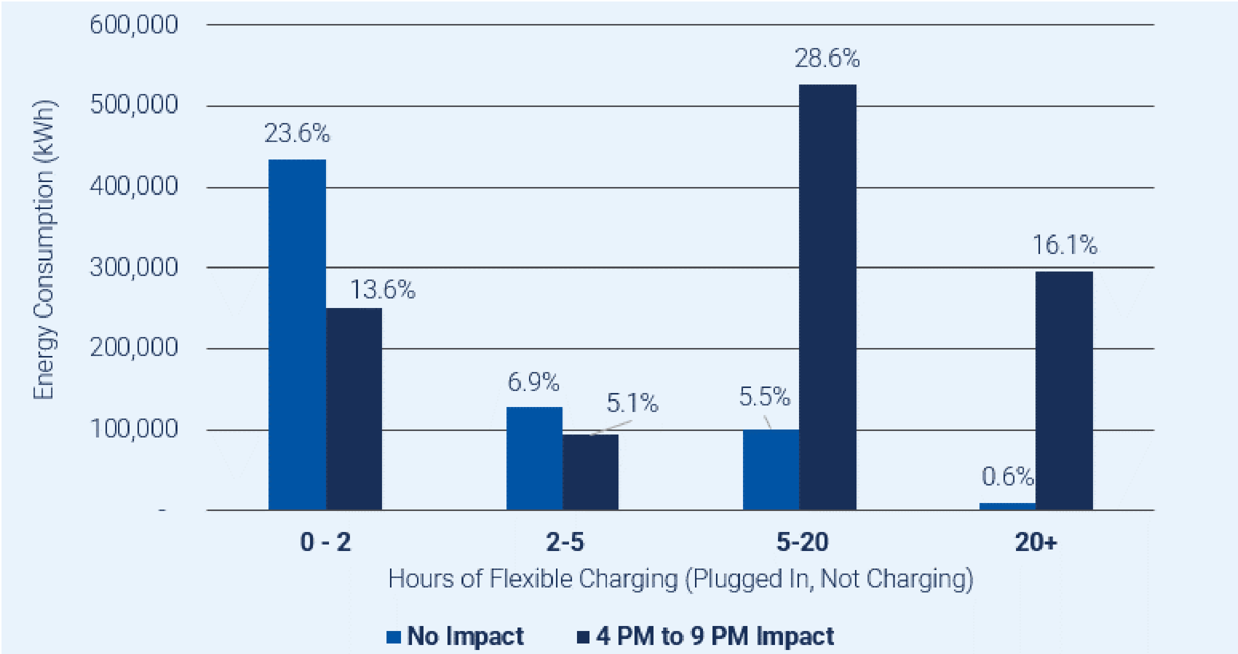
Figure 33. SCE CRT Program Example of Customer Using Load Management on Single Day



The team used charging session summaries from EVSPs to assess potential flexibility for when charging sessions consumed energy. Flexibility is currently defined as how much time a vehicle was connected to a charging port beyond the point at which the vehicle is fully charged. In the Evaluation Team's initial analysis of sessions, we scanned for realistic durations of connection or charging and potential faults ending sessions prematurely.

Figure 34 shows results of the charging flexibility analysis conducted by the Evaluation Team of school buses across all Utility programs. This analysis reveals that nearly 50% of charging energy and nearly 40% of school bus charging sessions (not pictured) overlapped with the high-cost peak demand period from 4 PM to 9 PM yet have evident flexibility to avoid consuming energy during this period. This indicates that most school bus charging can be optimized. It is apparent that load management strategies could allow operators to shift much of this consumption to other lower cost and lower emissions time periods. To a similar extent (not pictured), about 30% of non-school bus charging sessions during the 4 PM to 9 PM peak-rate period have enough charging flexibility to avoid this time period through the use of load management.

Figure 34. SCE, PG&E, and SDG&E MDHD Programs School Bus Charging Flexibility, Program-to-Date Sites



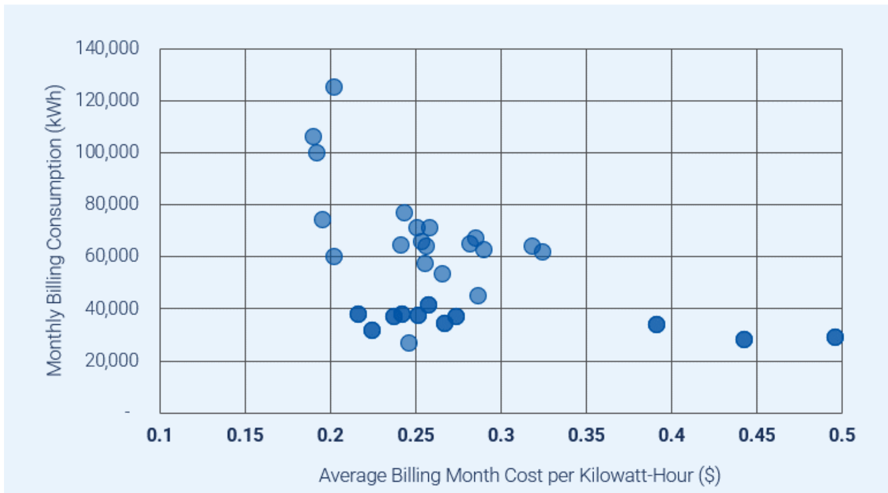
As part of the review process, the Evaluation Team frequently communicated with EVSPs, typically to collect data and to verify site activity when charging session data should be flowing. During these conversations, the Evaluation Team discussed load management capabilities and usage trends.

Nearly every EVSP involved in the program provided reliable data. However, not all EVSPs offered load management as of the end of 2022. Of the EVSPs that do provide load management, there is a mix of those that provide load management as part of their base offering versus others that offer it at an additional cost. Interoperability between hardware, software, and vehicles has presented an additional challenge that could make load management impractical or difficult to achieve. EVSPs are pursuing different business models and they differ in how they communicate with fleet operators. Site operators differ in their ability to perform load management.

Many fleet operators remain unaware of their energy consumption usage and charging costs even though most EVSPs make this data available. Often a site host's finance office will receive utility bills but not share this information with fleet operators that would enable them to compare energy costs with other fuel types in their fleet. The Evaluation Team uses energy trends as discussion points during site visits if operations have started. Many fleets had not seen these data trends prior to the evaluation site visits.

In terms of cost, larger fleets with consumption above 20 MWh per month generally had an average below $0.30 per kilowatt-hour monthly (Figure 35). They may have multiple daily operational and charging shifts that force more demand into periods outside of the 4 PM to 9 PM peak rate. For medium-sized consumers, with monthly consumption from 5 MWh to 20 MWh, costs often scale with the proportion of energy demand during the 4 PM to 9 PM peak-rate and have a substantial number of billing months averaging over $0.30 per kilowatt-hour (Figure 36). Small-sized users, with monthly consumption below 5 MWh, appear to have costs inverse to usage: less usage shows higher costs with less consumption over which to spread fixed fees (Figure 37).

Figure 35. SCE CRT Program Average Monthly Billing Cost for Large Consumption Customers (>20 MWh monthly), Program-to-Date Sites



There appears to be a significant opportunity for most fleets to substantially change their energy usage to shift charging load to lower cost time periods. This was evident in the Evaluation Team's analysis of charging flexibility and from speaking with operators. Current SCE tariffs reflect the costs during peak-rate time periods as being six times higher than the lowest cost time-period. Most operators seem sensitive to this regardless of whether they aware of their own usage trends and costs.

Figure 36. SCE CRT Program Average Monthly Billing Cost for Medium Consumption Customers (5 MWh to 20 MWh monthly), Program-to-Date Sites

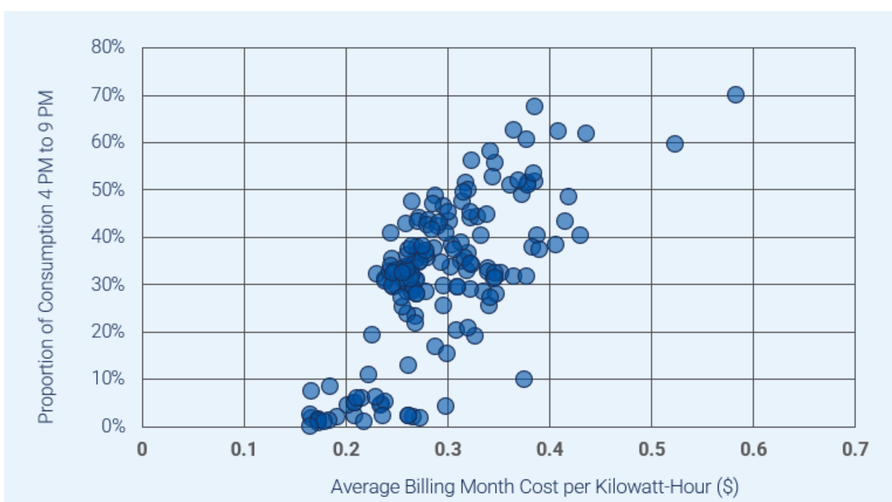
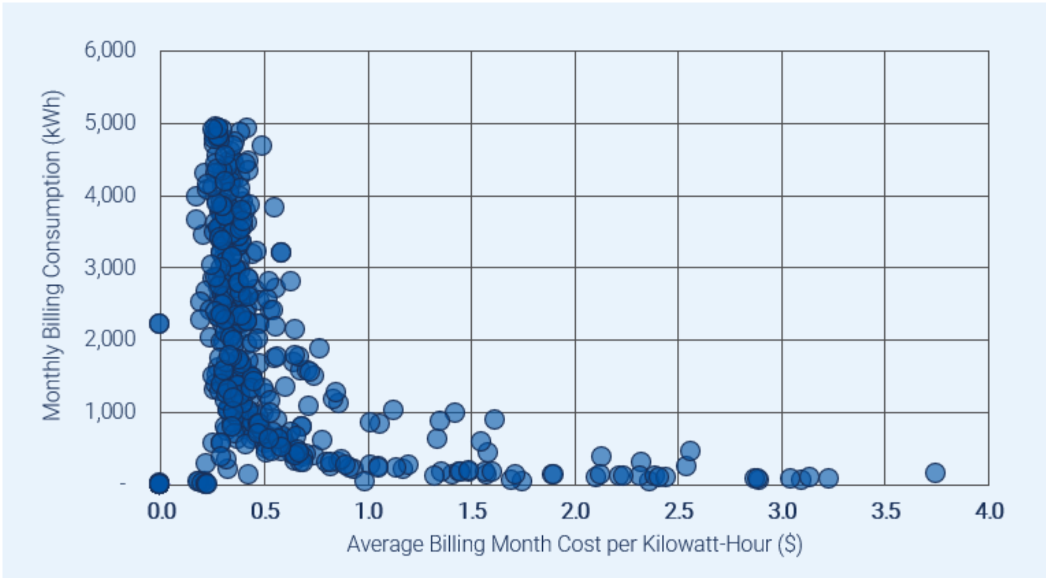
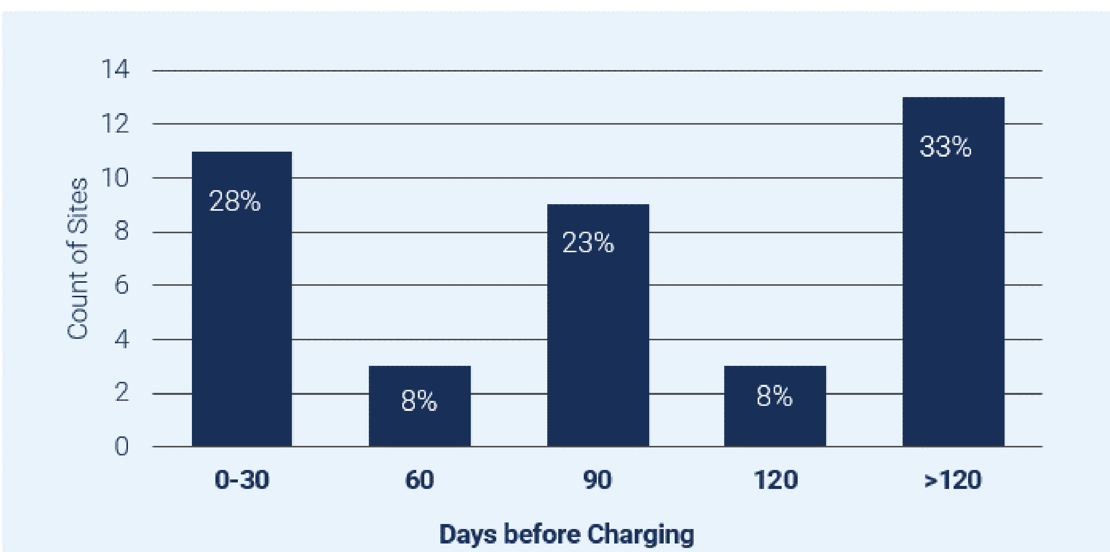


Figure 37. SCE CRT Program Average Monthly Billing Cost for Small Consumption Customers (<5 MWh monthly), Program-to-Date Sites



AMI data have shown that sites in general take substantial time to begin, and then to stabilize or mature their new EV operations. Figure 38 summarizes the duration between power being available for sites and when charging first begins. While it appears that about 30% of sites began charging within 30 days, a significant number of sites are taking longer than that, often due to supply chain issues. Projects that were brought online in 2022 are likely to stabilize their consumption trends in 2023. Several of these sites were not yet regularly charging vehicles in 2022, because vehicles had either not been delivered or were out of service or had vehicle-to-charger inter-operability issues.

Figure 38. SCE CRT Program Frequency of Days Site is Powered before Charging Starts, Program-to-Date Sites



Highlights

- Charging data indicates that there is significant opportunity for most fleets to shift their charging energy use to lower cost time-periods.
- Interoperability between hardware, software, and vehicles presents as significant a challenge to load management as education and awareness.
- Nearly 40% of school bus charging sessions overlapped the 4 PM through 9 PM peak-rate period but have enough flexibility to delay charging to a lower cost time-periods with effective load management.
- While nearly 30% of sites began vehicle charging within 30 days of power availability, more than 30% took over 120 days, often driven by supply chain issues.

Petroleum Displacement

The Evaluation Team determined petroleum displacement that is attributable to the vehicle electrification enabled by SCE's CRT program. We used DGE for reporting purposes. Transit bus primarily use CNG fuel, which means that the analysis needed to convert their natural gas consumption into DGE units based on the fuel's energy content.

Table 17 summarizes petroleum displacement impacts for CRT through 2022, including estimated annualized impacts for EY2022 sites, actual impacts for program-to-date sites, and the 10-year forecast for program-to-date sites. For EY2022 sites, nearly 1.5 million electric miles are estimated on an annualized basis. This translates into the displacement of over 200,000 DGE on an annualized basis. The results below are reported for the five market sectors represented in the program. If there are fewer than 15 customers for any market sector, the results are shown as totals across all market sectors only.

Table 17. SCE CRT Program Petroleum Displacement Summary

Market Sector	Usage		Petroleum Displacement (DGE)		
	EY2022 Sites Annualized (kWh) (n=15)	EY2022 Sites Annualized (miles, hours) (n=15)	EY2022 Sites Annualized (n=15)	PTD Sites Actuals (n=39)	PTD Sites 10-Year Projection (n=39)
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus				94,940	739,727
Transit Bus					
eTRU					
Total	**2,432,098**	**1,498,971 miles**	**208,972**	**396,073**	**4,079,368**

Note: values for population of less than 15 sites are redacted

Based on the Evaluation Team's analysis of EY2022 operational sites, the program is on target to displace over four million DGE over a 10-year period. The actual displacement will be higher as more EVs are added at existing sites. In addition to greater use at existing sites, SCE will build out additional sites through the program, resulting in higher total program impacts in the months and years ahead.

Highlights

- The 15 operational EY2022 sites achieved an annualized impact of over 200,000 gallons of petroleum displaced.
- The School Bus sector accounts for one quarter of the actual petroleum displaced by all sites participating in the program to date.
- Over a 10-year period, all sites in the program to date can be expected to displace over 4,000,000 gallons of petroleum.

Greenhouse Gas and Criteria Pollutant Impact

The Evaluation Team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service because of CRT. First, we developed ICE counterfactual equivalents for each market sector, then the team calculated the emissions associated with these vehicles under conditions that otherwise matched the EVs, which provided a baseline. Although EVs have no tailpipe emissions, the mix of generation sources from the electric grid includes renewable as well as fossil fuel power to supply electricity to the charging stations, with the latter primarily responsible for emitting GHGs and criteria pollutants into the atmosphere.

Table 18 summarizes GHG impacts from CRT for three time periods: (1) estimated annualized reductions that reflect what the program would have saved in 2022 if all EY2022 activated sites had been fully operational for all 12 months, (2) actual program to date reductions from EY2021 and EY2022 activated sites, and (3) a 10-year projection based on annualized data from EY2021 and EY2022 activated sites.

Table 18. SCE CRT Program GHG Reductions Summary

Market Sector	Usage		GHG Reduction (MT)		
	EY2022 Sites Annualized kWh (n=15)	EY2022 Sites Annualized Use (n=15)	EY2022 Sites Annualized (n=15)	PTD Sites Actuals (n=39)	PTD Sites 10-Year Projection (n=39)
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus				812	6,620
Transit Bus					
eTRU					
Total	**2,432,098**	**1,498,971 miles**	**1,739**	**2,985**	**32,889**

Note: values for population of less than 15 sites are redacted

Table 19 shows estimated reductions in local emissions from the tailpipes of ICE vehicles that were displaced through this program. The estimates of local emissions reductions are still relatively small in the first two years of the program, with the exception of transit bus (which have higher ROG and CO emissions due to the assumption that the displaced transit bus ran on CNG). In addition, our analysis confirmed that eTRU sites can achieve substantial savings on PM and ROG due to the poor emissions profile of diesel powered eTRU.

Table 19. SCE CRT Program Local Emissions Reductions, Actual Program-to-Date Sites

Market Sector	PTD Sites Actuals (n=39 sites)				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus	-	1.93	1.84	8.59	247
Transit Bus					
eTRU					
Total	**33.2**	**9.72**	**9.07**	**372**	**35,610**

Note: values for population of less than 15 sites are redacted

Table 20 shows the same information as above, but on an annualized basis for EY2022 sites. These are the localized emissions reductions that would have occurred if the sites were fully operational for the entire year. This annual estimate is necessary to calculate a 10-year reduction projection based on the program to date results.

Table 20. SCE CRT Program Local Emissions Reductions, Annualized EY2022 Sites

Market Sector	EY2022 Sites Annualized (n=15 sites)				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus					
Transit Bus					
eTRU					
Total	**63.1**	**16.0**	**14.9**	**656**	**36,191**

Table 21 provides an estimate of savings over the 10-year period. These are the annualized reductions from all projects to date extended over a decade.

Table 21. SCE CRT Program Local Emissions Reductions, 10-Year Projection Program-to-Date Sites

Market Sector	PTD Sites 10-Year Projected Impact (n=39 sites)				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus	-	17.4	16.7	75.5	2,073
Transit Bus					
eTRU					
Total	**2,500**	**221**	**2059**	**24,910**	**311,734**

Note: values for population of less than 15 sites are redacted

Table 22 shows counterfactual vehicle GHG emissions, emissions from the electricity used to charge the EVs, GHG emissions reductions, and percentage differences. Table 23 shows the net reductions of NO_x emissions from using EVs based on the counterfactual and Utility emissions. The Evaluation Team estimated a total annualized GHG reduction of 80% and a NO_X reduction of 83% from the use of EVs compared to counterfactual vehicles for EY2022 sites. Looking at the program to date sites, there is an estimated 75% actual reduction in GHG emissions and 65% reduction in NO_x emissions.

Table 22. SCE CRT Program Counterfactual GHG Reductions

Market Sector	EY2022 Sites Annualized GHG (MT) (n=15)				PTD Sites GHG (MT) (n=39)			
	Counter factual	Utility	Reduction	% GHG Reduction	Counter factual	Utility	Reduction	% GHG Reduction
Heavy-Duty Vehicles								
Medium-Duty Vehicles								
School Bus					1,004	192	812	81%
Transit Bus								
eTRU								
Total	**2,168**	**429**	**1,739**	**80%**	**3,742**	**757**	**2,809**	**75%**

Note: values for population of less than 15 sites are redacted

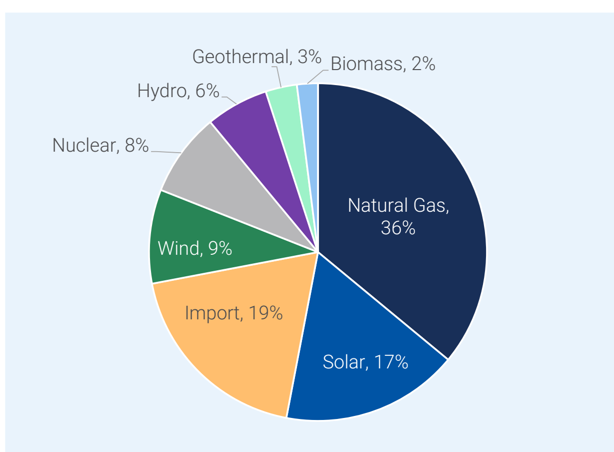
Table 23. SCE CRT Program Counterfactual NO_x Reductions

Market Sector	EY2022 Sites Annualized NO_x (kg) (n=15)				PTD Sites NO_x (kg) (n=39)			
	Counter factual	Utility	Reduction	% NO_x Reduction	Counter factual	Utility	Reduction	% NO_x Reduction
Heavy-Duty Vehicles								
Medium-Duty Vehicles								
School Bus					889.0	187.4	701.6	79%
Transit Bus								
eTRU								
Total	**2,532.3**	**418.2**	**2,114.1**	**83%**	**2,081.1**	**734.1**	**1,347.0**	**65%**

Note: values for population of less than 15 sites are redacted

Figure 39 shows the annual program net electricity generation mix matching the hours when the EVs were charging. The California Independent System Operator (CAISO) grid mix continually changes depending on factors such as the level of total demand for power on the grid and the availability of fossil generation and variable renewable resources such as solar.

Figure 39. SCE CRT Program Net Electricity Mix, Annualized EY2022 Sites

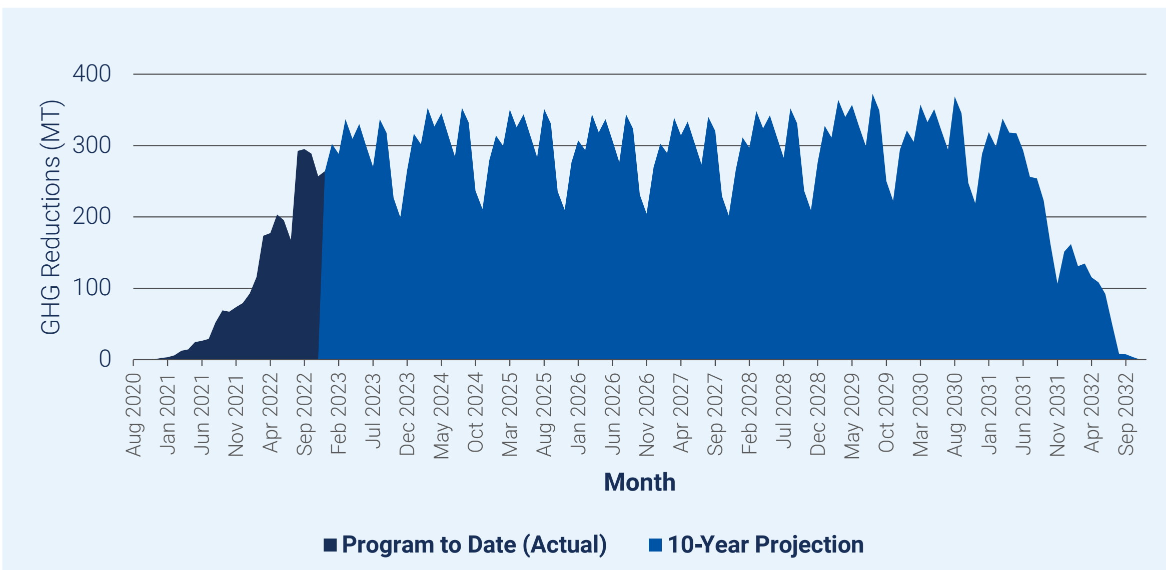


At this early stage of the program, it appears that the vehicles were not predominantly charging during the peak hours of solar output when grid emissions were the lowest. Approximately 19% of the grid mix is comprised of electricity imports, which do not vary by time of day for analysis purposes but match the resource mix purchased for the California grid.[43]

Based on the real-time grid conditions when charging occurred, the overall energy mix was comprised of 45% zero-emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 36% natural gas. Emissions reductions from these sites over 10 years are expected to increase as the grid becomes cleaner. Additionally, the increased use of managed charging, where possible, will reduce emissions as EVs charge at off-peak times and when the grid is supplied with greater amounts of renewable generation. Emissions will further decrease as more charging sites and EVs are added in future evaluation years.

Figure 40. shows how program GHG reductions have increased to date and are expected to grow over time for EY2021 and EY2022 activated sites. The analysis period ranges from the date that the first site in the program was activated through the end of 2022.

Figure 40. SCE CRT Program GHG Reductions, Historical and Forecasted, Program-to-Date Sites



The analysis incorporates the net reduction (counterfactual emissions minus utility emissions) for each fleet within the SCE CRT program. Program to date emission reductions are shown in dark navy while anticipated benefits based on annualization are presented in royal blue. As each site has its own starting date of operation, the 10-year sunset for each site is observed as a gradual tapering off of program benefits between 2029 and 2032. While each year's operations appear similar, there are several key factors driving the variations such as seasonality of utility generation sources (high utility emissions will

43 The power associated with imports comes from a mixture of renewables, hydro, nuclear, and natural gas power plants located outside of California (https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation).

appear as a dip on the curves), holidays occurring on weekends versus weekdays, and sites that became operational late in 2022 having predicted operations year-round in future years.

Highlights

- For EY2022 sites, analysis of annualized data estimated an 80% reduction in GHGs and an 83% reduction in NO_x emissions.
- The local emissions analysis for these sites estimated that the highest impact was the reduction of CO (annualized reduction of more than 36,000 kg and a projected 10-year reduction of more than 311,000 kg).
- Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 45% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 36% natural gas.

Health Impacts

The Evaluation Team calculated public health impacts (as benefits or costs) of reductions in criteria pollutants from vehicle electrification. Pollutants included in the analysis are primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, including NO_x, sulfur dioxide (SO_2), ammonia (NH_3), and volatile organic compounds (VOCs). The analysis only considers tailpipe emission reductions, rather than the full lifecycle emissions (such as power plant emissions). The Evaluation Team used the U.S. Environmental Protection Agency's (EPA's) CO-Benefits Risk Assessment Health Impacts Screening and Mapping tool (COBRA) to evaluate the health benefits associated with the emission reductions. COBRA estimates the benefits at the county level for the county in which emissions are reduced. It also estimates the effect on all counties in the U.S. due to the transport of emissions. This analysis includes only the effects of the emissions reductions in California. The Evaluation Team disaggregated the county-level effects to estimate the potential health benefits of projects for DACs and non-DACs.

The total value of the health benefits associated with the emission reductions is between $185,524 and $416,349. Table 24 shows the cumulative health benefits for counties in California associated with the emission reductions realized by the electrification of EY2021 and EY2022 CRT sites.

Table 24. SCE CRT Program California Health Benefits for EY2021 and EY2022 Sites

Health Endpoint	Change in Incidence (Annual Cases)		Monetary Value (Annual, 2023 Dollars)	
	Low	High	Low	High
Mortality	0.014	0.031	$181,942	$411,832
Avoided Medical Care				
Nonfatal Heart Attacks	0.001	0.006	$113	$1,048
Infant Mortality	< 0.000	< 0.000	$1,046	$1,046
Hospital Admits, All Respiratory	0.003	0.003	$149	$149
Hospital Admits, Cardiovascular	0.003	0.003	$170	$170
Acute Bronchitis	0.024	0.024	$18	$18
Upper Respiratory Symptoms	0.434	0.434	$23	$23
Lower Respiratory Symptoms	0.305	0.305	$10	$10

Emergency Room Visits, Asthma	0.005	0.005	$3	$3
Asthma Exacerbation	0.451	0.451	$41	$41
Lost Productivity				
Minor Restricted Activity Days	13.414	13.414	$1,446	$1,446
Work Loss Days	2.280	2.280	$562	$562
Total Health Effects	-	-	**$185,524**	**$416,349**

At the site level, the TRU market sector has the highest health benefits overall, followed by school bus, heavy-duty vehicle, transit bus, and medium-duty vehicle market sectors. The TRU market sector also had the highest health benefits on a per-site basis, followed by the heavy-duty vehicle, school bus, transit bus, and medium-duty vehicle market sectors.

As part of this analysis, the Evaluation Team also examined the health benefits within DACs. The COBRA tool estimates effects at the county level, so the team disaggregated the monetary health benefits by census tract using the relative population of each tract from the most recent American Community Survey. For example, for a census tract with 10% of the county's population we allocated 10% of the value of the health benefits. The Evaluation Team then estimated the total benefits allocated to DACs and non-DACs.[44] The approach implicitly assumes that the benefits of emission reductions are distributed evenly throughout the county. If the sites are located in DACs, and the emission reductions are greater in the tracts near the sites, this approach would understate the potential benefit to DACs. Additional information about emission dispersion within counties is needed to provide more precise estimates of the health benefits to DACs and non-DACs. Los Angeles County had 78% of the total benefits, followed by Orange County (8%), San Diego County (4%), Ventura County (2.2%), and Riverside County (1.9%). Overall, 37% of the benefits are in DACs.

Highlights

- Cumulative health benefit results for counties in California realized by the electrification of EY2021 and EY2022 CRT sites in terms of monetary benefits range from $185,524 for the low estimate and $416,349 for the high estimate.
- Sites in the TRU market sector have the highest health benefits overall as well as on a per-site basis.
- Los Angeles County had the highest proportion of overall impacts at 78%, followed by Orange County (8%), San Diego County (4%), Ventura County (2.2%), and Riverside County (1.9%).
- As a proportion of overall benefits, the benefits attributed to DACs is 37%.

[44] DAC census tracts are defined as those included in in the SB 535 Disadvantaged Communities List (2022), which includes DAC categories for CalEnviroScreen 4.0 Top 25%, CalEnviroScreen 4.0 High Pollution Burden Score and Low Population Count, and 2017 Disadvantaged Community (CalEnviroScreen 3.0 only).

Net Impacts

As part of the net impacts analysis, the Evaluation Team estimated program effects on participants to exclude impacts from actions that participants would have taken without the program (freeridership) and to include any program attributable indirect impacts on participants (participant spillover) and nonparticipants (market effects). The team conducted three separate analyses to assess net impacts from the MDHD programs.

Enhanced Self-Report

The Evaluation Team based our approach for the MDHD programs' enhanced self-report NTG analysis on information obtained as part of in-depth surveys with participating fleet managers. The Evaluation Team conducted the survey via an online survey platform, Qualtrics, and delivered the survey using email contact information provided by SCE. The Evaluation Team used the CPUC nonresidential customer self-report NTG framework as the base to develop the MDHD fleet manager NTG methodology approach.[45]

The *Methodology* section details the MDHD fleet manager self-report NTG methodology. The Evaluation Team estimated the core component of the CPUC NTG methodology through three separate program attribution index (PAI) project scores. The Evaluation Team used three separate sets of questions to assess three components of the core NTG ratio, with each PAI score on a 0.0 to 1.0 scale representing a different way of characterizing CRT program influence. The analysis included fleet manager responses from four of the 14 participating sites that were sent the survey.[46]

The Evaluation Team calculated the resulting self-report NTG for each project, prior to accounting for participant spillover, as the average of the PAI-1A, PAI-2, and PAI-3 score values. One minus the final core NTG ratio of 0.48 equals the 0.52 freeridership ratio for the MDHD program.

The participant spillover analysis revealed that none of the surveyed sites reported electrifying more of their fleet since participating in the CRT program, without the benefit of funding from the SCE program or where their SCE CRT program participation was important in this additional purchasing decision. The resulting participant spillover ratio is 0.00. The final program-level NTG ratio of 0.48 equals one minus the freeridership ratio plus the participant spillover ratio. These NTG values are presented in Table 25, along with the average final core NTG for the surveyed SCE CRT program sites.

Table 25. SCE CRT Program MDHD NTG Analysis Results in EY2022

Fleet Manager Survey Completes (n)	Average of PAI-1A Score NTG	Average of PAI-2 Score NTG	Average of PAI-3 Score NTG	Average of Final Core NTG	Freeridership Ratio	Participant Spillover Ratio	Final NTG Ratio
4	0.52	0.38	0.55	0.48	0.52	0.00	0.48

---

45 California Public Utilities Commission, Energy Division. February 20, 2015. *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Nonresidential Customers.*

46 Three school bus sites and one medium-duty site completed the survey.

Highlight

- EY2022 program-level freeridership ratio is 0.52 with a 0.00 participant spillover ratio, which resulted in a program-level NTG ratio of 0.48.

Truck Choice Model

The Evaluation Team assessed the impacts of the Utility MDHD programs using a modified version of the Truck Choice Model, developed at the University of California-Davis.[47] The model mimics new vehicle purchase decisions made by MDHD fleet operators when accounting for lifecycle vehicle and operating costs and human preferences. Notable barriers to electric MDHD vehicle adoption—such as vehicle availability of specific market sectors—is not captured in the model.

The Evaluation Team calculated new MDHD adoption for four market sectors—school bus, transit bus, medium-duty vehicles (delivery vehicles), and heavy-duty vehicles (short-haul trucks)—for 2025, 2030, and 2035. The Evaluation Team developed three scenarios that vary by who pays for the TTM and BTM infrastructure for electric MDHD vehicles, thereby isolating the impact of the TTM and BTM expenses on the vehicle purchase decision, all else equal. These three scenarios were:

- **Scenario 1: No Utility Support** = No Utility support for TTM or BTM. The fleet operator pays for the BTM costs, including EVSE installation and EVSE capital expenses;
- **Scenario 2: TTM Support** = Utility support for TTM infrastructure as required by AB 841 but the fleet operator pays for the BTM costs, including EVSE installation and EVSE capital expenses; and
- **Scenario 3: TTM + BTM Support** = Utility support for both TTM and BTM infrastructure, including partial rebates for EVSE installation and capital expenses.

Table 26 shows new MDHD vehicle adoption for the three scenarios and four market sectors. The difference between scenarios within a market sector is the impact of Utility-sponsored TTM or TTM+BTM infrastructure. For example, for school buses in 2025, the difference between the No Utility Support and TTM+BTM Support scenario is 26% (29%-3%), which—under the assumptions in the model—implies that Utility support for TTM and BTM infrastructure will increase electric school bus adoption by 26 percentage points.

47 University of California–Davis Institute of Transportation Studies (Miller, Marshall, Qian Wang, and Lewis Fulton). 2017. *NCST Research Report: Truck Choice Modeling: Understanding California's Transition to Zero-Emission Vehicle Trucks Taking into Account Truck Technologies, Costs, and Fleet Decision Behavior*." Research Report UCD-ITS-RR-17-36.

Table 26. California EV Sales Shares for Each Segment as a Function of the Three Trajectories

Market Sector	2025	2030	2035
School Bus			
No Utility Support	3%	21%	40%
TTM Support	11%	45%	74%
TTM + BTM Support	29%	69%	92%
Transit Bus			
No Utility Support	1%	41%	84%
TTM Support	41%	80%	100%
TTM + BTM Support	44%	99%	100%
Medium-Duty Vehicle			
No Utility Support	0%	0%	0%
TTM Support	2%	5%	7%
TTM + BTM Support	33%	63%	65%
Heavy-Duty Vehicle			
No Utility Support	0%	0%	0%
TTM Support	1%	5%	9%
TTM + BTM Support	9%	30%	43%

The results illustrate that new electric MDHD vehicle adoption increases substantially across market sectors when TTM and TTM+BTM support is provided. The results also demonstrate the importance of the HVIP program, California's vehicle incentive program. For market sectors with high HVIP incentives relative to the new vehicle cost, like transit bus, adoption rates are higher than those for other market sectors that have lower relative incentives compared to new vehicle cost, like short haul.

There are several reasons for caution when interpreting these results. For example, HVIP and LCFS funding levels vary year to year based on decisions in the state government or fluctuations in the LCFS credit market. Additionally, the Evaluation Team has intentionally not included California's ACT and ACF regulations, which mandate the sale and purchase of zero-emission MDHD vehicles. This allows the Evaluation Team to isolate the impact of only the TTM and BTM costs. Finally, as noted above, these results do not reflect certain known barriers to electric MDHD vehicle adoption, like vehicle availability, which would dampen the trajectories.

Highlights

- In scenarios in which fleet operators have no financial responsibility for TTM or BTM infrastructure expenses (TTM+BTM Support Scenario) and have no external constraints or requirements on vehicle purchases (such as vehicle availability and ACF purchase requirements), results of the Truck Choice Model suggest that Utility TTM and BTM programs are critical to changing the adoption trajectory of MDHD vehicles.
- Factors that are not easily captured in the model (such as ACF regulation, switchgear wait times, and vehicle availability) could change the trajectories.

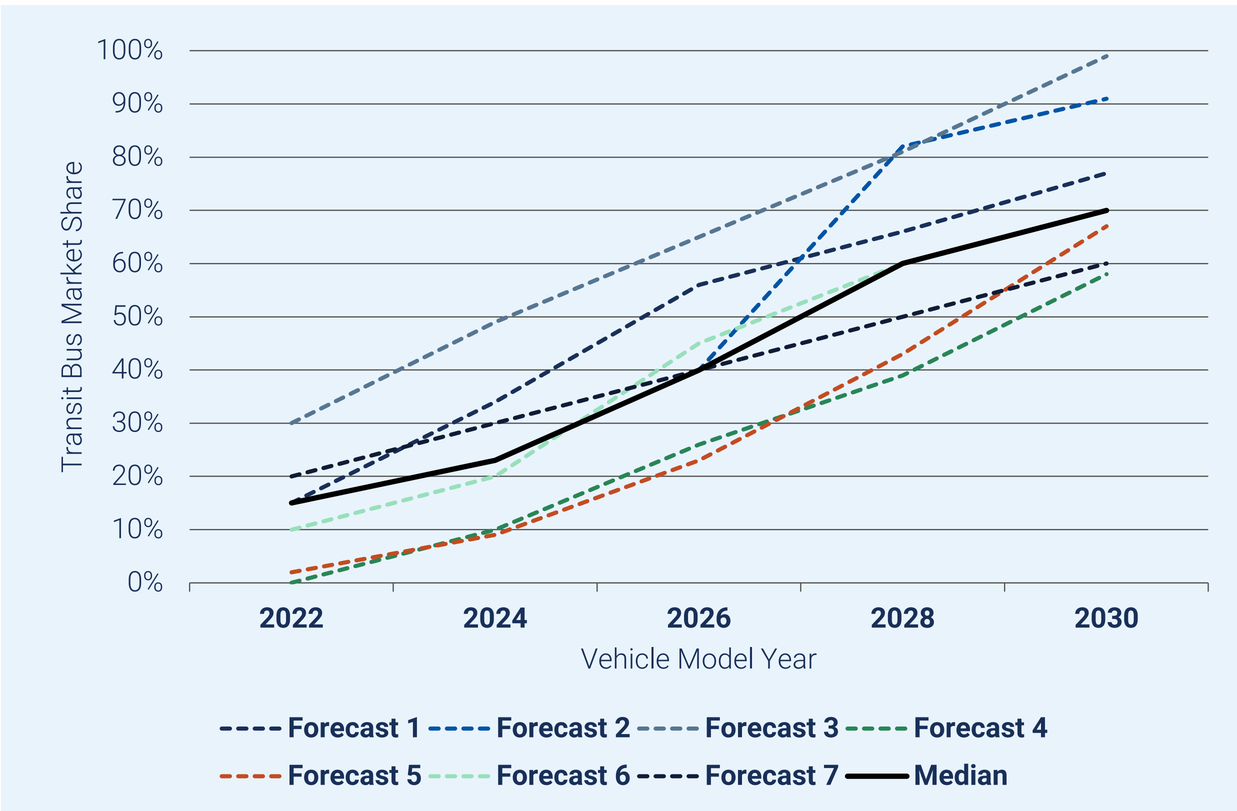
Market Effects

For the market effects analysis, the Evaluation Team assessed structural long-term changes in the TE market by comparing actual market activity to what would have happened in the absence of the programs.

Transit Bus Electrification Market Share Baseline

The Evaluation Team developed a baseline market share forecast of electric transit bus in California through vehicle model year 2030 based on two rounds of input from the Delphi process. This baseline represents electrification in the transit bus market in California in the absence of Utility incentives. Figure 41 shows the individual curves from the first round of input (Round 1), along with the median curve. Note that the horizontal axis indicates vehicle model year and only applies to *new vehicles*, not to the entire statewide vehicle stock.

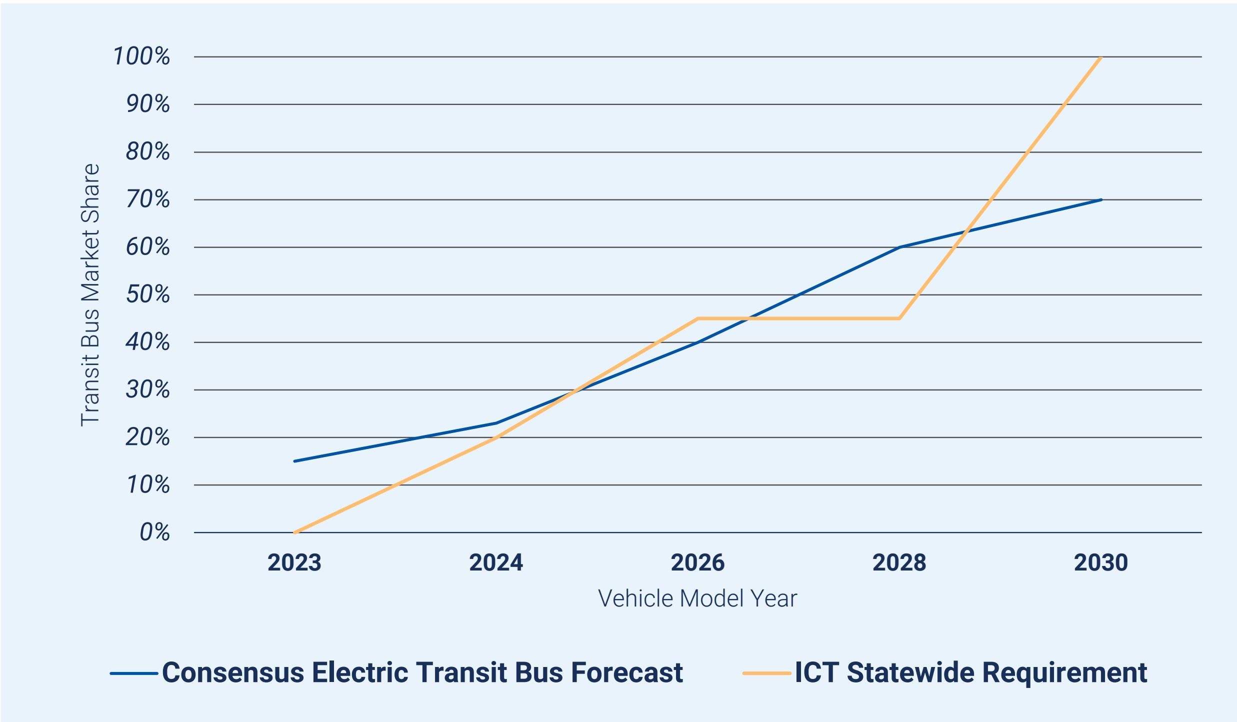
Figure 41. Delphi Panel's Round 1 Baseline Electric Transit Bus Adoption Forecasts



Despite the range in Round 1 forecasts, there was general agreement within the Delphi panel that the electric transit bus market will experience relatively linear growth over the next several years and will reflect most of the overall transit bus market by 2030. In Round 2, five of seven panelists agreed with the median or consensus forecast, while two panelists submitted new forecasts and rationales. As described in the *Methodology* section, the forecasting rounds continue until a majority consensus is reached. Since over half the panelists were in agreement after Round 2, the median forecast is considered the final consensus result. Figure 42 shows the final consensus estimate compared to the zero-emission transit bus sales schedule from the ICT regulation. The ICT regulation specifies calendar year purchase requirements (where a certain percentage of all new vehicle purchases must be zero-emission) for California public transit agencies.[48]

The consensus trajectory generally aligns with the ICT requirement for 2024 and 2026. It stays above the ICT required level for 2028 but falls short of the 100% requirement for 2030, possibly because the ICT regulation allows for flexibility in how transit agencies meet purchase requirements. Hydrogen fuel cell bus are also considered zero emission under ICT.

Figure 42. Delphi Panel's Electric Transit Bus Baseline Market Share Forecast



Of the two experts who did not agree with the median, one said the market share will grow faster than the median forecast starting in the mid-2020s due to headwinds against the fossil fuel industry, increased public support for electrification, and compliance with the ICT requirements. The other dissenting expert said the median forecast is too aggressive and that the electric transit bus market share will grow at a slower rate due to supply chain constraints (specifically that there are many competing demands for these batteries, such as for use in LDVs).

While deriving the majority consensus forecast achieved the main goal of the Delphi panel, panelists' supporting rationales also contain valuable qualitative information. Aggregating the supporting

48 The ICT regulation specifies different sales requirements for small (<100 bus) and large (>100 bus) transit agencies. The Evaluation Team used the statewide requirement in our analysis, which assumes similar turnover at large and small transit agencies.

comments revealed deeper insights into factors that panelists predict will accelerate or impede transit bus electrification in California.

One panelist specifically cited the $1.3 billion in annual Federal Transit Administration grants for low- and zero-emission bus and infrastructure that is expected over the next five years. Another panelist projected that starting in the 2026 to 2028 timeframe, transit buses will achieve cost parity on a TCO basis, which will drive up market penetration. Another noted that EV penetration will likely continue to increase with technology improvements, cost reductions, and competition in the transit EV market.

One panelist noted that without continued funding support at the federal and state levels, such as CARB's HVIP program, transit agencies may struggle to electrify larger proportions of their fleets. It will be particularly challenging to finance new bus if existing bus are still mid-lifecycle and not up for replacement. Buses are typically retired on a 12-year cycle; however, transit agencies may be down-sizing their bus fleets due to increased micro-transit and demand response service, which could alter vehicle replacement timing and subsequently slow the speed of adoption. Rationales for forecasts with lower and slower market growth included the possible lack of manufacturer compliance and the persistence of late adopters due to technology concerns.

Although this study only considered battery electric transit bus market share, two panelists also mentioned hydrogen fuel cell technology. Fuel cell bus could potentially allow the ICT requirement to still be met without achieving 100% battery electric bus market share in the transit bus market sector by 2030. Fuel cell bus may become an attractive option if battery supply remains constrained. One expert noted that the advancements in and adoption of hydrogen will aid battery electric technology, specifically using hydrogen as an energy storage technology to support high-powered EVSE.

The fact that the consensus forecast falls short of ICT requirements in 2030 shows that experts believe it will be challenging for transit agencies to scale all-electric fleets to the ICT regulation levels without additional support. The consensus forecast represents the market share of electric transit bus in the *absence* of California Utility incentives. In conclusion, panelists agreed that transit agencies may struggle to scale up charging infrastructure and electrify larger proportions of their fleets to meet the later ICT requirements without either financial incentives and support from various sources, including Utilities, or the help of other ZEV technologies such as fuel cell bus.

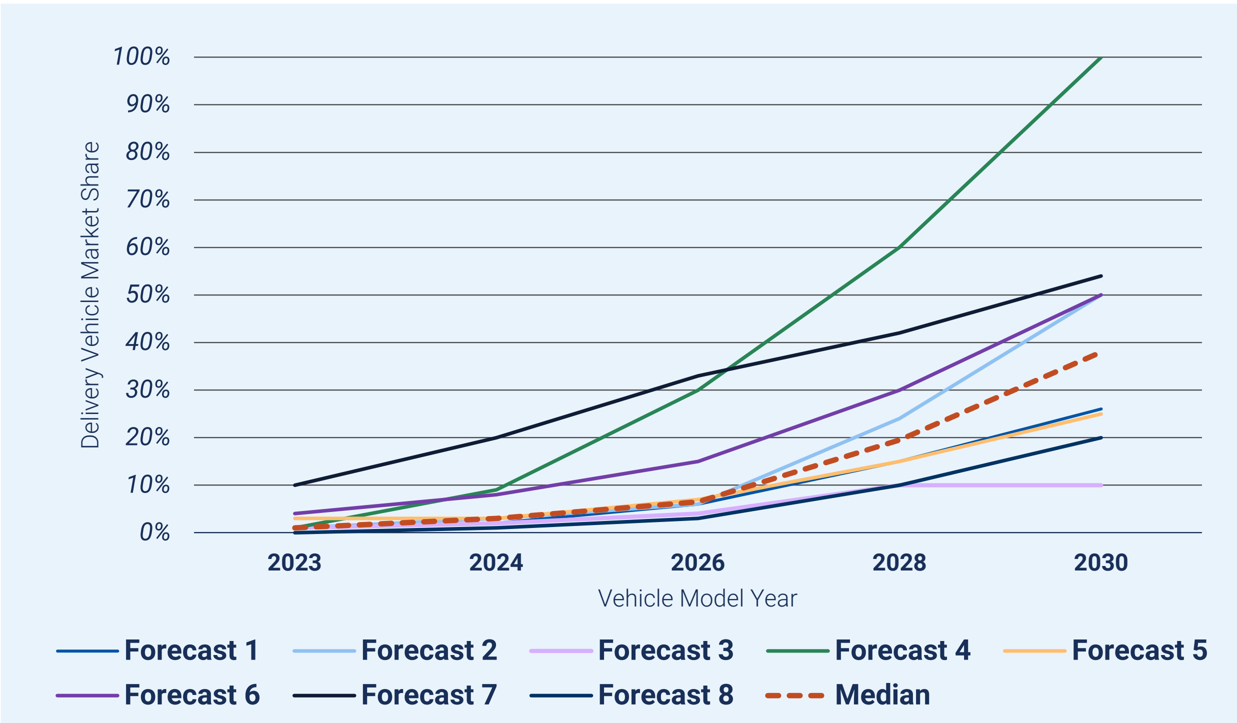
Highlights

- The consensus forecast for electric transit bus market share in California generally aligns with the ICT regulation requirements for 2024 and 2026 but falls short of the 100% level for 2030.
- Increased availability of funding is the primary factor in transit agencies meeting the initial purchase requirements of the ICT regulation, while economics will drive adoption starting in the mid- to late-2020s due to battery technology improvements, cost parity with diesel bus, and technological advances in charging infrastructure.

Delivery Vehicle Electrification Market Share Baseline

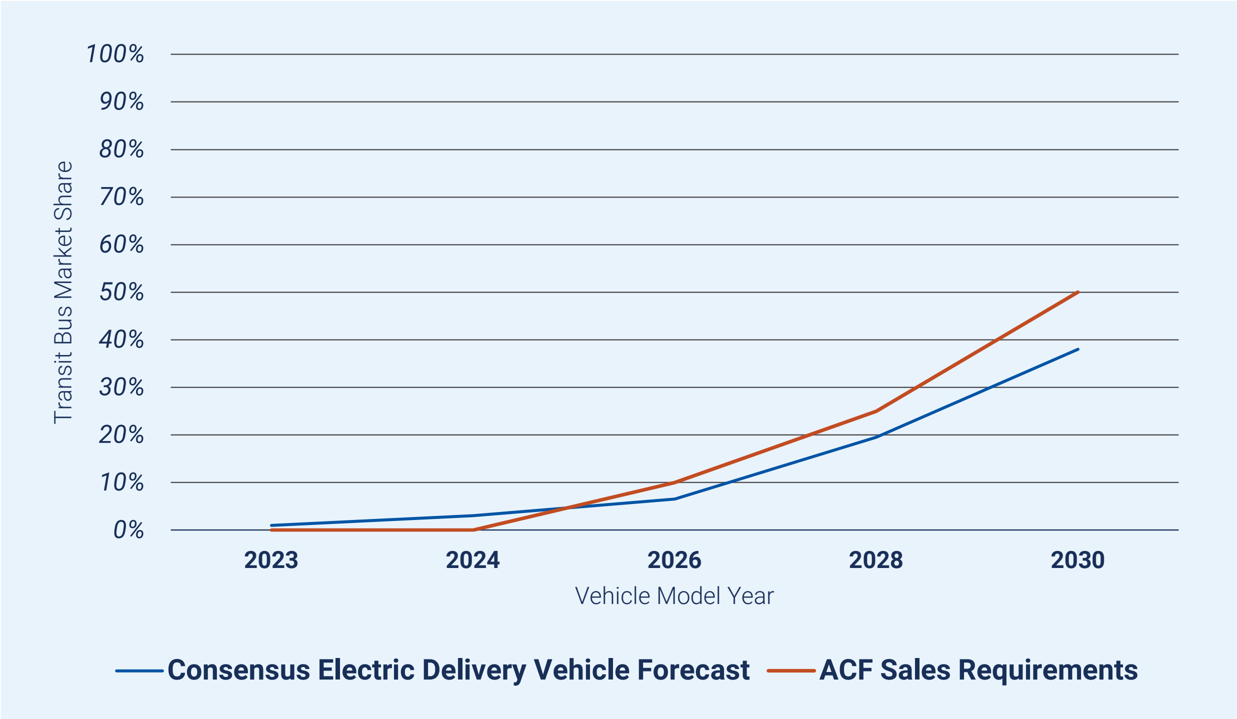
The Evaluation Team forecasted the baseline market share of electric delivery vehicles in California through vehicle model year 2030 following two rounds of input from the Delphi process. For this study the delivery vehicle market sector is defined as cargo vans, step vans, and box or straight trucks operating last-mile parcel delivery. Figure 43 shows the individual curves from the first round of input (Round 1), along with the median curve. Note that the horizontal axis indicates vehicle model year and only applies to *new vehicles*, not to the entire statewide vehicle stock.

Figure 43. Delphi Panel's Round 1 Baseline Electric Delivery Vehicle Adoption Forecasts



The Round 1 forecasts contain a few outliers, but in general panelists agreed that the electric delivery vehicle market will increase slowly until a tipping point in the mid-2020s when growth accelerates. In Round 2, five of eight panelists agreed with the median or consensus forecast, while three panelists submitted new forecasts and rationales. As described in the *Methodology* section, the rounds continue until a majority consensus is reached. Since over half the panelists were in agreement after Round 2, the median forecast is considered the final consensus result. Figure 44 shows the final consensus estimate compared to the zero-emission sales schedule for last-mile delivery vehicles from the ACF regulation. The ACF regulation imposes targets beyond those of the ACT regulation for fleets, businesses, and public entities that own or operate MDHD vehicles in California. The ACF regulation specifies calendar year purchase requirements (that a certain percentage of all new vehicle purchases must be zero-emission) for certain fleet market sectors that are well-suited for electrification, including parcel delivery vehicles.[49]

Figure 44. Delphi Panel's Electric Delivery Vehicle Baseline Market Share Forecast



Of the three experts who did not agree with the median, two decreased their projections while one increased their projection. The rationales for decreased projections warn of supply constraints on the battery market and the high costs of installing charging infrastructure. Battery supply will be in competition for use in LDVs, and the necessary grid improvements for high penetration rates will take significantly more time than accounted for in high adoption predictions, as permitting alone can take years. Delivery depots that house dozens to hundreds of vehicles will need massive electrical upgrades, and the costs of installing charging infrastructure will not be covered by EV energy savings alone, especially because charging will likely occur during peak periods. The panelist who increased their forecast argued that Class 2b trucks and vans will increasingly dominate the parcel delivery market sector and are well-suited for electrification given their lower power requirements.

While deriving the consensus forecast achieved the main goal of the Delphi panel, panelists' supporting rationales also contain valuable qualitative information. Aggregating the supporting comments revealed deeper insights into factors that panelists predict will accelerate or impede delivery vehicle electrification in California.

---

[49] Parcel delivery vehicles are included in the ACF sales requirements for Milestone Group 1, which is composed of box trucks, vans, bus with two axles, yard tractors, and light-duty package delivery vehicles.

The median trajectory shows the electric delivery vehicle market falling short of the ACF sales requirements, which start in 2025. Panelists noted several reasons this market sector could struggle to meet the ACF targets:

- Three panelists mentioned infrastructure costs in particular as a major concern.
- One panelist mentioned the potential of grid congestion and questioned whether California Utilities can build out new grid capacity before the existing distribution grid capacity is too constrained.
- From the fleet operator perspective, another panelist noted that high infrastructure costs will absorb all the financial benefits of fleet electrification and fleet operators will not see any return on investments.

Other rationales included a slow ramp-up of production, the lack of market-ready options, and the fact that electric delivery trucks have yet to definitively demonstrate being reliable and durable for demanding work requirements. Two panelists also mentioned market contractions and the potential of a global recession, which could have a negative impact on the uptake of EVs across all applications.

Three individual forecasts were more optimistic and showed the ACF requirements either being met or exceeded. These panelists cited the increasing availability of models from national OEMs and incentive programs like the CARB's HVIP program that help to make delivery vehicles cost-competitive with their ICE counterparts. They noted that this market sector is well-positioned for electrification by having predictable routes along relatively shorter distances in urbanized environments and the ability to charge overnight at depots (similar to transit bus).

After submitting their forecasts, the Evaluation Team asked the panelists about the impacts of the ACF and ACT requirements and Utility incentive programs on the electric delivery vehicle market share through 2030. Two panelists said that both the CARB regulations and Utility programs are accelerating the market. According to one expert, it is because of California's suite of ZEV-supportive policies that roughly half of all zero-emission trucks and bus sold in the U.S. and Canada are sold in the state of California. Without the CARB regulations, this panelist would have reduced their forecast by 50%.

Panelists also agreed that Utility programs are having a positive impact on electric delivery vehicle sales. Experts noted several benefits of the Utility programs, including the investments and partnerships to deploy truck-specific public charging and fast-tracking the installation of depot charging. Given that the consensus forecast represents the market share of electric delivery vehicles in the *absence* of Utility incentives, a potential 10 percentage point bump from these programs could be the difference in delivery fleets meeting or missing ACF requirements.

Highlights

- The baseline forecast for the electric delivery vehicle market share falls short of ACF sales requirements, which start in 2025. This shortfall is due to high infrastructure costs, competition with the light-duty market for battery supply, grid congestion, a slow ramp-up in the production of market-ready options, and the impacts of market contractions.
- The ACF and ACT requirements and Utility incentive programs are helping to accelerate the electric delivery vehicle market.

3.1.3. Lessons Learned

The team identified a number of lessons learned from EY2022. These lessons, presented below with key supporting findings and recommendations, may be applied to future program years and to other similar efforts. Note that these lessons were derived from a limited number of program participants across most but not all market sectors. Additional insights will be gained as more sites are completed in the coming years.

The CRT program is progressing well towards its EV supported goal but lagging behind its goal for number of sites.

In EY2022, 15 sites with 432 charging ports were activated supporting 456 vehicles, based on VAPs of activated sites. A new vehicle market sector, eTRU, was supported by the CRT program in EY2022 with two activated sites (including the largest project site across all Utility programs), bringing the total market sectors to five. As of the end of 2022, 39 sites have been activated with 590 charging ports to support 747 additional electrified vehicles.

The 108 contracts signed in the CRT program to date support 2,344 MDHD vehicles, meeting 28% of the program's *per se reasonableness* goal of 870 sites and support 12% of the program's *per se reasonableness* goal of 8,490 additional vehicles electrified. A total of 211 customer applications to date could satisfy approximately 24% of the program's site goal and 50% of the vehicle goal. However, SCE staff are concerned about achieving programmatic site goals. The prescriptive program design may restrict some customers and impact the total number of project sites. CRT program staff noted that some of the program requirements can be challenging for small fleets. Specifically, staff reported that the requirements are challenging because some small fleet customers do not own their sites and are not able to meet the vehicle requirements per site, which may limit the number of sites that can enroll in the program.

Overall program spending is ramping up slowly, however program spending on DAC sites exceeds targets.

SCE spent $10.3 million of the CRT program budget in EY2022, bringing total spending to $22 million out of $342.6 million of the approved program budget, or 6.4% of available funding. Fifty-eight percent of SCE CRT program spending- on infrastructure for financially closed out sites to date has been on DAC sites, exceeding the 40% program target. Additionally, both in EY2022 and program to date, greater than 69% of sites, charging ports, and vehicles are in DACs.

Fleet programs are having a measurable and increasing impact on petroleum reduction, GHG emission reductions, criteria pollutant emission reduction, and health benefits.

The 15 activated EY2022 sites achieved an annualized impact of over 200,000 gallons of petroleum displaced, and program to date sites are expected to displace over 4,000,000 gallons of petroleum over a 10-year period. EY2022 activated sites resulted in an 80% reduction in GHG emissions relative to the counterfactual vehicles, while program to date sites achieved a 75% reduction. Annualized GHG emissions reductions from EY2022 sites was 1,739 MT with 47% in DACs.

The CRT program to date has reduced GHG emissions by 2,985 MT and currently activated program to date sites are expected to reduce GHG emissions by 32,889 MT over a 10-year period. The total value of the health benefits associated with the emission reductions in the program to date is between $185,524 and $416,349. The overall energy mix in EY2022 contained about 45% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear). Emissions impacts could be greater through the use of greater load management, specifically by enabling vehicles to avoid charging during peak rate periods while taking advantage of periods with a higher mix of renewable generation.

SCE expanded and improved CRT program customer education and outreach efforts to strengthen number and quality of applications received.

Through the TEAS program, SCE provided fact sheets, webinars, and other educational materials to assist its customers. SCE also provided grant writing and review assistance to smaller fleets to enhance their participation in the CRT program, as well as EV readiness studies including one-on-one conversations with customers about the electrification process. Based on the evaluation survey, three of the four responding fleet managers heard about the program directly from SCE, and all were highly satisfied with program communication.

TTM and BTM infrastructure costs continue to vary widely between project sites. Program participants continue needing Utility infrastructure incentives.

Across 16 financially closed out sites, Utility spending resulted in an average infrastructure cost of $195,420 per project site, $1,269 per kW, and $25,180 per vehicle, when including TTM and BTM infrastructure but excluding EVSE cost. These values include both L2 and DCFC sites and aggregate multiple market sectors across EY2021 and EY2022. The simple average across the 16 for TTM is $8,042 per vehicle and BTM is $17,138 per vehicle. Vehicles in the CRT program average 8,430 VMT per annum, resulting in lifetime operational cost savings of approximately $34,000 in comparison to conventional ICE vehicle (10-year NPV). These savings alone are unlikely to cover the purchase price increment of an EV at present.

As the CRT program continues to evolve, surveyed program participants and EVSPs report high satisfaction with the program and with SCE.

All four responding fleet managers rated themselves as *very satisfied* with the program and as *very likely* to recommend the program to others, noting excellent communication by SCE staff. Both fleet managers who withdrew from the CRT program also rated the program favorably. Environmental benefit, followed by operational and cost benefits, continue to be the strongest motivators for program participation.

EVSPs stated that there is sufficient demand from fleet owners to warrant expanding the CRT program with additional technical assistance and incentive funds. EVSP interviewees also noted that Utilities are good partners for deploying infrastructure and that the CRT is well-implemented.

Program timelines were longer than expected, and site costs and supply chain delays continued to be a challenge.

The median start-to-fish duration is 841 days for all EY2022 activated sites and is 722 days for all activated sites in the program to date. For program to date activated sites, Design and Permitting is the longest phase, with a median of 205 days, followed by Construction Complete with a median of 133 days. EVSPs and program staff noted that delays from switchgear procurement was the most important driver in delays. Switchgear cannot be ordered until Phase 3 (Contract Issuance) is complete and delivery can take over 70 weeks.

Two of the four surveyed fleet managers also noted the long timeline for program implementation. EVSPs noted that while SCE has been a strong project partner, additional staffing could expedite the site analysis process. Fleet operators reported that delays were also driven by vehicle availability and said several sites had not yet received some or all of the expected vehicles at the time of site visits.

Installed EV ports are underutilized, and the majority of fleet operators are not implementing load management.

Across EY2022 activated sites, 11,000 kW of new charging capacity was installed, bringing total capacity for the program, to date sites to 16,000kW. However, peak demand never exceeded 2,215 kW in 2022, or 14%, highlighting underutilization. Many fleet operators said they had not yet received some or all of their vehicles, contributing to underutilization. There may be an opportunity to increase the number of vehicles per charging port in future years to maximize program impacts and reduce vehicle TCO.

Only three of 39 operational program to date sites exhibited the use of load management, shown by sharp increases in load beginning after 9 PM, when the peak rate time period ends. On a monthly basis, 50% of all fleet charging in the took place during the peak rate time period of 4 PM and 9 PM, resulting in negative impacts on operational costs and grid congestion. However, 40% of school bus charging sessions and 30% of non-school bus fleet charging sessions have enough flexibility to avoid charging during that peak rate time-period, offering significant opportunity for cost savings.

Not all EVSPs offer load management capability, and utility bills may not be available to fleet operators so they can understand the cost impacts of time of use. During site visits, many fleet operators said it was the first time they had seen their own usage information, and almost every operator had a disconnect between what they expected the electricity to cost versus their actual costs. However, most fleet operators are aware of time-of-use pricing, regardless of knowing their own usage trends and costs. Site visits indicated that successful load management was implemented at sites where the EVSP shared in financial benefits.

Recommendation: SCE should review current processes around communicating load management to ensure customers are maximizing monetary and emissions savings.

The Evaluation Team identified several challenges to the implementation of load management in this report related to awareness, operational constraints, knowledge of rate structure, and organizational capacity. Following site energization, SCE should review customer usage data over six to 12 months of operations and follow up with sites that exhibit opportunities for better load management. The Evaluation Team's interactive dashboard (an SCE-facing tool not publicly accessible) provides key metrics on customer load management performance that can be leveraged to highlight site-level charging behavior and opportunities for monetary and emissions savings.

There was general consensus among market experts that the EV market share for transit bus and delivery vehicles will increase over time, and that utility programs are critical to meet deployment targets.

The market forecast for the electric transit bus market share in California aligns with ICT requirements through 2025 but falls short of 100% by 2030. The increased availability of funding is expected to be the primary driver for transportation agencies to meet purchase requirements. Experts forecasted the electric delivery vehicle market share to fall short of ACF sales requirements in 2025, driven by high infrastructure costs, battery market competition, and limited product availability. EVSPs and fleet operators identified utility incentives as a key mechanism to reduce the barrier to electrification presented by high EV costs and the high cost of installing EV charging infrastructure.

3.2. Schools and Parks Pilots

3.2.1. Overview

This overview provides a detailed description of the SCE Schools and Parks Pilots as well as summaries of the Pilot implementation process; performance metrics, program materials, and budget summary; and a major milestone timeline. Following the overview, the Evaluation Team presents the EY2022 findings, highlights, and lessons learned.

Pilot Description

Schools Pilot: Per Decision 19-11-017, SCE's Schools Pilot offers the direct installation of and incentives for installing approximately 250 L1 and L2 charging stations at 40 K–12 schools. SCE staff designed the Pilot to enable K–12 schools to offer public charging to support not only school staff, but also the communities in which the schools are located.

Participating schools can opt for SCE-owned EVSE or to own the EVSE itself. In cases where SCE owns the EVSE, SCE also operates and maintains the EVSE. However, the site host is still required to meet the needs for make-ready deployment (such as easement) and to pay all electricity charges. In cases where the site host opts to own the EVSE, SCE offers a rebate based on the market costs for each type of charging station. At the time of the Decision this rebate was up to $2,000 per charge port for L1 and L2 charging stations. However, before the Pilot was launched, staff adjusted the incentive approach to ensure that sites choosing the ownership option receive the same benefits as those choosing for SCE to own the EVSE. This adjustment maintains a static cost for the EVSE, but also considers the required agreement to operate and maintain the equipment, warranty, and network fees for eight years. As a result of this change, the Pilot rebate is focused on L1 and L2 chargers. As per the Decision, SCE staff offers customers an option to manage and pay for the qualified state-licensed labor to install customer-side infrastructure, for which SCE will provide a rebate of up to 100% of the installation cost. Participating schools also commit to providing charging equipment usage for a minimum of eight years.

Schools Pilot Targets

- 250 L1 and L2 charging stations
- 40 K–12 schools
- 40% in DAC locations

Schools Pilot Design Goal

Empower K–12 schools to offer public charging to staff, students, parents, and the greater community.

Finally, through the Pilot SCE staff will develop a K–12 Campus EV Awareness Campaign in 2023 aimed at empowering administration, faculty, students, and parents to become EV ambassadors in their communities. This Campaign will provide grade-level-specific material to increase awareness of EV ownership, repair, and maintenance skills; a faculty education program leveraging calls to action, signage, new web content, and the launch of an educator EV proponent network; and an EV economic education program to promote online self-service tools to help educators estimate the total cost of EV ownership, access lower-income resource support and information, and promote alternatives to new EV purchases, including previously owned EVs, leases, and ride-sharing.

Parks Pilot: Per Decision 19-11-017, SCE offers the direct installation of approximately 120 L2 chargers, 10 DCFC, and an optional 15 mobile chargers across 27 state parks and beaches. SCE staff designed the Parks Pilot to encourage state parks and beaches to charge their own EV fleets and to offer charging services to staff and patrons of LDVs.

Parks Pilot Targets

- 120 L2, 10 DCFC, and 15 mobile charging stations
- 27 state parks and beaches
- 25% in DAC locations

SCE owns, builds, and operates the EVSE and contracts with a third-party vendor to serve as the customer of record for the charger. The third-party vendor is responsible for all electricity costs, must participate in a demand response program, and must report on prices being passed to the drivers.

Parks Pilot Design Goal

Encourage state parks and beaches to charge their own EV fleets and to offer charging to staff and patrons with LDVs.

In addition to EVSE, SCE staff will deploy a customer marketing campaign in 2023 to publicize the availability of EV charging stations, aiming to reduce range anxiety, facilitate EV adoption, and encourage park patrons to drive EVs to the parks or beaches.

Implementation

As interested customers become aware of either Pilot—through SCE marketing efforts, word-of-mouth, or directly from a SCE account manager—they can choose to submit an application as the first step in the implementation process (parks may not submit an application as the first step of their Pilot participation). Figure 45 shows the implementation process for the Schools and Parks Pilots. Note that the Contract Issuance step is slightly different for the Parks Pilot, since the California DPR approved a master participation agreement that applies to all state parks in SCE service territory participating in the Parks Pilot. Each individual site will have site addendums to the master agreement based on specific site needs and designs.

Figure 45. SCE Schools and Parks Pilot Implementation Process

SITE IDENTIFICATION

1. *SCE identifies a potential site*
2. *SCE conducts a desktop review*
3. *SCE reaches out to the customer to engage with the Pilot*

SITE ASSESSMENT

1. *SCE conducts a site visit*
2. *SCE drafts a conceptual design*

CONTRACT ISSUANCE

1. *SCE issues the program agreement to the site host*
2. *Site host reviews and signs the agreement*
3. *SCE executes program agreement*

DESIGN AND PERMITTING

1. *SCE details site design*
2. *Site host reviews and approves design*
3. *SCE and site host complete easement process*
4. *SCE requests and secures permits*

SUPPORTING INFRASTRUCTURE IS CONSTRUCTED

CHARGING EQUIPMENT IS INSTALLED AND ACTIVATED

CLOSE-OUT

1. *SCE issues the rebate (if applicable)*
2. *Customer is on-boarded with EVSP*
3. *Customer commits to port-level data sharing for eight years*
4. *Customer commits to maintaining and operating charging equipment for eight years*

Program Performance Metrics

The EY2022 data included the number of sites for the Schools Pilot, location of sites, DAC status of sites, and days by application phase. SCE did not have any Parks Pilot sites activated or constructed in EY2022. Table 27 provides the count of SCE Schools Pilot sites by completion status in EY2022 and program to date.

Table 27. SCE Schools Pilot Complete Site Count by Status

Site Status	EY2022	Program-to-Date [a]
Utility Construction Complete	12	13
Activated	12	13
Operational	8	9
Closed Out	1	1

[a] One site was activated in EY2021 but was not operational for purposes of the EY2021 report.

As shown above, by the end of EY2022, the Schools Pilot had 12 activated sites, with eight of these being operational. Eight of the 12 sites are outside of DACs and four sites are within DAC (shown in Figure 46).

Figure 46. SCE Schools Pilot EY2022 Site Locations

Table 28 presents site-level data for the Schools Pilot, showing DAC activation status and number of chargers for the activated sites in EY2022 and for the program to date. The number of ports ranges from six to 12 per site, with a total of 100 ports installed program to date.

Table 28. SCE Schools Pilot Activated Site Data

Pilot	EY2022			Program-to-Date		
	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports
Schools Pilot	4	8	88	4	9	100
Total	**4**	**8**	**88**	**4**	**9**	**100**

The median number of days by phase for the Schools Pilot EY2022 sites ranged from 33 days for Site Assessment and Contract Issuance to 377 days for Design and Permitting. Table 29 shows the median number of days by phase for EY2021, EY2022, and program to date sites.

Table 29. SCE Schools Pilot Median Number of Days by Phase

Phase Status	EY2021 Median Number of Days	EY2022 Median Number of Days	Program-to-Date Sites Median Number of Days
Application Reviewal	63	63	63
Site Assessment	44	33	40
Contract Issuance	48	33	40
Design and Permitting	321	377	371
Construction Complete	75	92	91
Activation [a]	0	0	0

[a] SCE counts the end date of the construction complete phase as the activation date; therefore, there are no days within the Activation phase.

Program Materials Summary

Schools Pilot and Parks Pilot: In EY2021 SCE staff identified potential sites for both the Schools Pilot and Parks Pilot prior to launch. In EY2022 SCE staff focused on the construction of sites and working with site hosts. The primary marketing activity for EY2022 was the Schools Pilot questionnaire and Launch Kit, and there was no marketing specifically for the Parks Pilot.

Figure 47. SCE Schools Pilot Informational Posters from Launch Kit

Schools Pilot: To support the Pilot managers with direct outreach and orient school and district administrators to the Pilot, SCE staff developed a questionnaire and coordinated discovery meetings. These activities allowed SCE to gather feedback about schools' marketing preferences from SCE and gauge staff interest in the school curriculum. SCE used the information to develop a Charge Ready Schools Pilot Launch Kit. The kit contained marketing materials for schools to use on campuses to educate students and teachers on the societal and economic benefits of EV ownership. Figure 47 shows examples materials from the Launch Kit.

Figure 48. SCE Schools Pilot Fact Sheet

SCE staff planned to begin designing the Schools Pilot curriculum in EY2021; however, the third-party vendor that was originally contracted was unable to meet the needs of the Pilot, so SCE began the process of procuring a different vendor. In EY2022, the curriculum was still under development. SCE plans to provide grade-level-specific material to increase awareness of EV ownership, repair, and maintenance skills; a faculty education program leveraging calls to action, signage, new web content, and the launch of an educator EV proponent network; and an EV economic education program to promote online self-service tools to help educators estimate the TCO for EVs, access lower-income resource support and information, and promote alternatives to new EV purchases, including previously owned EVs, leases, and ride-sharing.

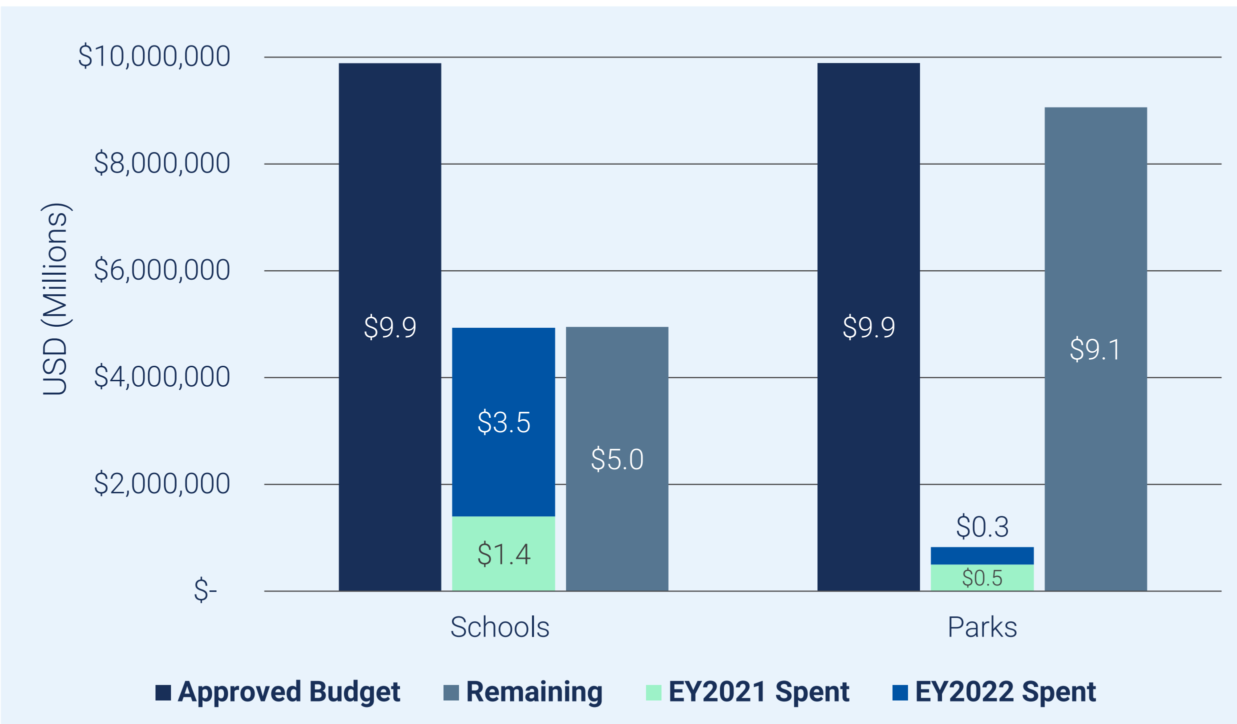
Finally, in support of the Schools Pilot, SCE staff created a Charge Ready Schools Fact Sheet, shown in Figure 48, to help schools understand the pilot and begin engagement.

Parks Pilot: SCE did not conduct any Parks Pilot–specific marketing or outreach activities in EY2022.

Budget Summary

As shown in Figure 49, through the end of 2022 SCE spent $4.9 million of $9.9 million on the Schools Pilot and $0.8 million (de-escalated costs) of $9.9 million on the Parks Pilot. SCE spent $3.5 million of the Schools Pilot budget in EY2022, greatly increased from the $1.4 million spent in EY2021 due to increased construction activity. Meanwhile, SCE spent a relatively consistent amount for the Parks Pilot in EY2021 and EY2022, as that Pilot was still in the Site Assessment phase at the end of EY2022.

Figure 49. SCE Schools and Parks Pilots Budget Remaining versus Spending through EY2022



Timeline

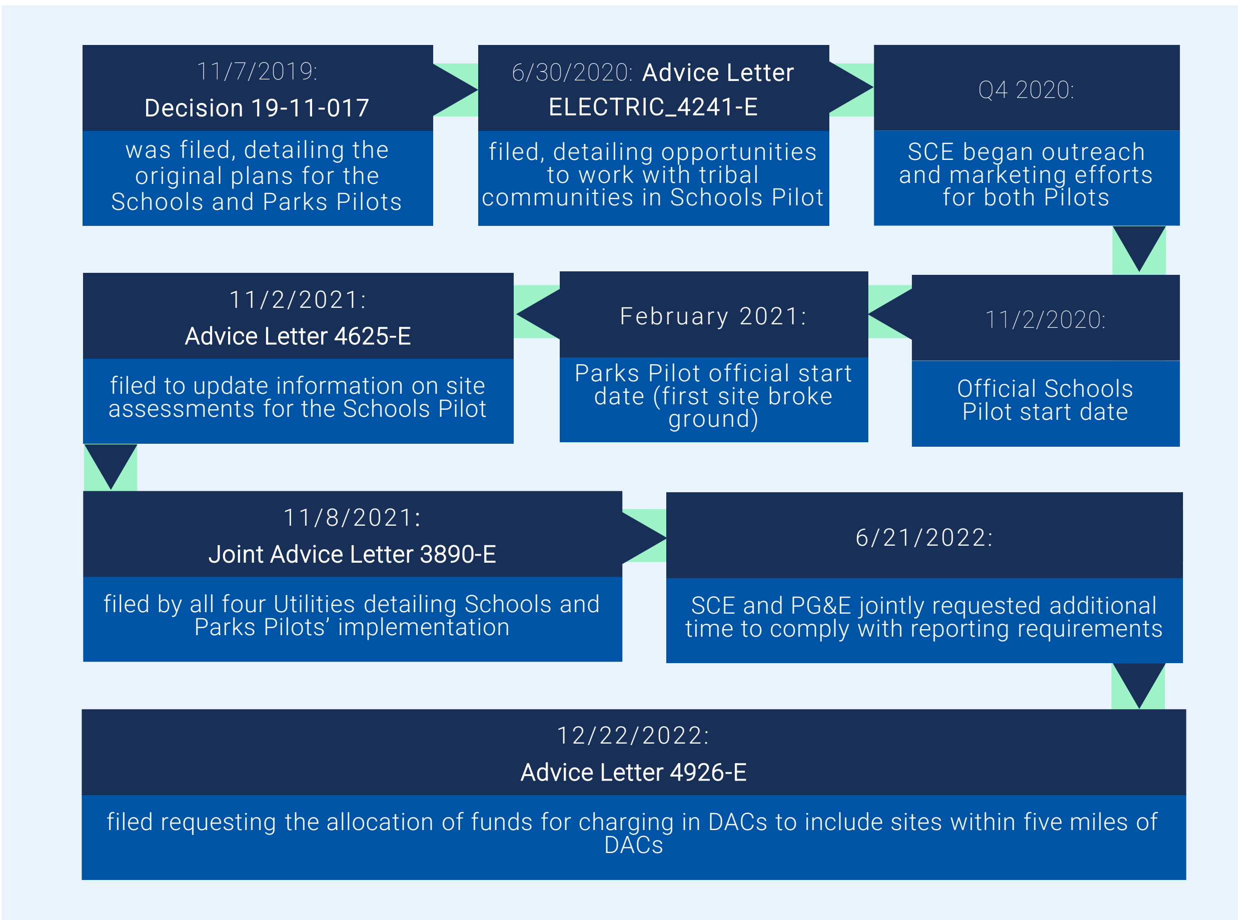
Since the beginning of the EY2022, SCE made one formal request and filed one Advice Letter about the Schools and Parks Pilots.

In a joint request with PG&E to the CPUC on June 21, 2022, SCE requested additional time to comply with reporting requirement due to their lack of committed projects. The CPUC denied this request, stating that not having sites or programs was not sufficient justification for an extension, as SCE could instead provide rationale for the lack of sites.

SCE then filed Advice Letter 4926-E on December 22, 2022, requesting the reallocation of funds for charging in DACs to include potential sites within five miles of DACs. SCE submitted this letter after negotiating a Master Participation Agreement with the DPR that can apply to all sites through SCE's Parks Pilot. Though SCE and DPR have negotiated a Master Participation Agreement, they are still finalizing site selection. DPR provided SCE with site priorities and only two of those sites are in DACs. Since Decision 19-11-017 currently stipulates that 25% of sites must be in DACs, SCE must extend DAC funding to sites within a five-mile radius of DACs in order to reach its overall site targets (otherwise the overall number of sites will be capped at eight). As of May 2023, this request is still under deliberation.

Figure 50 shows all major milestones since the beginning of the Pilots.

Figure 50. SCE Schools and Parks Pilots Key Milestones



3.2.2. Findings

The following sections provide findings from analyses of the incremental EV adoptions, site visits, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health impacts, and TCO, as well as insight from Utility staff interviews.

Table 30 summarizes key impact parameters for EY2022 as well as for the program to date. Annual estimates of impacts are provided for metrics calculated as part of the impact evaluation. Additionally, the table provides estimates of impacts across all sites included in the program population through the end of EY2022.[50]

Table 30. SCE Schools Pilot Impacts Summary

Impact Parameter	EY2021 Sites[a]	EY2022 Sites[a]	EY2022 Sites Percentage in DAC	Program-to-Date Sites Actuals	Program-to-Date Sites Actuals Percentage in DAC
Population of Activated Sites	1	12	33%	13	31%
Sites included in analysis (#)	0	8	38%	9	33%
Charging Ports Installed (#)	12	88	N/A	100	N/A
Electric Energy Consumption (MWh)	N/A	50	16%	22	26%
Petroleum Displacement (GGE)	N/A	4,137	16%	1,833	26%
GHG Emission Reduction (MT GHG) [b]	N/A	32	16%	14	27%
PM_{10} Reduction (kg)	N/A	0.2	16%	0.1	26%
$PM_{2.5}$ Reduction (kg)	N/A	0.1	16%	0.1	26%
ROG Reduction (kg)	N/A	2.6	16%	1.1	26%
CO Reduction (kg)	N/A	86	16%	38	26%

[a] Energy consumption, petroleum displacement, emission reductions, and health benefits are based on annualized data. Program-to-date results in the table are based on actual data (see the *Methodology* section for more details). The one site in EY2021 was not included in the EY2021 Evaluation Report due to insufficient data but is included in Program-to-date impact results in this report.

[b] GHGs include CO_2, CH_4, and N_2O multiplied by their respective GWP as defined by IPCC AR5 (see the *Methodology* section for more details).

50 For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

Incremental EVs Adoption

The team estimated the effect of the public charging stations on household EV adoption for neighboring populations[51] with a two-stage analysis: (1) historical analysis of public EV charging impacts on vehicle ownership and (2) analysis of EV ownership attributable to SCE Schools Pilot investments. See the *Methodology* section for the details of the Stage 1 analysis.

Using the impact estimates from the Stage 1 analysis, the Evaluation Team estimated the impact of SCE investments in public charging on EV ownership. By the end of EY2022, 13 charging sites in SCE's Schools Pilot were activated and nine were operational. We estimated the impact of these stations based on annual EV registrations in EY2022 as well as program-to-date cumulative EV registrations.

Based on the composite measure of public charging access, the Evaluation Team calculated the change in access to public charging due to SCE's Schools Pilot investment for each census block group (CBG) where access was affected by the investments. As shown in Table 31, the pilot-to-date average change in access across all affected CBG was 5.6, and the average change in the number of chargers (ports) was 4.6 per affected CBG. For reference, the average change in access across all CBGs in California was 0.57 between 2015 and 2020. The average normalized EV annual registration per 1,000 households was 127.3 in the affected CBGs in 2020.

Table 31. SCE Schools Pilot Summary Statistics of Effects on CBGs

	CBG Mean (Standard Deviation)			
	Change in Composite Measure of Access	Change in Number of Chargers	Normalized Annual EV Registrations	Number of Households
SCE Schools Pilot	5.57	4.64	127.32	553.40
	(5.46)	(4.11)	(530.42)	(319.00)
CBGs (N)	22	22	22	22

Notes: The values are averages for the CBGs whose access to public charging was affected by SCE's investments. The team measured these changes between 2020 and EY2022. The normalized EV registration are average annual values in the affected CBGs in 2020. The number of households are based on the 2015–2019 American Community Survey (ACS). Sample standard deviations are in parentheses.

---

51 There are two main channels through which the availability of public charging networks may affect EV purchases. The first is a network effect, through which EV owners gain increased access to the public charging stations because of the stations' placement at destinations such as workplaces, commercial establishments, schools, and parks. The availability of EV charging equipment at convenient locations (for midday charging away from home) is expected to increase the convenience of owning an EV (such as lessening range anxiety) and to increase the probability of EV ownership. The second channel is a neighborhood effect on the driving population living in areas neighboring the public EV charging stations. The availability of nearby charging infrastructure is expected to lower the cost of EV ownership by providing alternatives to home charging. It is expected that public EV charging will have the biggest impact on residents of multifamily buildings, many of whom will have limited access to EV charging equipment, or on low-income households, who may be unable to afford home EV charging equipment. Public charging access may lift EV ownership through both channels and there may be positive interactive effects between the channels that lift the overall impact of public charging networks. The Evaluation Team focused on analyzing the second channel. We will analyze impacts for the first channel separately when data become available.

The Evaluation Team combined the ordinary least squares (OLS) and instrumental variable two-stage least squares (IV-2SLS) regression estimates of the impact of public charging access on EV registrations from Stage 1 with the estimates of the CBG changes in public charging access and household counts to calculate the impact of the Schools Pilot Utility charging investments on neighboring EV ownership.[52] The impacts of the SCE investments on EV registrations will depend on how much the investments increased access in the affected CBGs and the number of neighboring households in the CBGs.

Table 32 shows estimates of the annual and program-to-date EV registrations attributable to the Utility Schools Pilot charging investments. Based on the OLS long differences model,[53] SCE School Pilot investments in charging facilities increased EY2022 annual EV registrations by 2.7 vehicles. As the one Schools Pilot charging facility was not fully operational, and therefore not included in the EY2021 evaluation, the program-to-date impacts are the same as the EY2022 annual impact. Based on the IV-2SLS long differences model, the School Pilot investments increased annual EV registrations by 12.4 vehicles. The Evaluation Team prefers the IV-2SLS-based estimates because they account for the potential endogenous siting decisions of public charging (public charging infrastructure may have been built in locations with expected rates of EV adoption that are lower or higher than the average). These estimates are based on the 13 activated Schools Pilot facilities operating for a whole year.

Table 32. SCE Schools Pilot EV Registrations Attribution

	EY2022 Annual Increase of EV Registrations Driven by the Utility Program		Program-to-Date Cumulative Increase of EV Registrations Driven by the Utility Program	
	OLS	IV-2SLS	OLS	IV-2SLS
SCE Schools Pilot	2.67	12.40	2.67	12.40
	(0.45)	(2.24)	(0.45)	(2.24)

Note: The table shows the EV registrations attributable to the utility investments in public charging infrastructure. The left panel shows the impacts of utility investments since 2020 on registrations in EY2022. The right panel shows the cumulative impacts of Utility investments since 2020 on EV registrations in EY2021 and EY2022. The Evaluation Team based these estimates on the OLS and IV-2SLS long differences models. The team estimated the OLS long differences model using data for all CBGs in the analysis sample. We estimated the IV-2SLS long differences model for CBGs in the 20 largest California cities. The long differences are five-year estimates, which the Evaluation Team annualized by dividing the results by five. For each affected CBG, the team calculated the increase in annual registrations as the product of the regression-based access coefficient divided by five, multiplied by the change in composite public charging access from utility investments (between baseline 2020 and EY2022), multiplied by the number of CBG households (in thousands). Robust standard errors clustered at the block group level are in parentheses.

The SCE Schools Pilot investments in public charging had relatively small impacts on EV ownership in EY2022. Across all 22 affected CBGs, the total annual number of EV registrations is about 2,801 (22 * 127.32), so the program-to-date cumulative impact of the SCE Schools Pilot, based on the

---

[52] In Stage 1 the Evaluation Team estimated the impact of public EV charging access on EV ownership. Stage 2 built on the Stage 1 analysis and was an attribution analysis for Utility-specific investments. A notable benefit of this approach is that it can be applied to evaluations of other programs increasing EV charging access as well, which ensures methodological consistency.

[53] The long differences model estimates indicate the impact of public charging on EV registration over five years. The team annualized these estimates by dividing the results by five.

preferred IV-2SLS regression estimate, is to lift EV registrations by about 0.4% (12.4 / 2,801). The estimated impact is small, likely because SCE Schools Pilot charging stations are located in or close to nonresidential areas with few households. Specifically, about 39% of the affected CBGs had no households according to the U.S. Census. An average of 127 EV registrations per CBG puts these CBGs in the 95th percentile of the EV registration distribution of CBGs, which implies a high level of baseline EV registration. The percentage effects are small because the baseline adoption rate was high.

Highlights

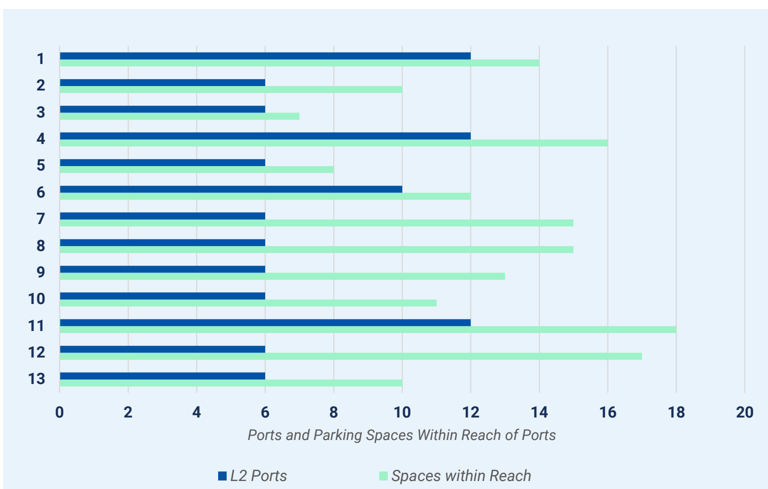
- The Schools Pilot contributed to increased EV adoption by 12 EVs for households neighboring the infrastructure.
- The impact of the Schools Pilot was small relative to baseline registrations due to the location of the charging stations in nonresidential areas.

Site Visit Findings

The Evaluation Team visited all 13 Utility construction completed sites, including the 12[54] EY2022 activated sites. While visiting the sites, the team documented the number of ports (about 100), total installed charging power capacity (over 600 kW total), parking spaces within reach of the port (1.7 spaces per port), and Americans with Disabilities Act (ADA) accessibility parking spaces (1 to 2 per site).

The team also assessed how the sites fit into the local charging context and pricing mechanisms. As shown in Figure 51, the sites reflected a range in the number of total parking spaces with access to charging. SCE staff confirmed that site designs are an outcome of host approval to maximize the use of space where possible.

Figure 51. SCE Schools Pilot Program-to-Date Comparison of Ports to Parking Spaces within Reach



Note: This analysis includes one EY2021 site and 12 EY2022 sites.

54 While 12 sites were activated in EY2022, nine were also operational, including one site that was activated in EY2021.

All the SCE Schools Pilot sites are at schools except for one, which is located at a school district office. These schools may occasionally have public charging during weekend and evening events.

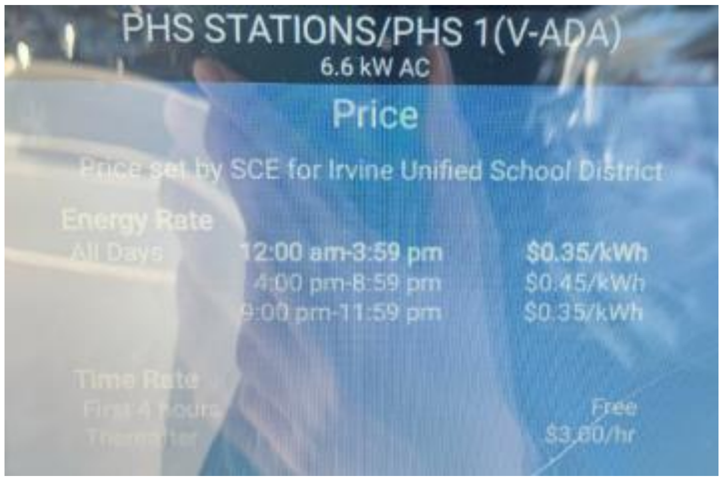
Figure 52 and Figure 53 provide examples of schools charging station installations at sites designed to maximize charger accessibility and increase rates of utilization.

Figure 52. SCE Schools and Parks Pilot Head-to-Head Parking Resulting in Each Port Reaching 2.2 Spaces

Figure 53. SCE Schools and Parks Pilot Spread Out and Head-to-Head Parking Resulting in Each Port Reaching 2.5 Spaces

The Evaluation Team collected information on pricing[55] during eight of the 12 site visits. These sites displayed pricing on the charger screen or the EVSP's website, and were listed as either TOU or flat rates. Six of the sites we visited impose idle fees that could be incurred after charging (actual consumption) is completed. Idle fees are a proven way to induce turnover of charging ports in locations where EV drivers stay relatively close by (such as at work and sports fields). Figure 54 presents an example of TOU rate and idle fees.

Figure 54. SCE Schools and Parks Pilot Example of Time-of-Use Rate and Idle Fee



Highlights

- The combined EY2021 and EY2022 sites have between six and 12 L2 ports per site, and they all include at least one ADA-accessible charging spot. Some designs have placed charging ports such that more than one parking space is within reach, in some cases greatly increasing the number of parking spaces that can satisfy EV charging throughout the day. All charging ports are 6 kW and the total installed charging power capacity ranges from 30 kW to 80 kW per site.
- Site designs are dependent on host approval to maximize the use of space and charger accessibility and increase rates of utilization.
- Eight sites displayed pricing on a screen or website, listing either TOU pricing or flat rates.
- Four sites included idle fees that would be incurred once charging (actual consumption) was completed.

55 Irvine 4321 Walnut Ave and Portola 1001 Cadence $0.35 to $0.45 + $3 per hour idle after 4 hours; Lindsay 1849 Tulare Rd $0.32 to $0.40; Porterville 465 W Olive $0.12 to $0.40 + $5 per hour idle after one hour; San Jacinto not publicly displayed; Mission 3442 East Beardsley Ave $0.35 + $20 per hour idle after 90 minutes; Tulare 755 E Tulare Ave $0.35 + $20 per hour idle after 90 minutes; Redwood not listed publicly; Golden West 1717 North McAuliff no listed pricing; Chaparral 27215 Nicolas Rd $0.44 + $3.5 per hour idle after 5 hours; Great Oak 3255 Deer Hollow Way $0.45 + $3.5 per hour idle; Lynwood 11321 Bullis St not listed publicly.

Grid Impacts

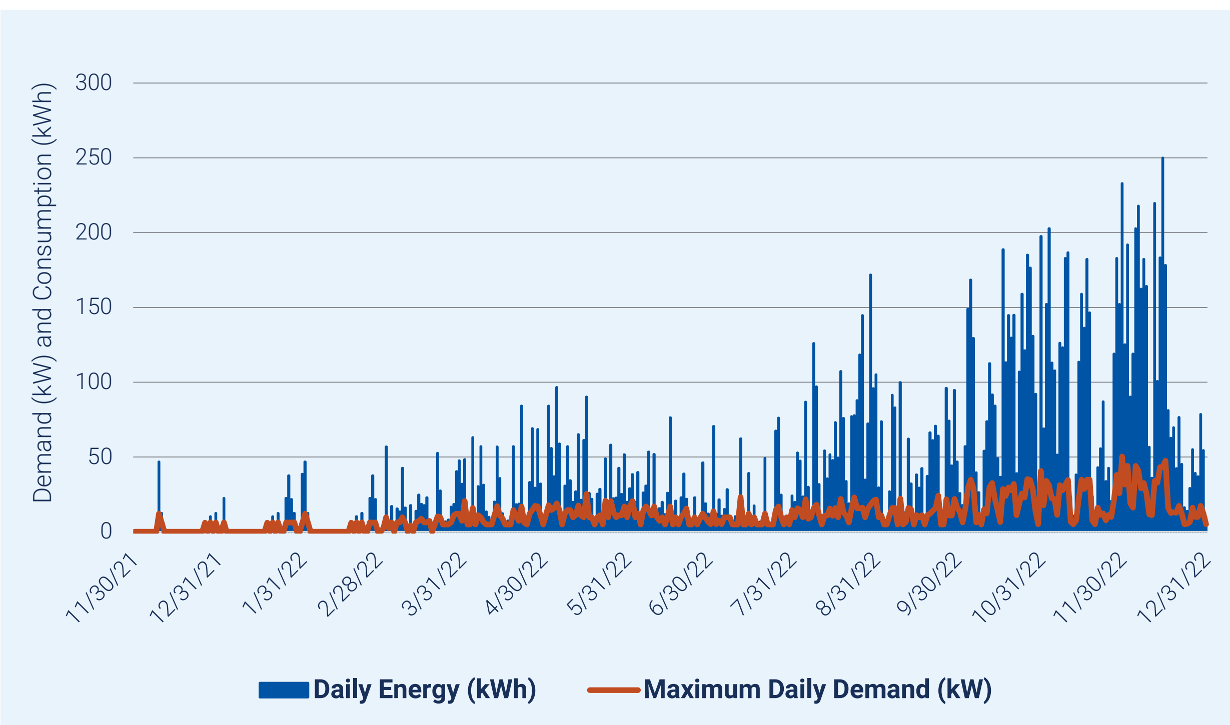
The Evaluation Team estimated grid impacts for the SCE Schools Pilot based on the power consumed by eight operational charging sites installed through the program in EY2022, combined with charging session data from the EVSPs. Table 33 presents a summary of the estimated Schools Pilot grid impacts in 2022, as an annual estimate, program to date actual, and 10-year forecasts.

Table 33. SCE Schools Pilot Grid Impacts

Impact Parameter	EY2022		Program-to-Date	
	Actual EY2022	Annualized EY2022	Actual PTD	10-Year Projection PTD
Operational Sites	8	8	9	9
Electric Energy Consumption, MWh	19	50	22	520
On-Peak MWh (4 PM to 9 PM) (and % of total)	3 (13.0%)	8 (15.1%)	3 (12.9%)	79 (15.1%)
Maximum Demand, kW (with date and time)	50 (11/30/22 8:45 AM)	53 (12/15/22 8:15 AM)	53 (12/15/22 8:15 AM)	N /A
Maximum On-Peak Demand, kW (with date and time)	24 (9/23/22 8:30 PM)	30 (10/8/22 5:30 PM)	35 (10/8/22 5:30 PM)	N /A

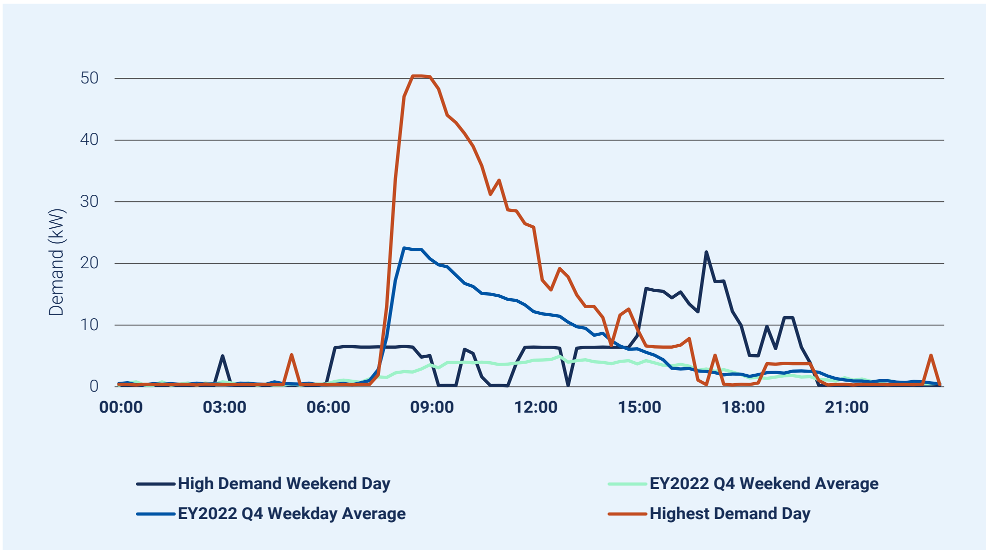
The remainder of this section provides findings on the actual monthly consumption, daily energy consumption and demand, maximum demand, charging sessions per month, frequency of charging session consumption, and power draw of charge for the combined EY2021 (N=1) and EY2022 (N=8) operational sites. As shown in Figure 55, daily energy consumption (kWh) accelerated more quickly than demand (kW) for the combined EY2021 and EY2022 sites.

Figure 55. SCE Schools Pilot Daily Demand and Consumption, Program-to-Date Sites



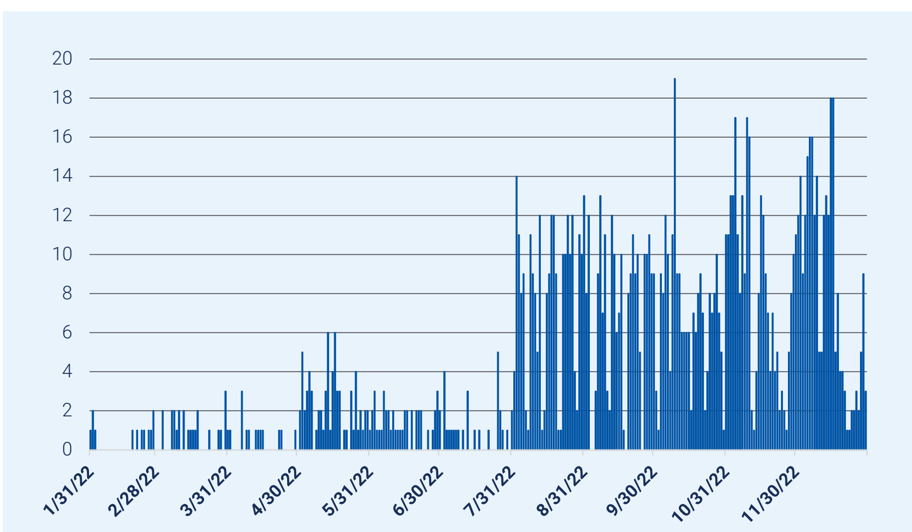
With nearly 650 kW of installed charging capacity potential, the highest demand day (November 30, 2022) reached only 50 kW, or 8%. As shown in Figure 56, the average weekend demand and highest weekend demand days are much lower than demand during the week, when more employees were on site.

Figure 56. SCE Schools Pilot Maximum Demand Day of 50 kW by 8:30 AM and Quickly Tapering Off (November 30, 2022), Program-to-Date Sites



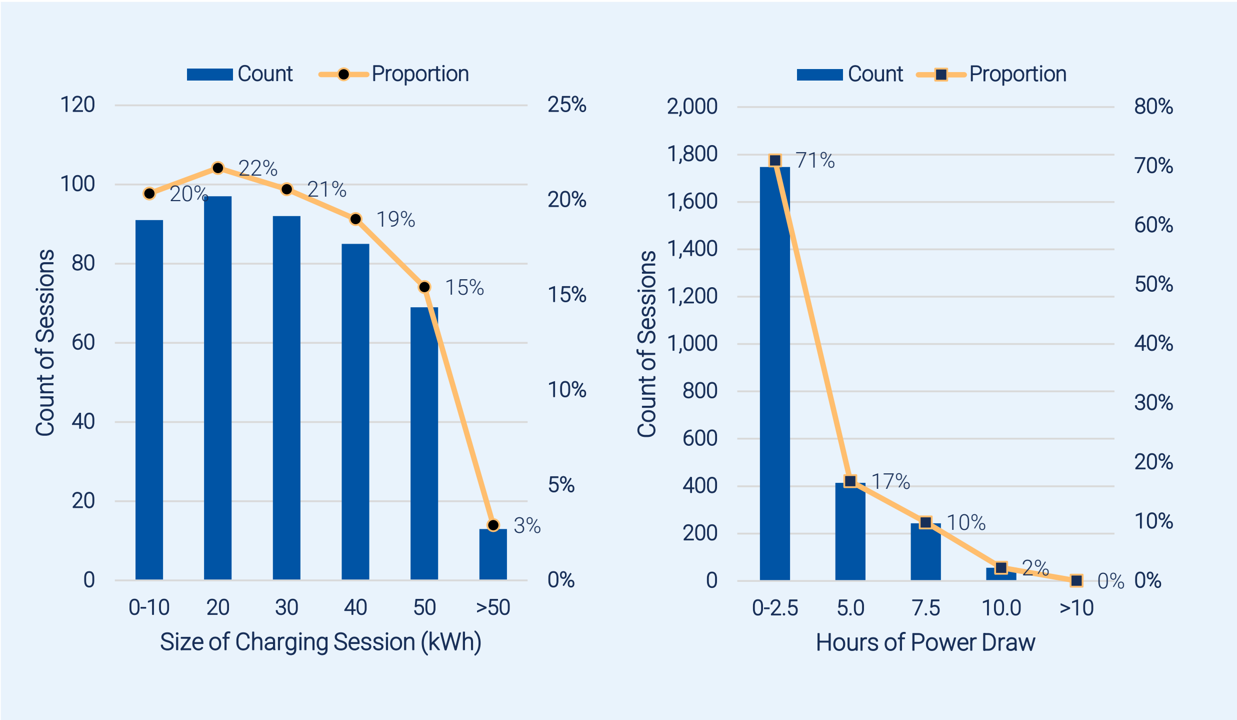
Program to date, SCE Schools Pilot sites accrued almost 1,500 charging sessions throughout 2022. These sessions ramped up sharply in early fall, influencing the increase of daily energy consumption. As shown in Figure 57, the number of daily charging sessions increased through the end of 2022, reaching a maximum of 20.

Figure 57. SCE Schools Pilot Charging Sessions by Day, Program-to-Date Sites



As shown in Figure 58, almost two-thirds of the charging sessions in 2022 consumed less than 30 kWh. About 70% of the Schools Pilot charging sessions in 2022 lasted under 2.5 hours, which allows for several charging sessions per charging port each workday if there is sufficient access (Figure 58). Current utilization rates indicate that the electrical design does not require a typical continuous load capacity for each charging port.

Figure 58. SCE Schools Pilot Charging Session Size and Power Draw Duration, Program-to-Date Sites



Highlights

- In spite of 650 kW of installed charging capacity potential, the highest demand day (November 30, 2022) reached only 50 kW. The number of daily charging sessions and amount of daily energy consumption appears to be growing.
- Both the average and the highest weekend demand days were much lower than weekday demand.
- About 70% of the 2022 Schools Pilot charging sessions lasted under 2.5 hours, which allows for several charging sessions per charging port each workday if there is sufficient access or parking space turnover.
- Current utilization rates indicate that the electrical design does not require a typical continuous load capacity per charging port. All charging ports on a site very rarely (if ever) operate at full power at the same time.

Petroleum Displacement

The Evaluation Team estimated program-induced petroleum displacement related to the eight SCE Schools Pilot sites for EY2022 using three key pieces of information: electricity used for vehicle charging, EV annual miles traveled, and annual counterfactual vehicle fuel consumption. From this information we estimated the reduction in equivalent gallons of petroleum as a result of the SCE Schools Pilot. Table 34 presents the petroleum displacement resulting from operational sites to date, along with annualized EY2022 and 10-year totals, by impact location.

Table 34. SCE Schools and Parks Pilot Petroleum Displacement Summary

DAC	Usage		Petroleum Displacement (GGE)		
	EY2022 Sites Annualized (kWh) (n=8)	EY2022 Sites Annualized (miles) (n=8)	EY2022 Sites Annualized (n=8)	PTD Sites Actuals (n=9)	PTD Sites 10-Year Projection (n=9)
Inside DAC	8,188	24,484	673	480	6,378
Outside DAC	42,130	125,985	3,464	1,353	33,864
Total	**50,318**	**150,469**	**4,137**	**1,833**	**40,242**

Highlights

- The eight operational EY2022 sites resulted in an annualized impact of more than 4,000 gallons of petroleum, with 16% within DACs.
- Over a 10-year period, the combined EY2021 and EY2022 sites will result in displacing more than 40,000 gallons of petroleum.

Greenhouse Gas and Criteria Pollutant Impact

The Evaluation Team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service as a result of the SCE Schools Pilot. The team first developed one ICE counterfactual, then calculated the emissions associated with these vehicles under conditions that otherwise matched the EVs in order to provide a baseline. Although EVs have no tailpipe emissions, the fossil-fuel power plants that supply electricity to the vehicle chargers still release some GHGs and criteria pollutants.

Table 35 presents the GHG reduction resulting from the School Pilot sites to date, along with annualized EY2022 and 10-year totals, by impact location. Overall, the Pilot resulted in an 80% reduction of GHG emissions relative to the counterfactual in EY2022 (13 MT total), with just over 16% of the total 32MT reduction occurring within DACs.

Table 35. SCE Schools Pilot GHG Reductions Summary

DAC	Usage		GHG Reduction (MT)		
	EY2022 Sites Annualized (kWh) (n=8) [a]	EY2022 Sites Annualized (miles) (n=8) [a]	EY2022 Sites Annualized (n=8)	PTD Sites in CY2021+CY2022 Actuals (n=9) [a]	PTD Sites 10-Year Projection (n=9) [a]
Inside DAC	8,188	24,484	5	4	52
Outside DAC	42,130	125,985	27	10	280
Total	**50,318**	**150,469**	**32**	**14**	**332**

[a] Out of 12 EY2022 sites, four were not operational (did not have any AMI data usage in 2022) and are therefore not included in the impacts.

Overall, of the local emissions, the Pilot had the highest impact in reducing CO, resulting in an estimated annualized reduction of 86 kg (see Table 36).

Table 36. SCE Schools Pilot Local Emissions Reductions

Emissions	EY2022 Sites Net Reduction			Program-to-Date Sites Net Reduction	
	Inside DAC	Outside DAC	Total [a]	Actuals	10-Year Projected Impact
PM_{10} (kg)	0.03	0.14	0.16	0.07	1.59
$PM_{2.5}$ (kg)	0.02	0.13	0.15	0.07	1.46
ROG (kg)	0.42	2.16	2.57	1.15	33.04
CO (kg)	14	72	86	38	1,080

[a] Columns may not sum to Total due to rounding.

The current mix of electricity from the CAISO grid used to support the SCE Schools Pilot sites is shown in Figure 59.[56] Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 58% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 30% natural gas. With the CAISO grid adding more renewables to meet the Renewable Portfolio Standard, the GHG and criteria pollutant emissions will continue to decrease.

Figure 59. SCE Schools and Parks Pilot Net Electricity Mix, Annualized EY2022 Sites

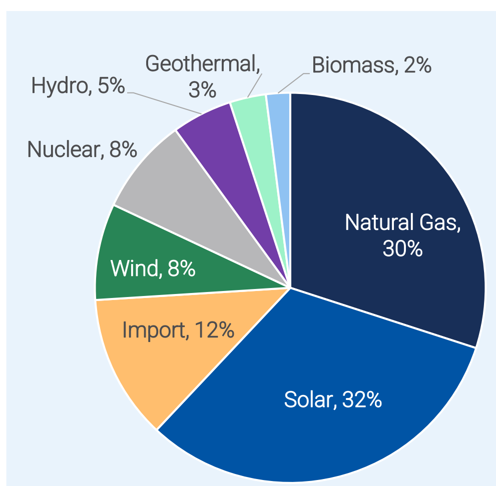
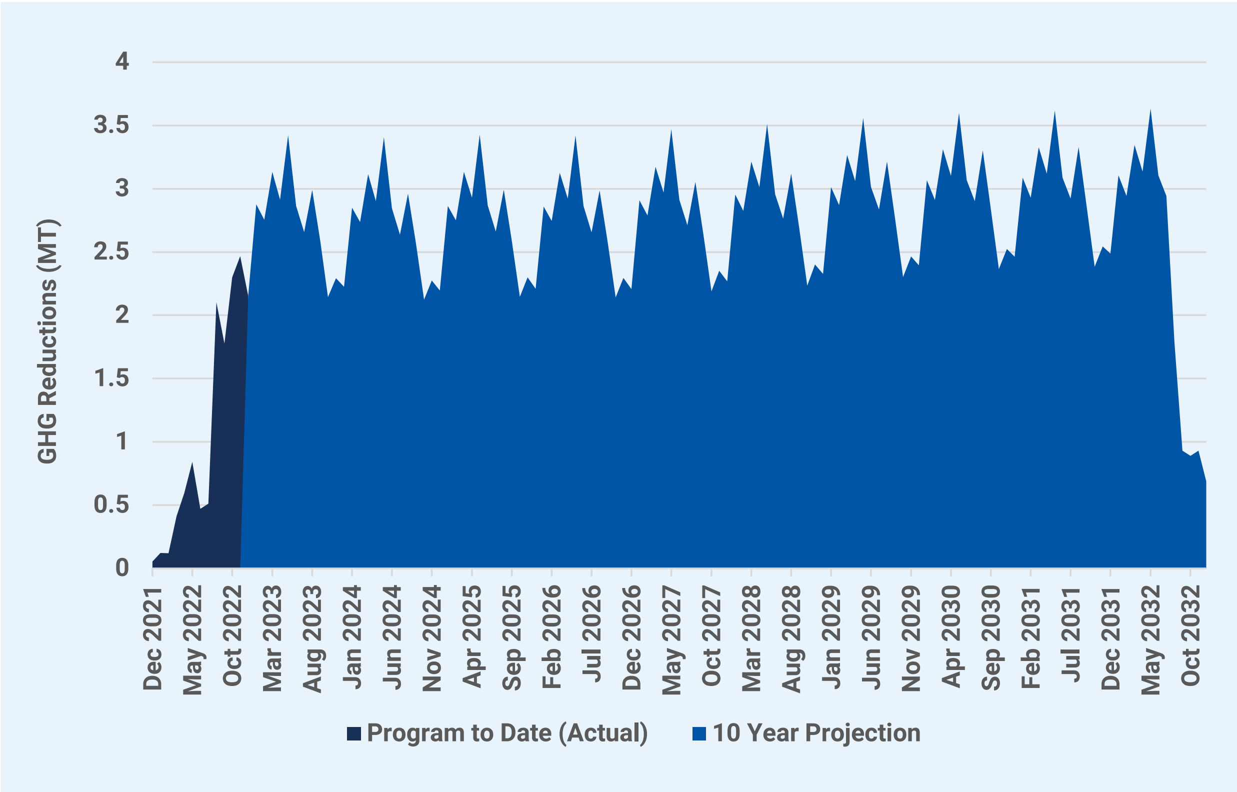


Figure 60 shows how program GHG reductions have increased to date and are expected to grow over time for EY2021 and EY2022 activated sites. The analysis period ranges from the date that the first site in the program was activated through the end of 2022. The analysis incorporates the net reduction (counterfactual emissions minus utility emissions) for each site within the SCE Charge Ready Schools program. Program to date emission reductions are shown in dark navy while anticipated benefits based on annualization are presented in royal blue. As each site has its own starting date of operation,

56 The power associated with imports comes from a mixture of hydro, nuclear, and natural gas plants located outside the CAISO grid.

the 10-year sunset for each site is observed as a gradual tapering off of program benefits in 2032. While each year's operations appear similar, there are several key factors driving the variations such as seasonality of utility generation sources (high utility emissions will appear as a dip on the curves), holidays occurring on weekends versus weekdays, and sites that became operational late in 2022 having predicted operations year-round in future years.

Figure 60. SCE Schools Program GHG Reductions, Historical and Forecasted, Program-to-Date Sites



Highlights

- The Schools Pilot has resulted in an 80% reduction of GHG to date with 16% of the impact occurring within DACs.
- Across the local emissions, the Schools Pilot had the highest impact in reducing CO, resulting in an estimated annualized reduction of 86 kg.
- Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 58% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 30% natural gas.

Health Impacts

The Evaluation Team calculated public health impacts (benefits and costs) of reductions in criteria pollutants from vehicle electrification. Pollutants included in the analysis are primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, including NO_x, SO_2, NH_3, and VOCs. This analysis only considered tailpipe emission reductions, rather than the full lifecycle emissions (power plant emissions). We used the U.S. EPA's COBRA to evaluate the health benefits associated with the emission reductions. COBRA estimates the benefits at the county level for the county in which emissions are reduced. The Evaluation Team disaggregated the county-level effects to estimate the potential health benefits of projects for DACs and non-DACs.

The total value of the health benefits associated with the emission reductions is small, between $103 and $203. Table 37 shows the cumulative health benefits in California associated with the emission reductions realized by the electrification of EY2021 and EY2022 SCE Schools Pilot sites.

Table 37. SCE Schools Pilot California Health Benefits for EY2021 and EY2022 Sites

Health Endpoint	Change in Incidence (Annual Cases)		Monetary Value (Annual, 2023 Dollars)	
	Low	High	Low	High
Mortality	< 0.0000	< 0.0000	$101	$228
Nonfatal Heart Attacks	< 0.0000	< 0.0000	< $0	$1
Infant Mortality	< 0.0000	< 0.0000	$1	$1
Hospital Admits, All Respiratory	< 0.0000	< 0.0000	< $0	< $0
Hospital Admits, Cardiovascular	< 0.0000	< 0.0000	< $0	< $0
Acute Bronchitis	< 0.0000	< 0.0000	< $0	< $0
Upper Respiratory Symptoms	0.0002	0.0002	< $0	< $0
Lower Respiratory Symptoms	0.0002	0.0002	< $0	< $0
Emergency Room Visits, Asthma	< 0.0000	< 0.0000	< $0	< $0
Asthma Exacerbation	0.0002	0.0002	$0	< $0
Minor Restricted Activity Days	0.0070	0.0070	$1	$1
Work Loss Days	0.0012	0.0012	< $0	< $0
Total Health Effects	-	-	**$103**	**$230**

As part of this analysis, the Evaluation Team also examined the health benefits within DACs. The COBRA tool estimates effects at the county level, so the team disaggregated the monetary health benefits by census tract using the relative population of each tract from the most recent American Community Survey. For example, a census tract with 10% of the county's population will be allocated 10% of the value of the health benefits. The approach implicitly assumes that the benefits of emission reductions are distributed evenly throughout the county. If the sites are located in DACs, and the emission reductions are greater in the tracts near the sites, this approach would understate the potential benefit to DACs. Additional information about emission dispersion within counties is needed to provide more precise estimates of the health benefits to DACs and non-DACs. The Evaluation Team then estimated the total benefits allocated to DACs and non-DACs.

Orange County had the highest proportion of overall benefits with 29% of the total, followed by Riverside County (24%), Los Angeles County (17%), San Diego County (15%), and San Bernardino County (5%). Overall, 21% of the benefits are in DACs.

Highlights

- The annual monetary health benefits from EY2021 and EY2022 SCE Schools Pilot sites range from a low estimate of $103 to a high estimate of $230.
- Orange County had the highest proportion of overall benefits at 29%, followed by Riverside County (24%), Los Angeles County (17%), San Diego County (15%), and San Bernardino County (5%).
- Overall, 21% of the benefits are in DACs.

Total Cost of Ownership

The EY2022 report does not include a TCO analysis for this program due to insufficient data (a single site was closed out in EY2022). The Evaluation Team conducted a contextual analysis based on a literature review that was included in the EY2021 report; however, future reports will include a TCO analysis based on Utility-reported costs when sufficient data are available.

Utility Staff Insights

In addition to monthly check-in calls with key SCE staff to discuss the status of the Schools and Parks Pilots, the Evaluation Team also conducted a close-out interview with staff in March 2023 to review overall Pilot challenges and successes in EY2022. The following sections group these challenges and successes by those that apply to both Pilots, followed by those that are applicable to only one Pilot.

Schools Pilot and Parks Pilot

In EY2021, SC&E staff reported that a central challenge with the Pilots was that site construction costs were higher than anticipated, compounded by labor constraints, supply chain delays, and permitting delays. Staff confirmed that these challenges continued into EY2022:

- **Construction Labor Costs and Supply.** Staff noted that construction labor costs have increased as inflation has risen. In addition, continued from EY2021, it has been difficult to secure a sufficient labor force since COVID-19.
- **Material Costs.** Most materials have been generally more expensive than originally anticipated in 2018 (when the Pilot funding caps were decided).
- **Supply Chain Delays.** Staff confirmed that supply chain delays, which started as a result of COVID-19, continue to be a challenge.

In December 2022, there was a successful transition of SCE’s primary manager for the Schools and Parks Pilots. Though there was a slight adjustment period, as expected with any staff transition, SCE staff said the transition was smooth and there were nearly no gaps in Pilot activity even directly after the previous manager’s departure.

Schools Pilot

In EY2021, SCE Pilot staff emphasized that a key barrier to participation in the Schools Pilot was the challenges schools were facing with balancing priorities due to the COVID-19 pandemic, when teachers had overwhelming workloads and needed to prioritize managing student safety. In EY2022, SCE staff were able to move their Schools Pilot forward to the point where it is now considered fully subscribed for several reasons:

- **Long-Term Engagement.** Over the course of implementing the Schools Pilot, SCE staff have worked with numerous schools for over a full calendar year. This long-term engagement has provided two benefits:
  - **Expanded Capacity.** Schools are now less burdened with balancing the demands of COVID-19 and can focus more on other initiatives such as the Schools Pilot. SCE staff said its longer-term engagement with schools before and after the pandemic started paying off in EY2022, as school staff had newly available capacity and renewed interest in the Pilot.
  - **Customer-Specific Expertise.** At the start of the Pilot, SCE staff had trouble navigating the complex school decision-making processes. In EY2022, SCE staff was much more adept at navigating the processes and therefore did not encounter as many delays when dealing with newer school sites.
- **Selected Accessibility.** In EY2021, SCE staff noted that many K–12 schools that wanted to install public charging infrastructure were concerned about student safety if chargers were always accessible to the public (within school hours). Therefore, SCE staff offered alternative participation options that allowed the schools to keep the chargers limited to private use by faculty, staff, and/or parents (depending on the school's preference). This policy continued to be offered and used by newly participating schools in EY2022.

Although staff identified clear successes, they also noted that challenges remain. Specifically reflecting on EY2022, SCE Pilot staff recalled challenges with coordination between multiple parties, TOU education, and unexpected permitting barriers, all which caused delays during the latter parts of the implementation process:

- **Ongoing Coordination and Training with Multiple Parties**. As part of the Pilot, SCE staff coordinates with EVSPs to provide trainings to help site hosts with setting up their EVSP accounts, ensuring they understand the fee structures and have access to EVSP online portals, and helping them to manage other project aspects of having the EVSE on their property. While the initial trainings regarding the various site features went well, Pilot staff noted general challenges when trying to schedule additional trainings that needed to be coordinated with multiple parties. SCE Pilot staff also noted difficulties when trying to schedule follow-up site visits to access breakers and other equipment, as only certain people at the school have the authority or keys to access that equipment.
- **TOU Decision-Making**. SCE staff reported that some sites have experienced activation delays when the site host school needs time to deliberate and choose a fee schedule for charging drivers.
- **Permitting.** Jurisdictions that had authority to provide permits (such as the Division of State Architect) were slowed by a backlog of projects, causing delays in beginning construction for many school sites.

Despite these delays, SCE staff were able to fully subscribe the Schools Pilot and complete 12 school sites in EY2022.

Parks Pilot

Despite limited activity in EY2021 and EY2022, the SCE staff recalled two important successes for EY2022:

- **Completed Master Participation Agreement.** Despite delays due to staff transitions and competing priorities in EY2021, SCE and the DPR signed a Master Participation Agreement, which was an essential first step to implementing the Pilot across all state parks sites and the key success of EY2022.
- **Site Selection.** After the Master Participation Agreement was finalized, SCE and DPR moved onto site selection. DPR and SCE staff partnered in an iterative site selection process using key site selection criteria (such as projected cost-effectiveness). SCE Pilot staff believed that establishing a regular cadence of communication and meetings with DPR was key to their success in site selection, which ultimately led to 19 viable sites.

The barriers the Parks Pilot faced in EY2022 were similar to those in EY2021 and centered on staff turnover in the DPR and Pilot design DAC requirements:

- **Staff Turnover.** When state DPR staff transitions occur, SCE staff must re-orient the new staff member on the purpose of the Pilot, all steps completed to date, and next steps needed. SCE staff cited that staff turnover affected progress in EY2021 and EY2022 but anticipate that this may have less impact in EY2023 and beyond as the Pilot moves to finalizing site selection, design, and construction.
- **DAC Requirements.** Though SCE and DPR staff were able to identify 19 potential cost-effective sites for the Pilot, only two of these sites are within DACs as defined in Decision 11-19-017 (which set the original parameters for the AB Pilots). With only two potential DAC sites and the defined goal to have 25% of AB 1083 sites in DACs, SCE would have to cap their Parks Pilot to eight total sites. SCE has filed Advice Letter 4926-E to request permission to allow sites within five miles of DACs to count toward their 25% DAC goal. As of May 2023, the Advice Letter is still under review by the CPUC.

Highlights

- Despite delays and staff changes, the SCE Schools and Parks Pilots both hit major milestones in EY2022:
  - The Schools Pilot is now fully subscribed
  - SCE and the DPS signed a Master Participation Agreement for the Parks Pilot
- In EY2022, SCE staff were able to leverage learnings from EY2021 about schools' decision-making process and priorities, which will allow it to improve the implementation process for both existing participants and newly enrolled participants.
- Due to a lack of overlap in potential sites and DACs, SCE's Parks Pilot may not be able to reach its goals of 25% of sites being in DACs.

3.2.3. Lessons Learned

The team identified a number of lessons learned from EY2022. These lessons, presented below with key supporting findings and recommendations, may be applied to future Pilot years and to other similar efforts.

Schools Pilot Only

The Schools Pilot sites are helping to displace petroleum, reduce GHG and local emissions, and achieve nominal health impacts overall and within DACs.

The School Pilot sites accounted for an EY2022 annualized impact of more than 4,000 gallons of petroleum (40,000 gallons over a 10-year period), with 16% within DACs. In addition, the Pilot resulted in an 80% reduction in GHGs, of which 16% occurred within DACs. These sites all positively contributed to lowering local emissions, with CO reduction being the most prominent, achieving a reduction of 86 kg in EY2022 and 1,080 kg over a 10-year period. Overall, 21% of the health benefits are in DACs with the monetary health benefits from EY2021 and EY2022 SCE Schools Pilot sites ranging from $103 to $230.

Market conditions contribute to higher-than-expected site costs.

SCE began the Schools and Parks Pilots during the COVID-19 pandemic. COVID-19 had unprecedented economic impacts across nearly every market, driving up costs for materials and labor and disrupting supply chains. These changes were so significant that the estimates SCE had created for Decision 19-11-017 (which mandated the Schools and Parks Pilots at their determined funding levels) did not reflect the actual costs for implementation. These struggles continued to impact sites in EY2022 as inflation impacted material costs.

As the School Pilot matures, SCE staff are improving coordination with and approvals from schools.

In EY2021, Pilot implementation was slower than anticipated as SCE staff established relationships with school staff and learned about the schools' multi-layered approval processes. For example, staff learned that approval must often come from the school board (which, in some cases, means the site may be open to scrutiny and public comment) or from specific personnel who may not work at the site. SCE staff began forming adaptation strategies to overcome these barriers in EY2021. In EY2022, with growing experience, SCE staff were more easily able to maneuver these complex decision-making structures. For example, SCE staff are better able to anticipate and address concerns (such as for student safety if chargers were accessible to the public) of newly enrolling schools.

The Schools Pilot has a modest causal influence on EV adoption.

While the Schools Pilot positively influenced EV adoption in households neighboring the infrastructure, the effects were small relative to baseline registrations. This modest impact was small likely due to the location of the charging stations in nonresidential areas, resulting in limited impacts for neighboring homes.

Parks Pilot Only

The prescriptive Parks Pilot design may be susceptible to significant delays or even prevent the Pilot from achieving desired participation and DAC targets.

In EY2021, SCE discussed how only being able to serve state parks through the Parks Pilot was preventing it from being able to engage similar customers that may be more proactive partners, such as city or county parks. However, in EY2022 SCE was able to successfully finalize a Master Participation Agreement with the DPR and officially begin planning individual parks sites. Through coordination with the state department and local state park staff, SCE was able to identify 19 potential, viable sites. However, only two of those sites are within DACs as defined in Decision 11-19-017 (which set the original parameters for the AB Pilots). With the defined goal to have 25% of Parks Pilot sites in DACs, SCE would have to cap their Parks Pilot to eight total sites. Therefore, SCE staff filed Advice Letter 4926-E to request permission to allow sites within five miles of DACs to count toward their 25% DAC goal. As of May 2023, the Advice Letter is still under review by the CPUC.

4. PG&E Transportation Electrification Programs

4.1. *EV Fleet Program*

4.1.1. Overview

This overview provides a detailed description of the PG&E EV Fleet program, as well as summaries of the program implementation process; performance metrics, program materials, and budget summary; and a major milestone timeline. Following the overview, the Evaluation Team present the EY2022 findings, highlights, and lessons learned.

Program Description

Per Decision 18-05-040, PG&E designed the EV Fleet program to provide infrastructure for fleet electrification at low or no cost to participants. The program launched in June 2019 and encompasses incentives and rebates, site design and permitting, construction and activation, and maintenance and upgrades. The program goal is to assist fleets to install EV charging easily and cost-effectively, saving money, eliminating tailpipe emissions, and simplifying maintenance.[57] PG&E's EV Fleet has an approved budget of $236.3 million and a program-specific goal to support fleet electrification for 700 sites supporting 6,500 MDHD EVs that are procured or converted.[58]

EV Fleet Target
Achieve minimum of 700 sites supporting 6,500 MDHD EVs.

Through the EV Fleet program, PG&E constructs all TTM infrastructure and, depending on the cost-effectiveness of each site, will cover the costs for BTM infrastructure. Otherwise, fleet operators design, build, own, operate, and maintain BTM infrastructure. PG&E provides rebates for BTM infrastructure based on the number of vehicles supported by the infrastructure or 80% of the cost of the BTM infrastructure, whichever is lower. Additional charger rebates of up to 50% of the cost are available for transit agencies, school districts, and fleets located in DACs that are not operated by Fortune 1000 companies.

EV Program Design Goal
Accelerate adoption by providing fleet assistance to install EV charging easily and cost-effectively, saving money, eliminating tailpipe emissions, and simplifying maintenance.

The EV Fleet program requires participating customers to lease, purchase, or convert at least two MDHD EVs. Applicants are not restricted by industry: PG&E will support any nonresidential site aiming to procure two or more MDHD vehicles. Additionally, fleets must own or lease the property where the chargers are installed, must operate and maintain the infrastructure for 10 years, must provide data related to EV usage for five years, and must use EVSEs that meet CPUC safety checklist requirements, among other participation requirements. PG&E offers EV-specific TOU rates (BEV-1 and BEV-2). The SB 350 Decision

---

57 Pacific Gas and Electric. Accessed April 28, 2022. "EV Fleet Program."

58 This amount does not include the evaluation budget.

determines the ranges of spending for EV Fleet. The infrastructure budget is to be spent with a minimum of 15% for transit agencies, maximum of 10% for forklifts, and minimum of 25% on installations in DACs in PG&E's territory.

Implementation

Figure 61 shows the key steps in the EV Fleet program implementation process.

Figure 61. PG&E EV Fleet Program Implementation Process

PRELIMINARY DESIGN PHASE

1. *Customer applies through the online application portal*
2. *PG&E develops an initial design and cost estimate for the project based on scope and site characteristics*
3. *PG&E determines if the project is eligible for TTM only, TTM plus incentives, or TTM plus BTM*
4. *Contract is signed by customer and PG&E*

FINAL DESIGN & EXECUTION PHASE

1. *Customer designs BTM infrastructure, begins permitting process (may be done by PG&E if applicable)*
2. *PG&E finalizes TTM design*
3. *Customer constructs BTM infrastructure*
4. *PG&E constructs TTM infrastructure*
5. *PG&E turns on service*
6. *Customer commissions the EVSE*
7. *PG&E issues rebates*

Program Performance Metrics

The Evaluation Team reviewed the sites participating in PG&E's EV Fleet program and analyzed them by program status. Table 38 provides the count of sites in the PG&E EV Fleet program by completion status as of December 31, 2022.[59] Note, EY2021 data includes three years of program activity whereas EY2022 includes only a single year. Therefore, the two columns are not directly comparable.

Table 38. PG&E EV Fleet Program Complete Site Count by Status

Site Status	EY2021	EY2022
Utility Construction Complete	28	18
Activated	28	14*
Operational	26	15
Closed Out	23	9

Note: For different site status categories site counts reported for EY2022 may include sites from EY2021. For example, a site activated in EY2022 could have been reported as construction completed in the EY2021 Evaluation Report.
* One site with a 2021 activation date was not reported in the 2021 PG&E SB350 and EY2021 Evaluation Report; therefore, it is included in EY2022 count for the EY 2022 Evaluation Report.

---

[59] Note that these numbers are not additive and apply only for that evaluation year; for example, in EY2022, 14 of the 14 completed sites in the program were activated, 14 sites were deemed operational, and nine sites were closed out.

In EY2022, PG&E's EV Fleet program received an addition 150 applications, signed contracts with 70 sites, and activated 14 sites to support 204 MDHD EVs across six market sectors. This raises the total number of applications received to date by PG&E's EV Fleet program to 349 and the total number of contracts executed to date to 158.[60] As Table 39 displays, the EV Fleet program had 36%, or five of its 14 activated sites located in DACs in EY2022 and 38% (or 16 of 42) of activated sites in the program to date are in a DAC.

Table 39. PG&E EV Fleet Program Activated Site Summary by Market Sector

Market Sector	EY2022 Number of Sites in DAC	EY2022 Number of Sites in Non-DAC	Program-to-Date Number of Sites in DAC	Program-to-Date Number of Sites in Non-DAC
Heavy-Duty Vehicles				
Forklift				
Medium-Duty Vehicles				
School Bus			6	17
Transit Bus				
eTRU				
Total	**5**	**9**	**16**	**26**

In EY2022, PG&E's EV Fleet program had the most participation from school and transit bus fleets, which represented more than half of activated sites. Medium-duty vehicle sites are the next most common market sector followed by the heavy-duty vehicles and eTRUs (new market sector in EY2022).

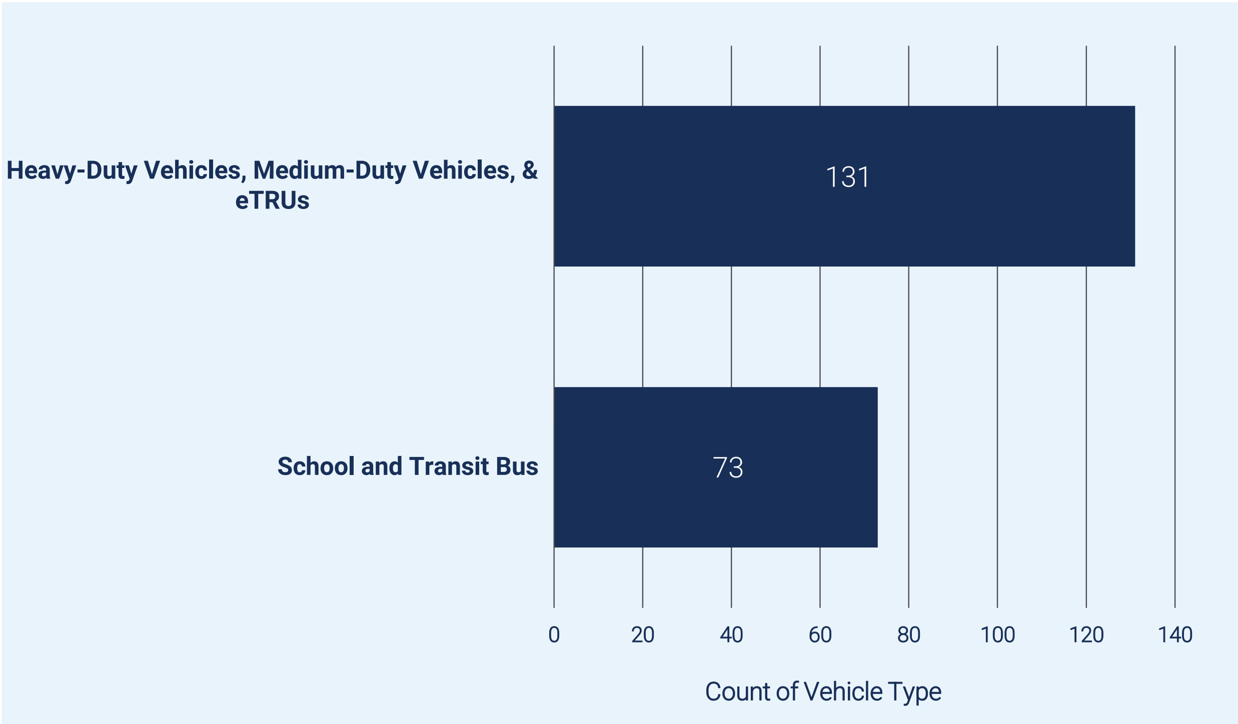
Participation to date in PG&E's EV Fleet program continues to be dominated by school bus fleets, which represent nearly 55% of all activated sites in the program to date. Transit bus and medium-duty vehicle fleets are the second most common market sectors overall. The heavy-duty vehicle and forklift market sectors are among the least represented market sectors based on the number of activated sites as of December 31, 2022.

As shown in Figure 62, through the EV Fleet program PG&E installed charging infrastructure to support a planned 204 MDHD vehicles across five market sectors in EY2022 based on 10-year VAPs submitted by the customers at time of application. This brings the cumulative number of MDHD vehicles electrified in EV Fleet to 505.[61] In contrast with the composition of previously activated sites in EY2021, school and transit bus do not represent the majority of MDHD vehicles electrified in EY2022. Rather medium-duty and heavy-duty vehicles were the most commonly electrified vehicles.

[60] This includes applications that were rejected, cancelled, or put on hold.

[61] The Evaluation Team calculated vehicle counts per customer applications' VAP.

Figure 62. PG&E EV Fleet Program Number of Vehicles Supported by Market Sector, EY2022 Sites



The CPUC established six phases in program timelines per the SB 350 reporting template. As presented in Table 40, as of December 31, 2022, most (50%) customer applications were either under review or undergoing design and permitting. The majority of the remaining applications were in the Site Assessment or Contract Issuance phase of the program, comprising 36% of all customer applications. Collectively, the applications in these four phases represent 88% of all vehicles in the EV Fleet program to date.

Table 40. PG&E EV Fleet Program Sites and Vehicles by Program Phase, as of December 31, 2022

Program Phase	Number of Sites[a]	Total Number of EVs Supported [b]
Application Reviewal	65	832
Site Assessment	58	534
Contract Issuance [c]	60	508
Design and Permitting	99	2,163
Construction Complete	4	68
Activation [d]	42	505

[a] Twenty-one of the 349 applications were inactive, either on hold or cancelled, as of the year end EY2022 and, as a result, are not included in this table.

[b] Vehicle counts derived from applications' VAPs. Totals include applications without vehicles' market sector(s) specified.

[c] Viable contracts exclude contracts that were rejected or withdrawn.

[d] Sites in Activation include those that have completed the sixth program phase (42 sites to date). There are four additional sites that have started but not yet completed the Activation phase as of December 31, 2022, and therefore are excluded from this total and are included in the count of sites for the fifth phase.

By the end of 2022, the PG&E EV Fleet program had 42 activated sites to support the electrification of 505 MDHD vehicles per customers' VAPs. The 158 contracts signed in the EV Fleet program meet 23% of the program's *per se reasonableness* goal of 700 sites and support 3,050 MDHD vehicles meeting 47% of the program's *per se reasonableness* goal of 6,500 additional vehicles electrified. The total of 270 customer applications could satisfy approximately 39% of the program's site goal and would support roughly 4,600 MDHD vehicles, which could satisfy 71% of the program's electrified vehicles goal.

Table 41 displays the median durations per program phase (measured in calendar days). The column labeled EY2021 Sites refers to sites activated between 2019 and the end of calendar year 2021.[62] The column labeled EY2022 Sites refers to sites activated during calendar year 2022. Program to date refers to all sites activated since the initiation of the program to December 31, 2022. Values in Table 41 are used as a representative indicator of project phase length trends over time. Note, sites in each column did not necessarily pass through each phase in the same calendar year. For example, some sites in the EY2022 Sites column may have passed through Design and Permitting in 2021 while others passed through in 2022. For this reason, the columns capture different moments in the Utility program's lifecycle and may not be directly comparable. Across all program phases, Activation has the shortest median duration, while Design and Permitting has the longest median duration. Across the EV Fleet program, the Application Reviewal and Activation phases continue to take applicants the shortest amount of time to complete. The Design and Permitting phase tasks the longest time to complete, with median duration of 265 calendar days for project activated in the program to date.

Note that these median durations vary by market sector. For instance, for sites activated in EY2022 medium-duty vehicle applications in the Contract Issuance phase took a median of 257 calendar days to complete, while it took only a median of 41 days for school bus applications to complete the same phase. Customer applications in the heavy-duty market sector took significantly longer in the Construction Complete phase compared with the overall median duration, with a median of 741 calendar days.

PG&E distribution engineers were included in the Site Assessment phase in EY2021 to check site designs, which impacted cycle times for projects completed in EY2022. There was an additional change in the calculation for median number of days for the Design and Permitting phase compared to the Construction Complete phase that resulted in a more accurate representation of the breakout between those two phases (numbers presented in Table 41 differ for these two phases from the ones in the EY2021 Report, shown in parentheses in Table 41).

---

62 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/sb-350-te/sb-350-standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

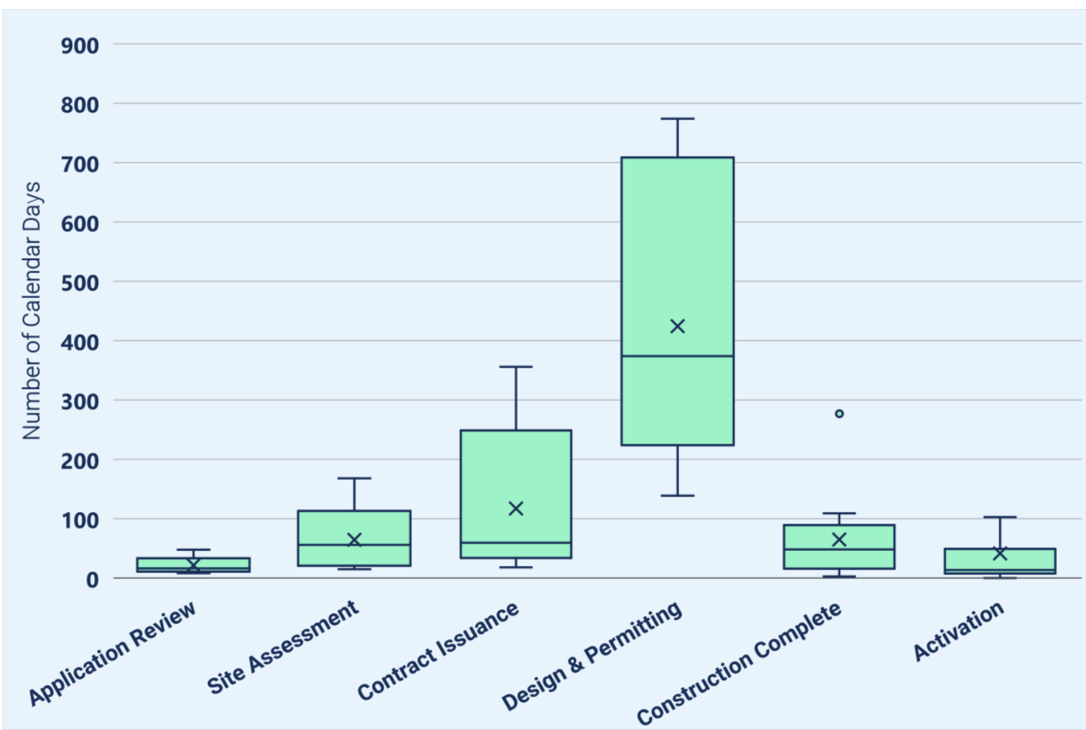
Table 41. PG&E EV Fleet Program Median Calendar Days Per Phase

Program Phase	EY2021 Sites (Median Calendar Days)	EY2022 Sites (Median Calendar Days)	Program-to-Date Sites (Median Calendar Days)
Application Reviewal	19	17	17
Site Assessment	51	56	51
Contract Issuance	42	60	46
Design and Permitting	252 (116)	374	265
Construction Complete	30 (169)	49	32
Activation	16	14	15
Number of Activated Sites	**28**	**14**	**42**

Note: This table only includes data for activated sites.

The analysis of program phase durations is expanded upon in Figure 63, which displays the average number of calendar days (denoted by X) as well as the median calendar days (middle line in box), first quartile (bottom of box), third quartile (top of box), minimum (bottom tail), maximum (top tail), and outliers (dots). The distribution of calendar days per phase is positively (right) skewed across program phases, which is evident by the average calendar days per phase exceeding the median number of calendar days per phase. This trend likely derives from the long top tails, meaning that some sites take an unusually long time to complete a given program phase. As shown in Figure 63, program customer applications can expect wider variances in the amount of time taken to complete the Contract Issuance and Construction Complete program phases.

Figure 63. PG&E EV Fleet Program Summary of Calendar Days for EY2022 Sites, by CPUC Phase



Note: This data only represents activated sites.

Table 42 displays the median quantity of calendar days that the EV Fleet program took from start to finish (application reviewal to activation) for 14 activated sites across six market sectors in EY2022. The overall median start-to-finish timeline for site activation for these sites was 784 calendar days. The overall median start-to-finish timeline for site activation for these sites was the shortest for eTRU application with 393 days while school bus and transit bus applications were the longest with 800 and 915 days, respectively.[63] The overall median start-to-finish timeline for site activation for all program to date sites was 557 calendar days, ranging from 393 days for eTRU applications to 672 days for transit bus applications. For program to date activated sites, Design and Permitting is the longest phase, with a median of 265 days, or nearly 50% of implementation timelines.

Table 42. PG&E EV Fleet Program Median Duration for Site Activation, by Market Sector

Market Sector	EY2022 Sites		Program to Date Sites	
	Median Duration Start-to-Finish Site Activation (Calendar Days)	Number of Activated Sites	Median Duration Start-to-Finish Site Activation (Calendar Days)	Number of Activated Sites
Forklifts	-	-	405	3
eTRU	393	1	393	1
Medium-Duty Vehicles	579	2	615	6
School Bus	800	4	600	23
Heavy-Duty Vehicles	565	3	557	3
Transit Bus	915	4	672	6
All Market Sectors	**784**	**14**	**557**	**42**

Program Materials Summary

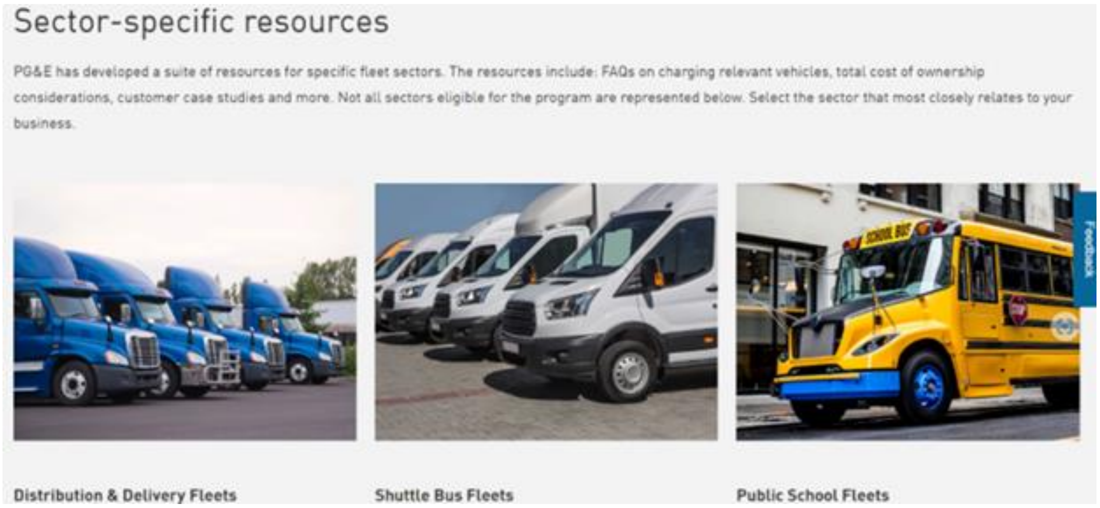
This section highlights findings from the review of program material and ME&O activities conducted by PG&E in EY2022. PG&E expanded its customer education and outreach efforts to increase program participation. Through its EV Fleet program website,[64] PG&E provides several informational resources to appeal to and educate potential fleet customers, including a program overview, information on incentives and rebates per vehicle and charger, eligibility requirements, and an "Other Resources" page that includes sector-specific resources as well as links to tools and important program documents. Through this website, PG&E provides sector-specific resources on distribution and delivery fleets, shuttle bus fleets, municipal fleets, and transit fleets (see Figure 64).

---

63 Median start-to-finish durations will not equal the sum of median calendar days per each phase due to gaps in the timeline between the completion of one phase and the start of another phase.

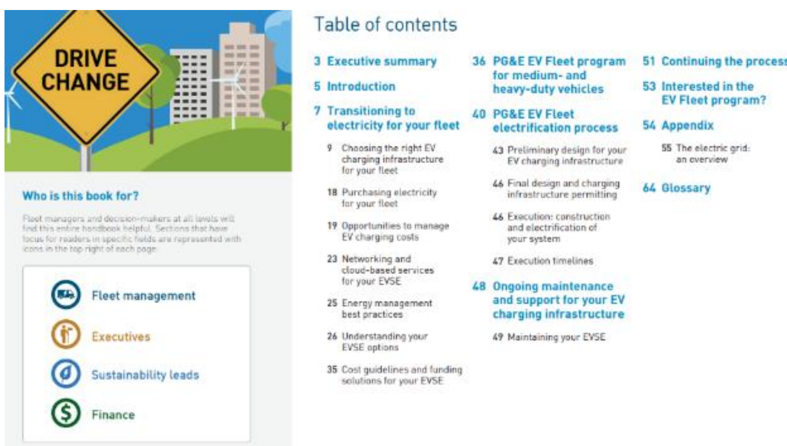
64 Pacific Gas and Electric. Last updated 2023. "EV Fleet Program." https://www.pge.com/en_US/large-business/solar-and-vehicles/clean-vehicles/ev-fleet-program/ev-fleet-program.page

Figure 64. PG&E EV Fleet Program Sector-Specific Resources Landing Page



The "Other Resources" page also includes tools such as an EV Fleet Charging Guidebook (see Figure 65), a fuel switching rate calculator to help program participants understand how the program will impact their rates, a frequently asked questions sheet, and a tool for checking grid capacity to help customers site their projects, along with several other program documents and resources. This page also includes links to pre-recorded webinars on topics such as stackable incentives, choosing the right hardware, creating a competitive funding application, permitting for EVs, and more.[65]

Figure 65. PG&E EV Fleet Program Charging Guidebook

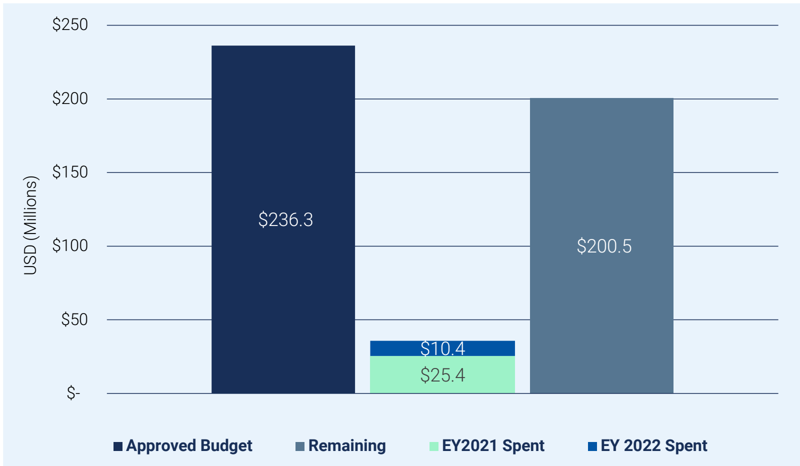


65 For more details see the following websites:
Stackable incentives: https://www.act-news.com/webinar/pge-webinar-3/
Choosing the right hardware: https://www.act-news.com/webinar/webinar-series-ev-charging-hardware-and-software-for-medium-and-heavy-duty-fleets-part-1/
Creating a competitive funding application: https://www.act-news.com/webinar/how-to-create-a-competitive-funding-application/
Permitting for EVs: https://www.act-news.com/webinar/ev-charging-infrastructure-permitting-and-construction/

Budget Summary

As shown in Figure 66, from program inception through December 31, 2022, PG&E spent $35.9 million of $236.3 million of the approved budget for EV Fleet. Program spending was $10.4 million in 2022, $8.6 million in 2021, and $16.9 million in years before 2021. Figure 66 follows this report's convention of referring to program activities that occurred between the program's inception and the end of calendar year 2021 as "EY2021." Thirty-nine percent[66] of PG&E EV Fleet program spending on infrastructure for financially closed out sites to date has been on DAC sites, exceeding the 25% program target.

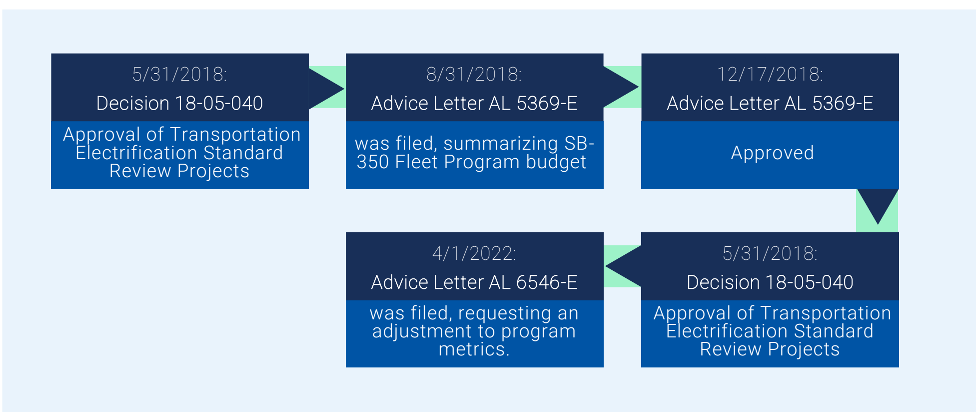
Figure 66. PG&E EV Fleet Program Budget as of December 31, 2022



Timeline

In April 2022, PG&E filed Advice Letter 6546-E jointly with SCE (SCE AL-4761-E) to request an adjustment to the metrics and timeline for site commitments. There were no other milestones or advice letters in EY2022. Figure 67 shows all major milestones since the beginning of the program.

Figure 67. PG&E EV Fleet Program Milestones



---

66 Calculated by summing utility TTM and BTM costs (for sites with customer constructed BTM, rebate for customer side infrastructure is used).

4.1.2. Findings

The following sections provide findings from the Utility staff and vendor interviews, surveys, and site visits. The Evaluation Team also provides insights from the deep dives, co-benefits and co-cost analysis, TCO, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health impacts, and net impacts.

Table 43 presents key impact parameters for EY2022 and the program to date, including annual estimates of impacts for metrics calculated as part of the impact evaluation and estimates of impacts across all sites in the program population through the end of EY2022.[67]

Table 43. PG&E EV Fleet Program Impacts Summary

Impact Parameter	EY2021 Sites [a]	EY2022 Sites [a]	EY2022 Sites Percentage in DAC	Program-to-Date Sites Actuals	Program-to-Date Sites Actuals Percentage in DAC
Population of Activated Sites (#)	28	14[b,c]	36%	42[b]	38%
Sites Included in Analysis (#)	24	13	38%	41	39%
Ports Installed in Analyzed Sites (#)	197	132	47%	345	50%
EVs Supported (#) [d]	265	184	51%	485	49%
Electric Energy Consumption (MWh)	2,806		42%	5,914	61%
Petroleum Displacement (DGE)	306,260	207,454	36%	647,652	67%
GHG Emissions Reduction (MT GHG) [e]	2,655	1,660	39%	5,810	70%
NO_x Reduction (kg)	1,625	587	82%	3,411	65%
PM_{10} Reduction (kg)	32.9	2.5	70%	69	93%
$PM_{2.5}$ Reduction (kg)	29.5	2.4	70%	62	93%
ROG Reduction (kg)	236	33.5	22%	576	91%
CO Reduction (kg)	12,946	20,884	7%	37,689	73%

[a] Energy consumption, petroleum displacement, emissions reductions, and health benefits are based on annualized data. Program-to-date results are based on actual data (see the *Methodology* section for more details).

[b] Includes one eTRU site, which was activated but had no usage in EY2022.

[c] One site with a 2021 activation date was not reported in the 2021 PG&E SB350 and EY2021 Evaluation Report; therefore, it is included in EY2022 count for the EY 2022 Evaluation Report.

[d] The Evaluation Team derived the EVs supported value from applicants' VAPs. This value represents the maximum number of vehicles expected to be supported by the charging infrastructure.

[e] GHGs include CO_2, CH_4, and N_2O multiplied by their respective GWP as defined by IPCC AR5 (see the *Methodology* section for more details).

Note: values for population of less than 15 sites are redacted

---

67 For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

Utility Staff Insights

The Evaluation Team interviewed PG&E program staff in October 2022 to discuss program challenges and successes. Program staff identified several program challenges:

- **Site cost.** Per-site costs continue to be higher than expected, both for TTM and BTM.
- **Supply chain delays**. Though not a barrier to current sites, supply chain issues continue to be a challenge, with some transformers taking up to 40 weeks to be delivered and lead times for switchgears taking 70 weeks or more.
- **Limited vehicle options and timing of replacement.** Staff reported lower-than-expected demand from fleet customers due to the lack of choice and availability of MDHD EV models, and due to the timing of when fleets are replaced (as fleet customers prefer to retire existing vehicles at the end of their useful life or when it is financially feasible).
- **Jurisdictional requirements.** New local ordinances (such as the San Jose pole restrictions and the San Francisco EV charger zoning) may prohibit customers in those areas from participating in the program. For example, requiring undergrounding of Utility lines may increase costs above project cost-effectiveness thresholds, which may put an extra burden on site owners, disincentivizing fleets to participate in the program.
- **Post-activation support**. Program participants require additional support after site activation. This was not accounted for in the program budget, and therefore program staff are limited in the post-installation support that they can provide.
- **Lessening impact of incentives.** Electric Rule 29, which provides service connections for EV charging sites, has diminished the value proposition of the program. Previously customers were required to pay for most or all of the TTM infrastructure if they chose not to go through the EV Fleet program, but these customers can now have that infrastructure covered through Rule 29.

PG&E staff also report notable successes in EY2022:

- **Expanded vehicles included.** The program transitioned to support more medium-duty vehicles in EY2022. Initial adopters primarily had school bus, but now more adopters have delivery trucks, laundry trucks, step trucks, and transit vans. PG&E additionally noted that more municipalities are applying for EV charging projects for diverse fleets that include maintenance and police vehicles.
- **Expanded outreach.** Generally, the program customer education efforts are going well, with PG&E noting that customers appreciate PG&E's fleet TCO tool, which helps them estimate the total cost of EV ownership, including fuel and operations. Staff also said customers appreciate PG&E's attention to EV services within the program, compared to going through the normal service planning process. Finally, staff reported that onboarding specialists have been the most effective outreach method for potential applicants, as this high-touch approach is needed to identify customers who are ready to apply. Therefore, in EY2023, PG&E plans to increase onboarding specialist support.

- **Program design enhancements.** In EY2022, PG&E staff developed internal guidance to facilitate future proofing and required adjustments to match TTM and BTM designs. In addition, the staff implemented several key changes to the program design:

  Removed the requirement to have a dedicated meter for EV service, which they hope will facilitate the use of existing infrastructure and help to more easily integrate distributed energy resources (this requirement still exists for off-road EVs).

  Began allowing customers to count the dispenser (instead of the power cabinet) toward rebates, which provides customers with more flexibility in the type and amount of EV charging infrastructure.

  Updated the EV procurement requirement from within five years of the program start to within five years after contract signing, giving customers more flexibility with procurement in response to supply chain and grant funding constraints.

Highlights

- Despite continued outreach, staff expressed concern about meeting current site goals.
- As site construction continued in EY2022, site costs continued to be a challenge. In addition, EV Fleet staff cited the lack of EV options, restrictive local ordinances, and long equipment lead times as factors impacting program participation.
- Despite staffing limitation, to further serve interested customers, EV Fleet staff expanded outreach and implemented program design enhancement such as developing guidance to facilitate future proofing of sites, allowing customers greater flexibility on issues impacting site design and EV procurement, and planning to add an onboarding specialist.

Vendor Interviews

The Evaluation Team interviewed representatives from four different charging providers, known as EV service providers (EVSPs), to explore their program experiences including Utility engagement; project installation; perceived insights from fleet owners, site hosts, and drivers; data collection and load management; barriers to electrification; overall market outlook; and suggestions for program improvement. Many of these findings are similar or identical to those reported for the SCE program (Chapter 2) and for the SDG&E program (Chapter 4), as EVSPs tended to offer observations on the Utility programs, rarely mentioning specific programs for praise or criticism.

Utility Engagement

Generally, the four interviewed EVSPs were strongly complimentary toward and supportive of Utility engagement through the EV Fleet program. In addition, three EVSPs reported that PG&E staff involvement in the make-ready infrastructure process was a very important element in accelerating EVSE deployment. One EVSP expressed a preference for PG&E’s BTM incentives to apply to all EVSE installations, rather than to just a subset, but also reflected that the EV Fleet program is very prescriptive, most notably for schools.

In addition, two of the four representatives said the Utilities (SCE, PG&E, and SDG&E) would benefit from additional staffing to expedite the analysis and accommodate the increased load attributable to EVSE.

Installation

EVSP representatives provided insights regarding installation challenges, interoperability, and installation cost differences.

- ***Installation challenges.*** The EVSPs reported several challenges with EVSE installation: (1) long lead times for vehicle and equipment availability, (2) labor shortages among installation contractors, and (3) long timelines for permitting approval at the city or state levels. For example, one EVSP noted that the Service Level Agreements with Utilities can require product delivery within 21 days, which can be difficult under current market conditions; however, the EVSP did not specify which Utilities had such challenging and inflexible Service Level Agreements. Three EVSPs also noted that permitting had previously been a problem (not simply with the EV Fleet program but with EVSE installation generally) but indicated that these challenges had largely been resolved (and attributed the remaining permitting challenges to staff shortages at the permitting entities). However, one EVSP reported that local permitting remained a barrier, with previously expected timelines of 12 months becoming 18 months. One EVSP also noted that EVSE installation at schools could be delayed by the need to secure approval from the Division of the State Architect.

  EVSPs identified additional challenges such as inconsistent processes for setting up right-of-way agreements for Utility-owned infrastructure across the three different Utilities (n=1), lack of readily available grid capacity information (n=1), and inconsistent responses from Utility staff about the eligibility of V2G-capable chargers for rebates and installation incentives (n=1).
- ***Interoperability.*** When asked about interoperability as a challenge, three EVSPs reported that interoperability issues between EVSE and specific vehicles were sporadic and rapidly rectified, generally through over-the-air software updates. As opposed to on-site software updates requiring a service call by a technician or engineer, over-the-air updates can be implemented remotely and therefore quickly.

  Additionally, one EVSP noted that more significant effort is now required to correct interoperability issues: while they have engineers working to better integrate their software with the vehicle software, a plug and play solution is about one year away.
- ***Installation costs.*** All four EVSPs reported that cost differences in the installation of comparable EVSE at different sites arise primarily from the status of the existing infrastructure on the site, such as the available load on the transformer, capacity of the distribution panel, need for facility upgrades, need for trenching, type of surface material, and distance from the meter to the EVSE. In addition, the EVSPs noted other factors including the quality of product installed (which materials and components are used), the quality and availability of software, and the desired EVSE functionality.

Fleet Owner, Site Host, and Driver Perspectives

All four EVSPs noted that there was extensive interest from customers in electrifying their fleets and good alignment between what Utilities can provide and what customers need.

EVSPs noted two key aspects of EV Fleet for customers:

- ***Capital funding***. All four EVSPs reported that program incentives for both the infrastructure and the vehicles is extremely important for accelerating customer EV adoption. In addition, the EVSPs agreed that there is sufficient demand from fleet owners to warrant expanding the EV Fleet program with additional technical assistance and incentive funds. Furthermore, all four EVSPs indicated that the current Utility incentive levels per site are adequate, although one noted that there could be benefits in helping customers (especially schools) to identify and access grant funding opportunities.
- ***Identified products***. One EVSP noted that the qualified products list supports fleet owners by removing some of the guesswork involved in fleet electrification.[68]

From the EVSP perspective, challenges for fleet owners include the rapid pace of changes in the MDHD EV industry. For example, a customer's needs may have changed since they developed their VAP or recommendations from the feasibility study may have lost some relevance by the time the fleet is ready to implement the plan. EVSPs expressed a desire for Utilities to offer greater flexibility to program participants in modifying their EVSE and vehicle plans, especially for schools.

EVSPs reported mixed perceptions from fleet drivers regarding EVs. One EVSP attributed uncertainty regarding EVs to a lack of knowledge about the vehicles, citing that some drivers worried about plugging in a vehicle to charge while it was raining, fearing the risk of electrocution.

Data Collection

The four EVSPs were generally supportive of the data collection required for the EV Fleet program. However, one EVSP said the data collection process carries a cost, and that individual EVSPs can be at a disadvantage if they invest in providing a large volume of high-quality data while some of their competitors provide lower-quality data. This EVSP recommended clear standards and requirements for the quality of data collection.

Load Management

Load management capabilities can reduce EVSE installation costs by avoiding the need for infrastructure upgrades, and they can reduce operational costs by reducing demand charges. However, one EVSP noted that uptake of the load management capabilities could be constrained by a fleet's operational needs. For example, some fleets require charging during peak hours, and not all loads can be shifted. One EVSP noted that they did not yet have fully operational load management capabilities but was in the process of developing such features. Three EVSPs reported that the use of load management often requires customized support that factors in each customers' unique operations and charging needs. One EVSP also noted some difficulty in calibrating load management systems to particularly complicated

68 The Approved Product List for PG&E's EV Fleet program is hosted by SCE at http://www.sce.com/APL.

Utility tariffs, especially when it was not clear which tariff would apply to a vehicle (such as when a vehicle can charge at multiple locations).

Barriers to Electrification

The most common barrier to fleet electrification reported by EVSPs was component supply, specifically transformers and switchgear. One EVSP noted that custom switchgear can have a 48-month timeline to delivery, but also recognized that Utilities had been receptive to recommendations from the EVSP on addressing supply chain issues.

Market Outlook

Forthcoming technological advances that could accelerate fleet electrification include plug-and-charge capability, V2G or bidirectional charging, wireless charging, and billing management through the vehicle's system. Additionally, two EVSPs noted that extensive grid communication strategies are in development, which one of these EVSPs plans to integrate with home energy management technologies.

All four EVSPs noted that the Utilities in general were good partners in deploying infrastructure, emphasizing that Utility engagement was vital and that the sector is not yet mature enough for a self-sustaining market if Utilities were to disengage. Compared to the light-duty market, the EVSP reflected that the MDHD market is at a much earlier stage of development. For example, one EVSP suggested that the transition in this segment may take another decade. This same EVSP noted that, while early adopters may have the financial means to make the shift today, there will be broader demand in five years, and those customers may also need Utility support. One EVSP said, "These are really great programs for everybody involved. They help the capital cost burden for early adopters. This is something that Utilities should continue to support going forward."

Suggestions for Improvement

The EVSPs had some suggestions for improving the EV Fleet program:

- Communicate major program changes more promptly to key partners such as EVSPs.
- Shorten the load analysis timelines.
- Standardize and clarify the program data collection requirements.

Highlights

- EVSPs agree that the EV Fleet program is beneficial and well-implemented but said PG&E could benefit from additional staffing to expedite site analysis and accommodate the increased load attributable to EVSE.
- Interoperability issues are relatively minor and are resolved quickly, generally through over-the-air software updates.
- Supply chain constraints continue to be a concern and impact installation timelines.
- EVSPs said Utilities are good partners in deploying infrastructure and emphasized the need for Utilities to stay involved, as the sector is not yet mature enough for a self-sustaining market.

Survey Results

The Evaluation Team surveyed six fleet managers[69] who participated in PG&E's EV Fleet program about their motivations for and barriers to electrification, program satisfaction and awareness, experience with EVs and charging infrastructure, the impact of the program on fleet electrification, and their perspective on the industry. Of these fleet managers, two were from the transit sector, one was from the medium-duty sector, and three were from school bus sector (Table 44). In addition, the sections below provide insights from two fleet managers who withdrew from the program (known as withdrawn fleet managers).

Table 44. PG&E EV Fleet Program Manager Survey Sample, EY2022

Survey Type	Sector	Number of Surveys Sent	Number of Partial Surveys	Number of Completed Surveys
Participating Fleet Managers	Airport GSE	0	0	0
	Medium-Duty	3	0	1
	Forklift	0	0	0
	Port Cargo Trucks	0	0	0
	School Bus	5	2	1
	Transit Bus	3	0	2
Total Participants	--	**12**	**2**	**4**
Withdrawn Fleet Managers	--	**6**	**0**	**2**

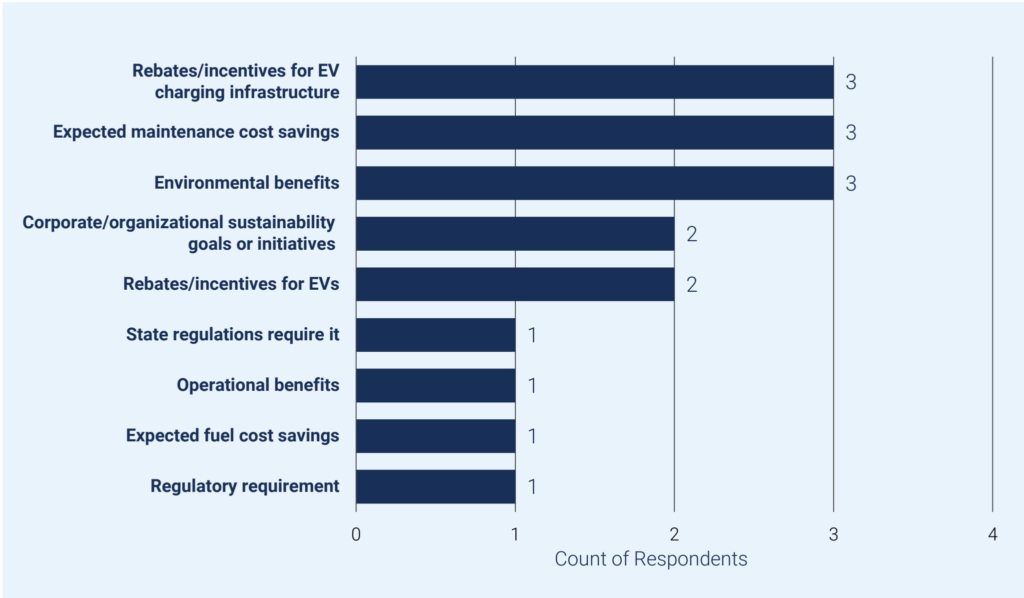
Electrification Motivators and Barriers

The Evaluation Team asked PG&E fleet managers about their motivations to transition to EVs. As shown in Figure 68, the top three motivators, mentioned by three respondents each, were the incentives for EV charging infrastructure, expected maintenance cost savings, and environmental benefits.

The Evaluation Team asked fleet managers which barriers to electrification their fleets faced before participating in the PG&E EV Fleet program and which remained after participation. As shown in Figure 69, prior to participating in the EV Fleet program, managers said the biggest barriers to electrification were the cost of installing EV charging infrastructure (three respondents), challenges finding the right EVs to meet fleet needs (two respondents), and the cost of EVs (two respondents). After participating in the program cost remained a key barrier, with two mangers reporting that the cost of installing EV charging infrastructure was still prohibitive and one reporting that the cost of the EVs remained prohibitive despite program incentives. Two managers also noted difficulty finding suitable EVs to meet fleet needs as a remaining barrier.

69 In some cases, the number of responses to a question is greater or less than six. This is due to the inclusion of partial participants (those who answered some questions but did not complete the survey) and cases where not all respondents answered a question. Despite the Evaluation Team's efforts to improve the response rate through multiple rounds of outreach and increased survey incentives, the fleet manager survey did not reach the target response number, which limits the insights that can be gleaned from a smaller sample size.

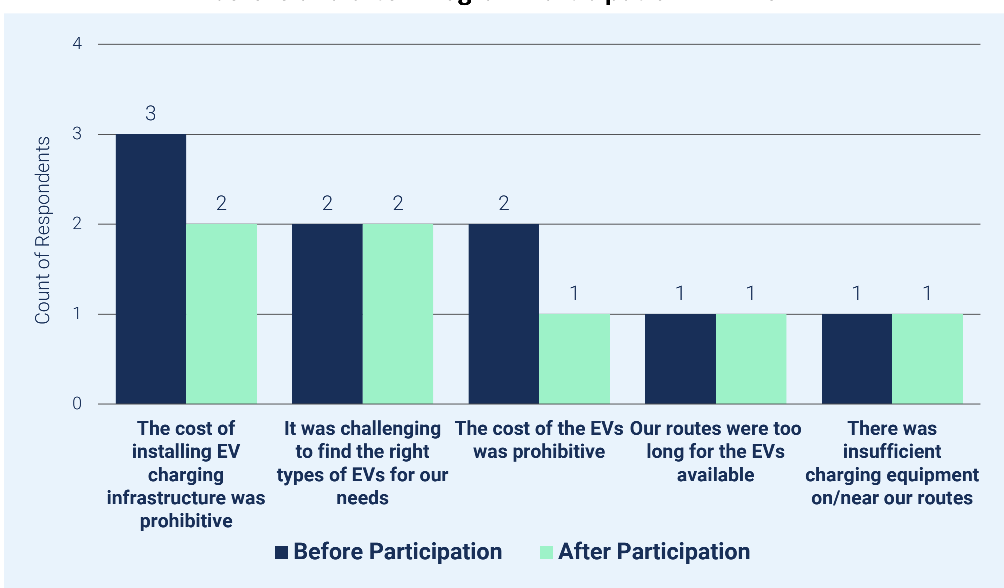
Figure 68. PG&E EV Fleet Program Participant Motivators for Transitioning to EVs in EY2022



Source: Fleet Manager Survey Question C1. "Why did your fleet decide to transition to EVs? Select all that apply." (n=6, multiple responses accepted).

After participating in the program, the largest remaining barriers reported by participating fleet managers were that the cost of installing EV charging infrastructure was prohibitive (two respondents) and that it was challenging to find the right types of EVs for their needs (two respondents).

Figure 69. PG&E EV Fleet Program Barriers to Electrification before and after Program Participation in EY2022



Source: Fleet Manager Survey Questions F3 and F4. "Which of the following barriers to electrification did your fleet face before participating in the EV Fleet program?" (n=6) and "You mentioned that the following were barriers to electrification before participating in the EV Fleet program. Do any of these barriers still exist after you participated in the program?" (n=6)

Program Satisfaction

When asked how likely they were to recommend the EV Fleet program on a scale of 0 to 10, with 10 being the most likely to recommend, four of six fleet managers said they already recommended the program or were extremely likely to recommend the program. The other two respondents rated their likelihood of recommending the program as an 8 and a 6. Together, these ratings led to a net promoter score of +50.[70]

Figure 70 shows satisfaction with the EV Fleet program. Overall, the surveyed fleet managers were highly satisfied with their overall experience, with three managers rating themselves as *very satisfied* and two rating themselves as *somewhat satisfied*. Managers were particularly satisfied with working with PG&E staff and the rebate process, though they gave very positive ratings for most program aspects. Three respondents included additional comments about their positive program experience:

- "The site assessment allowed us to better understand the kilowatt-hours of power available to the site."
- "All the people involved were extremely helpful, knowledgeable, and professional."
- "[I] had a great project manager. [They] were super helpful in navigating our agency through the process."

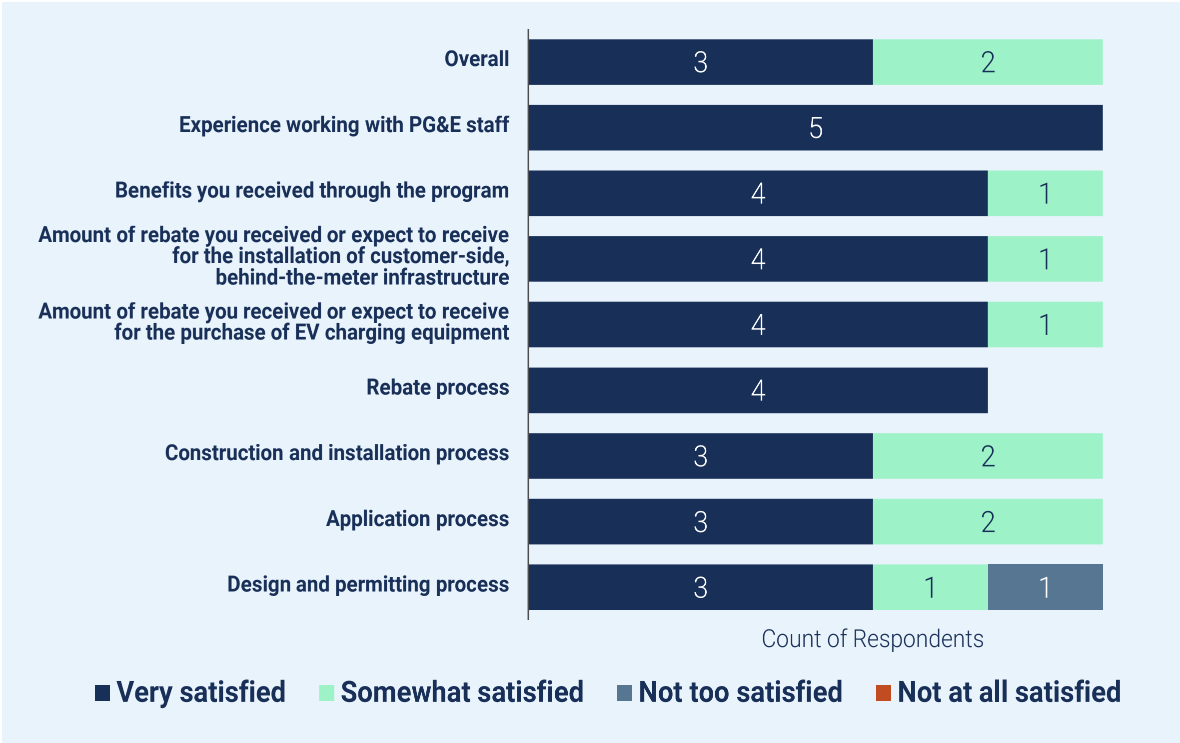
Program Awareness

The Evaluation Team asked fleet managers how they first learned about the EV Fleet program. Four of six fleet managers learned about the program directly from PG&E, while one learned about the program from another fleet, and one did not answer the question. When asked whether they knew prior to joining the program if upgrades to the electrical infrastructure were needed to charge EVs, three fleet managers said they were aware and two said they were not. One fleet manager did not respond to this question.

As shown in Figure 70, fleet managers were overall *very satisfied* or *somewhat satisfied* with the program elements, while one was *not too satisfied* with the design and permitting process. The Evaluation Team asked fleet managers to provide comments about aspects of the program where they were particularly dissatisfied. Some fleet managers provided additional comments about their experience, with one noting dissatisfaction with the easement process. Another said, "I wish PG&E could have helped us acquire long lead time items such as the switchgear. We understand, of course, that this was a nationwide issue."

[70] The net promoter score is calculated by subtracting program detractors (those who rated their likelihood to recommend the program to others as a 0 through 6) from the program promoters (those who rated their likelihood to recommend the program as a 9 or 10). The manager who gave a rating of 8 was labeled as passive and did not negatively or positively impact the score.

Figure 70. PG&E EV Fleet Program Satisfaction Elements in EY2022



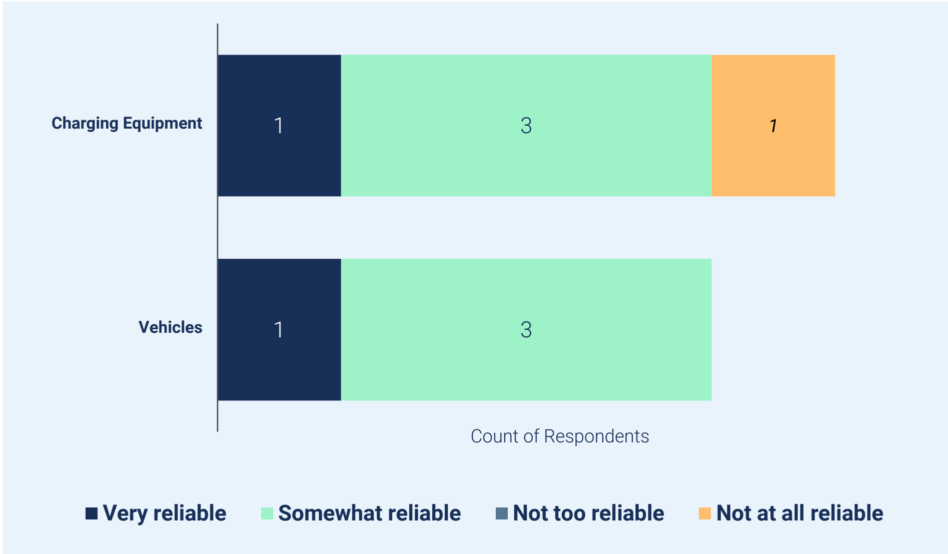
Source: Fleet Manager Survey Question B1. "Thinking about your experience with the EV Fleet program, how satisfied are you with the following?" (n=5)
Note: No respondents provided a rating of *not at all satisfied* for any element.

The Evaluation Team asked fleet managers what they would have done differently if they were to go through fleet electrification again. Two fleet managers provided answers. One said they would have planned further ahead for electrification and made sure to gain a better understanding of battery storage and resiliency. Another said they would have purchased different chargers, and would have used one charger for two vehicles, instead of having a one-to-one vehicle-to-charger ratio.

Experience with EVs and Charging Infrastructure

The Evaluation Team asked managers about the reliability and ease of using the EVs and charging equipment in their fleet: all four respondents who answered this question rated the EVs as either *somewhat reliable* or *very reliable*. However, a wider range of experiences were reported for charging equipment, with one fleet manager reporting this as *not at all reliable*, as shown in Figure 71.

Figure 71. PG&E EV Fleet Program Reliability of Vehicles and Charging Equipment in EY2022



Source: Fleet Manager Survey Questions C3 and C4. "How would you rate the reliability of the electric vehicles that are part of your fleet?" (n=4) and "How would you rate the reliability of the electric vehicle charging equipment?" (n=5)

Additionally, four fleet managers offered a range of feedback on the ease of using the charging equipment. Two fleet managers rated the charging equipment as *very easy* to operate, one rated it as *somewhat easy*, and another rated it as *not at all easy*.

Impact of Program on Fleet Electrification

The Evaluation Team asked fleet managers about their plans to accelerate their procurement of EVs and related equipment because of their program experience. Of four fleet managers who answered this question, two had no plans to further accelerate procurement in the future, while two had plans to accelerate procurement because of their program participation.

While only two of four fleet managers reported that the program influenced their plan to accelerate EV procurement, five fleet managers, including the four managers who answered "yes" or "no" regarding program impact on accelerated procurement, reported that they planned to acquire more EVs within the next 10 years:

- Combined 87 transit bus (across two respondents)
- Combined 46 medium-duty vehicles (across two respondents)
- Combined 16 school buses (across two respondents)

Of the two managers who said that participating in the EV Fleet program had changed the number of EVs that they acquired or plan to acquire, one said that the EV Fleet program allowed them to acquire vehicles sooner than they would have otherwise.

Industry Perspective

The Evaluation Team asked fleet managers for their thoughts on how well their industry or sector is positioned for electrification. Three of four managers rated their industries as *somewhat well-positioned*, while one rated their industry as *neutral* (Table 45).

Table 45. PG&E EV Fleet Program Industry Positioning for Electrification among Program Participants in EY2022

Market Sector	Extremely Well-Positioned	Somewhat Well-Positioned	Neutral	Not Too Well-Positioned	Not at All Well-Positioned
Medium-Duty (n=1)	0	1	0	0	0
School Bus (n=1)	0	1	0	0	0
Transit (n=2)	0	1	1	0	0

Source: Fleet Manager Survey Question F1. "How well-positioned do you think your industry/sector is for electrification?"
Note: No fleet managers provided a rating of *extremely well-positioned* or *not at all well-positioned.*

Fleet managers who rated their industry as *somewhat well-positioned* for electrification reported this result because of the available purchasing options for fixed route transit, availability of federal money for vehicle replacement, and state funding. However, obstacles still exist, specifically limited vehicle availability, delays in acquiring EVs, and limited options for certain market sectors such as paratransit vehicles. One fleet manager who rated their industry as *somewhat well-positioned* said, "I think it is a top priority for both state and federal governments to provide funding to school districts to go electric, so as long as it remains a top priority, we should continue to receive funding that will help offset the costs of transitioning to electric."

When asked about the availability of EV options in their sector, two fleet managers reported being satisfied with the current EV options for their sector and two reported not being satisfied. When asked about the limitations of current EV options, one respondent each mentioned the range, availability of units, underdeveloped vehicle markets, and wait times for receiving vehicles.

The Evaluation Team asked fleet managers, given what they know or believe about requirements for fleets to purchase zero-emission MDHD trucks, whether they believe electric or diesel trucks seem like a riskier purchase in the next three years and in the next 10 years. Two of four managers said diesel trucks seem like a riskier purchase while two said electric trucks seemed risker in the next three years. On a 10-year horizon, three of four fleet managers believed that electric trucks would be the safer purchasing decision over diesel trucks while one said electric trucks seemed like the risker purchase (n=4).

Withdrawn Fleet Managers

In addition to the fleet managers who participated in the program, the Evaluation Team surveyed two fleet managers who withdrew from the program (known as withdrawn fleet managers). Both of these fleet managers said they were originally motivated to participate because of rebates and incentives. One fleet manager was also motivated by expected maintenance cost savings, expected fuel cost savings, corporate sustainability goals or initiatives, and regulatory requirements.

When asked why they withdrew from the program, one fleet manager said the return on investment was too long and vehicle costs were too high. This fleet manager also said that they would have liked higher rebates or more funding, and that these features would have increased their likelihood to stay in the program. The other withdrawn fleet manager said that inadequate incentives and a lack of support from PG&E on the BTM make-ready process were barriers to continued participation, and that more support from PG&E would have increased their likelihood to stay in the program.

In terms of additional support, they would have liked, both withdrawn fleet managers reported improved "Utility-side make-ready infrastructure support." When asked what items the program should rebate, both withdrawn fleet managers noted that construction costs should be eligible for rebates, while one withdrawn fleet manager reported that EVSE costs should be eligible for rebates.

The Evaluation Team also asked the withdrawn fleet managers about their level of satisfaction with various program aspects. One fleet manager rated themselves as *very satisfied* with all aspects of the program. In contrast, the other withdrawn fleet manager rated themselves as *somewhat satisfied* with the program overall, but *not at all satisfied* with rebate amounts.

After withdrawing from the program, one respondent continued to build the intended project but scaled down from the original plan, citing that the EV Fleet program was not an important factor in their decision to build EV charging infrastructure. The other withdrawn fleet decided not to incorporate EVs.

Highlights

- Four of six responding fleet managers learned about the EV Fleet program directly from PG&E.
- Fleet managers were primarily motivated to participate because of the incentives for EV charging infrastructure, expected maintenance cost savings, and environmental benefits.
- Five of five responding fleet managers rated themselves as *very satisfied* or *somewhat satisfied* with their experience participating in the EV Fleet program.
- Four of six fleet managers already have or plan to recommend the program to others.
- Four of four responding fleet managers said EVs are *somewhat* or *very* reliable and four of five said charging equipment is *somewhat* or *very* reliable.
- The four responding fleet managers were split with regard to their plans to accelerate the procurement of EVs: two have plans to accelerate EV purchases, in part influenced by their participation in the EV Fleet program, and two have no plans to accelerate EV purchases.
- The two fleet managers who withdrew from EV Fleet program cited the long return on investment and insufficient incentives.

Site Visits

The Evaluation Team attempted to visit a census of project sites and ultimately performed site visits for 13 out of a total of 14 activated PG&E EV Fleet sites in EY2022. This included sites supporting MDHD vehicles, transit buses, school buses, and eTRUs. Additional sites were constructed but not yet activated.

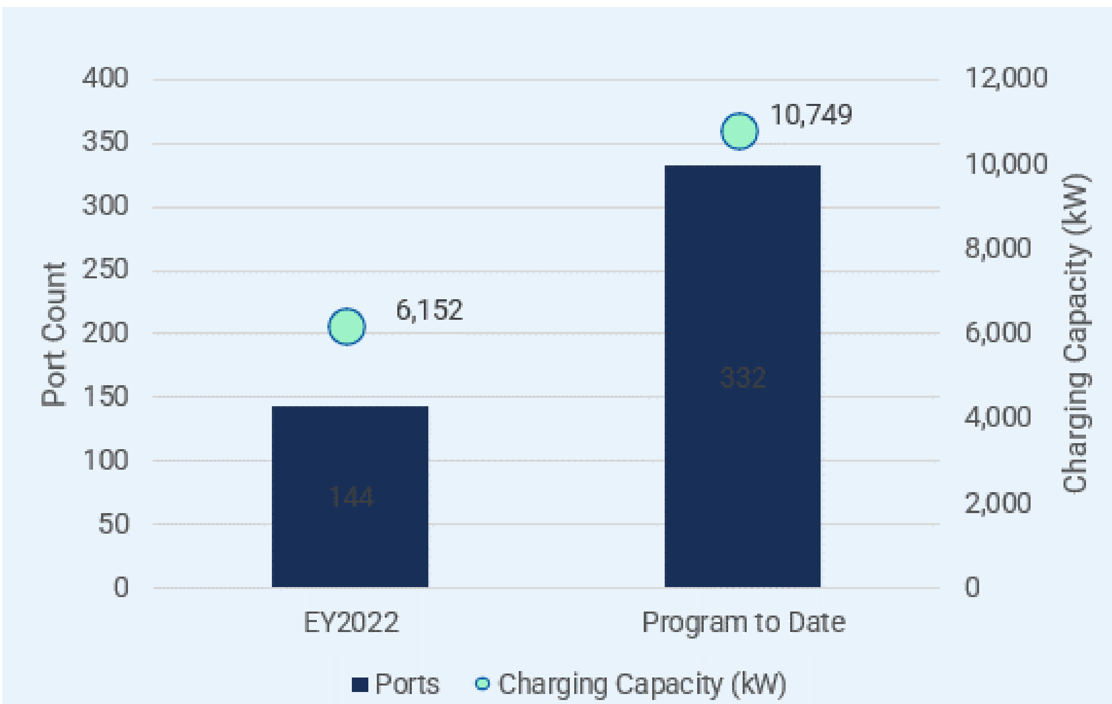
During the site visits, the Evaluation Team collected qualitative and quantitative information that provided an understanding of fleet composition and operations. We used the site visits to verify aspects such as quantity and power of charging stations installed, EVSPs used, types of EVs on site (or to be delivered), and physical influences on construction designs.

Table 46 summarizes charging site characteristics. In total, the EV Fleet program added 144 charging ports with more than 7 MW of EV charging capacity in EY2022. These additions bring total observed EV Fleet program charger installations to 332 charging ports and nearly 11 MW of total charging capacity. Figure 72 shows a comparison of ports and charging capacity for EY2022 and program to date sites.

Table 46. PG&E EV Fleet Program Site Visit Summary EY2022

Market Sector	Number of Sites	L2 Ports	DCFC Ports	Total Installed Charging Power Capacity (kW)
School Bus, Transit Bus, Medium-Duty Vehicles, Heavy-Duty Vehicles, and eTRU	13	67	77	6,152

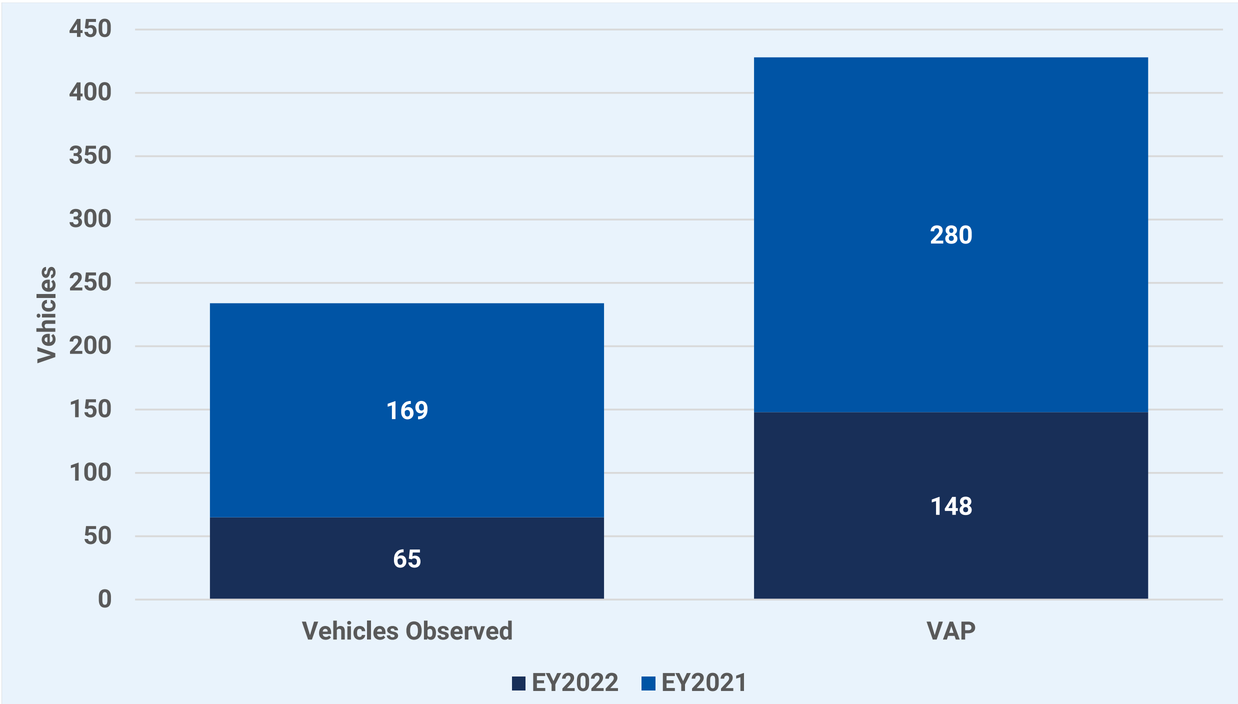
Figure 72. PG&E EV Fleet Program Recorded Charging Ports and Capacity from Site Visits



During the site visits the Evaluation Team reviewed charge management capabilities, electrical infrastructure, future vehicle/equipment replacement plans (including future vehicle adoption), and public funding sources and asked whether there was interest in on-site solar and/or storage associated with the site. Site visits allowed the Evaluation Team to obtain direct feedback from the individuals involved with operations and to identify information to initiate charging session data pathways such as EVSPs and points of contact.

A representation of vehicle data collected at the time of the site visits is provided in Figure 73. The 13 sites visited in EY2022 accounted for 65 vehicles, compared with the previous year's total of 169 vehicles.

Figure 73. PG&E EV Fleet Program Observed Vehicles from Site Visits Compared with Long-Term Vehicle Acquisition Plans



School Bus

The Evaluation Team visited four school bus sites with solely L2 ports in EY2022, as opposed to EY2021 sites which had a few DCFCs were in use. Figure 74 shows a site where, in addition to L2 chargers, several stub-outs were placed for installation of more chargers in the future. Fleet managers reported that most school bus operations comprise morning and afternoon drive cycles. Consequently, this market sector has more opportunity to use low-cost and low-emissions electricity for vehicle charging than other fleets in the morning. They also have ten or more hours to charge overnight, thus offering flexibility to shift load away from the high-cost hours of 4 PM to 9 PM. This can be accomplished by using load management software to avoid charging during the high-cost time periods and/or by reducing the speed of charging (kilowatt demand) during peak hours.

The only new EY2022 site that employs load management is manually plugging in vehicles after 9 PM. At the time of our site visit their software and hardware were not yet fully integrated with the vehicles.

Figure 74. PG&E EV Fleet Program Preparation for Future Charging Stations

Medium-Duty Vehicles

In EY2022, the Evaluation Team visited three completed medium-duty vehicle project sites. A smaller medium-duty vehicle site features both DCFC and L2 charging at an automobile dealership but did not yet have regular vehicle operations. The largest site, shown in Figure 75, was purpose-built from the ground up utilizing a megawatt-plus EVSE with dispensers. An example medium-duty delivery vehicle is shown in
Figure 76 with a view of the driver's dashboard showing the battery charge and vehicle range in Figure 77.

Figure 75. PG&E EV Fleet Program Layout of the First Site with Megawatt EVSE

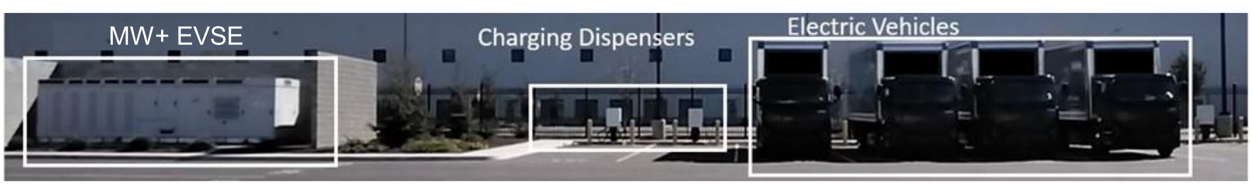


Figure 76. PG&E EV Fleet Program Medium Duty Truck and Charging Environment

Figure 77. PG&E EV Fleet Program Driver's Perspective of Electric Truck Range

Indoor projects, such as the one shown in Figure 78, can require large conduit runs across the ceiling. Although surface-mounted conduit would allow for an easier future charging expansion, the project already included charging for all vehicles that parked in or adjacent to the building. Delivery vehicles at this site operate on set routes and begin charging as soon as they return, which often results in charging between 4 PM and 9 PM, the period with the highest charging cost. Data shows this operator often has enough charging flexibility to avoid the high-cost time period.

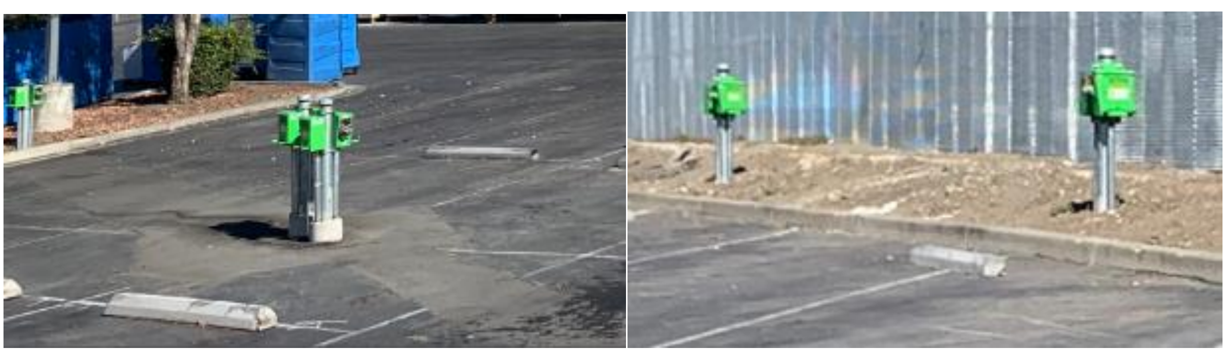
Figure 78. PG&E EV Fleet Program Indoor Parking at a Medium Duty Delivery Fleet Location

An automotive dealership site was also activated in EY2022, with several L2 and DCFC charging ports. The site plans to deploy medium-duty trucks for delivery of automotive service supplies; however, most usage to date was from incidental charging of customer vehicles.

eTRU

In 2022 the Evaluation Team visited the first EV Fleet eTRU project site. Figure 79 shows examples of the eTRU ports in the middle of head-to-head parking and curbside (disturbing only the softscape) to support medium-duty trucks.

Figure 79. PG&E EV Fleet Program Example eTRU Ports



Heavy Duty

In EY2022 the Evaluation Team visited two activated heavy-duty vehicle project sites: one operating electric commuter bus for its employees and the other charging electric bus at the manufacturing facility where they are assembled. The manufacturer site installed several different brands and models of chargers for testing purposes and is using them all on the same network, including a pantograph. The commuter bus site, shown in Figure 80, represents a large installation with a buildout of a complete parking lot for charging a fleet of commuter bus. Figure 81 shows an example of two large transformers needed to support the planned full buildout of the site with DCFCs at an adjacent parking lot, powered by the newly installed capacity at this site, which are currently used to charge the electric buses.

Figure 80. PG&E EV Fleet Program Large Site Doing Full Parking Lot Charging Infrastructure Build

Figure 81. PG&E EV Fleet Program Inset of Above Photo Showing Transformers, Switch Gear, and Stub Outs

Transit Bus

In EY2022 the Evaluation Team visited three activated transit bus project sites all using DCFC. One site had a wireless in-ground charging system and a single electric bus that did not meet its operational requirements (specifically hill climbs in the region), and therefore was not being used.

Another site was an expansion of a previous PG&E pilot project for a large transit fleet that added several DCFC charging ports (with pairing kits for 125 kW charging capacity) to an existing transformer and switchgear. At the time of the site visit, the first of the planned buses had just been delivered.

A smaller transit fleet shown in Figure 82 installed multiple 150 kW DCFCs, each with two ports that have sequential charging capability (see Figure 83). All three transit projects had little to no charging use in EY2022.

Figure 82. PG&E EV Fleet Program A Smaller Agency Going Electric

Figure 83. PG&E EV Fleet Program Sequential DCFC Dispensers

Common Site Visit Findings

Operators at many EY2022 sites reported that supply chain issues continue to impact vehicle and equipment deliveries. Large construction projects necessary to install charging equipment use space that has historically been used for parking, storage, and other purposes, as shown in Figure 84.

Figure 84. PG&E EV Fleet Program Electrical Equipment Can Take Up Valuable Real Estate

Few sites offered softscapes opportunities to build these projects. Figure 84 shows an example of a site constructed in an existing cement area, which likely cost more than work done in softscape in the example in Figure 85.

Figure 85. PG&E EV Fleet Program Rural Operators May More Often Find Softscape to Work in at Lower Costs

Many EY2022 site operators noted vehicle reliability issues, a problem that was also reported in the EY2021 evaluation. These issues have meant that site operators have been unable to keep their full fleet of EVs on the road. On the other hand, charger reliability has generally been high.

Fleet managers reported that drivers seemed to appreciate the experience of driving the EVs and that few, if any, needed to be towed due to range limitations.

Site operators have generally not reviewed charging session data to assess how deeply they are using vehicle batteries. While most of the operators monitor the fuel economy of their fleets on an aggregate monthly level, almost none were familiar with their electric consumption trends, or the billing costs associated with vehicle charging.

Most fleets do not use the software at their disposal to perform automated load management and authentication. Instead, most vehicles are plugged in and immediately start charging after their shift regardless of time of day. The absence of load management and information on electric consumption from vehicle charging is an important contributing factor to higher-than-necessary electricity costs associated with vehicle charging, especially for school districts.

Highlights

- Supply chain issues continue to limit the number of vehicles delivered, while vehicle reliability continues to limit the number of vehicles in operation and their associated benefits.
- Load management is not considered a priority by many operators, who typically are not comparing actual Utility billing costs for charging to the cost of fueling conventional vehicles. This is often due to a finance office receiving Utility bills instead of the fleet manager.
- When load management is considered a viable option by fleet operators, it may be unavailable from their EVSP or not work well with their combination of vehicles, charging hardware, and EVSP.

Deep Dives

The Evaluation Team conducted deep dives in EY2022 for three sites in the EV Fleet program. The Evaluation Team selected sites for deep dives from the EY2021 year that had significant demand, energy consumption, or installed charging capacity. The Evaluation Team was also interested in sites with a demonstrated ability to expand EV infrastructure, the presence of load management, unique vehicles or charging equipment, a large fleet size, and/or a fleet manager who was willing to participate.

The three PG&E EV Fleet sites examined were a freight-handling site operating electric light- and heavy-duty forklifts, a freight-handling site operating electric yard tractors, and a school district operating Type A and Type C electric school buses. The Evaluation Team conducted in-depth fleet manager interviews and analyzed data from AMI and EVSPs. The Evaluation Team attempted fleet driver surveys at all three participating fleets, but only one of the three fleets responded to the driver survey.

Findings presented in this section are based on the interviews, data analysis, and driver survey feedback (as available). *Appendix B* presents more detailed case studies on each of these fleets.

Freight Handling Site 1

The Evaluation Team selected a freight handling site that operates yard tractors due to its unique market sector and duty cycles (round-the-clock operation) and its high-power requirements. The site charges its yard tractors on a mix of equipment including 180 kW DCFC and 25 kW DCFC. This site follows a three-shift charging schedule, plugging in for bulk charging approximately once every six hours between 6 AM and 6 PM as well as shorter durations during breaks.

Charger reliability has been inconsistent although there have been incremental improvements. The operator expressed a desire for a simpler charger with fewer failure points (such as having no screen), and more predictable behavior. The operator expressed concerns with the performance of one manufacturer’s vehicles, noting limited acceleration and power in their environment. Satisfaction with another manufacturer was generally good, though the operator desired more local parts and service availability, and some component quality improvements. Due to the strict operational requirements at this site, charging flexibility is minimal. Consumption between 4 PM and 9 PM has limited financial impact because the site already consumes the bulk of energy outside of this peak-rate period.

Freight Handling Site 2

The Evaluation Team selected a freight handling site operating heavy-duty and light-duty forklifts due to its deployment of diverse cargo-handling equipment and significant ramp-up of operations. The site charges its heavy forklifts on 11 kW L2 chargers and its light forklifts on 15 kW L2 chargers. Energy usage data from this site is heavily skewed toward the heavy forklifts, as the chargers for the smaller forklifts do not have networking capability for reporting charging session data.

A major issue with the project concerns a mismatch of the L2 chargers with the 100+ kWh batteries on the forklifts. Because of extremely long L2 charge times and a desire to avoid having the forklifts recharge for extended periods during their shifts, the large forklifts primarily use DCFCs that are located elsewhere on the site and were not installed as part of the PG&E EV Fleet program. The model of forklift (at least the newest one) does offer faster charging that could be matched with more powerful L2 EVSE. While the operational data for this site was relatively incomplete, anecdotal information from the operator highlights the importance of matching charging levels to duty cycles and technology types. The AMI data primarily reflects the charging of the smaller forklifts. The resultant load curves show most charging occurring in the evening shortly after the end of each shift with little to no charging overnight due to relatively short charging cycles. This suggests a charging load shift opportunity when shift work allows and if load management software is available to delay charging until after 9 PM.

School District Site

The Evaluation Team selected a school district operating Type A and Type C school buses because it practices load management and has significant vehicle usage. The site charges its vehicles on L2 EVSE with automatic load management that avoids charging during the peak-rate period. The site follows a two-shift charging schedule, plugging in for a significant charge after the bus return to the depot around 8 AM, and plugging in again after the afternoon routes are complete at around 3 PM.

The operator expressed concerns with the range of the Type C bus and issues related to hot weather but was otherwise satisfied with both the vehicles and the charging hardware. The current charging schedule reduces the amount of energy consumed during the peak-rate period to less than 20% (on average), resulting in one of the lowest average monthly billing energy cost per kilowatt-hour for the EV Fleet program.

Fleet Driver Surveys

As part of the deep dives, the Evaluation Team surveyed five fleet drivers from one of the participating deep dive sites, asking about their experience driving these EVs and using the site's charging infrastructure.

Four of the five fleet drivers surveyed were satisfied with their experience operating EVs, using the charging stations, and the accuracy of the equipment range/battery status estimates. However, they expressed concerns that included lack of storage on the bus, vehicle range, equipment comfort (overheating when running AC or lack of heat in colder periods) and charging glitches. They said charging was easy and convenient, but they occasionally experienced problems that were challenging to identify and fix.

While all five fleet drivers said that the EVs and the charging equipment is reliable, they expressed concerns about charging capacity. They have differing charging patterns: three of five typically charge their fleet at night or in the middle of the day, one charges its fleet in the morning or during the night, and one charges its fleet during the morning and middle of the day.

Three of five fleet drivers said EVs are easier to drive than conventional vehicles, and four of five said it is easier to use the charging stations than to refuel an ICE vehicle.

Fleet drivers said the biggest changes to their job as they operate EVs and EV chargers were less air pollution and exhaust, a quieter ride, and more concerns about vehicle range.

Highlights

- One deep dive site experienced difficulty with a mismatch between installed chargers and some of their cargo handling equipment, ultimately requiring equipment to be charged elsewhere on the site away from the EV Fleet program investment.
- One site was able to achieve significant avoidance of peak rates by automating vehicle charging, thus reducing monthly peak-rate consumption from a high of 40% to a steady 15% to 20%. This demonstrates significant financial benefits from load management.
- Two sites (both freight handling sites) demonstrated little flexibility for load management due to a strict operational schedule at one site and a very limited charging speed at the other. Load management is generally unsuitable in cases with short charging station dwell times (beyond the period of active charging). Charging session data would help corroborate this but is often unavailable from off-road vehicle sites.
- Two of the three site managers expressed a desire for additional vehicle range or capability. Two of the three site managers mentioned shortcomings with charging equipment, either with charging speed or reliability.
- Four of the five fleet drivers were satisfied with their experience using charging stations at their company site, the accuracy of battery status estimates, and their experience operating EVs and EV equipment.

Co-Benefits and Co-Costs

Through fleet manager surveys, fleet manager interviews, and site visits, the Evaluation Team identified several co-benefits and co-costs associated with the EV Fleet program's vehicle electrification sites.

Fleet Manager Surveys

The Evaluation Team sent fleet managers surveys, which included questions asking about co-benefits and co-costs, both aided (asking fleet managers if they have noticed a specific co-benefit or co-cost) and unaided (via an open-ended question).[71]

Table 47 shows that four of five fleet managers expected to realize benefits for their community or fleet because electrifying. One of the five fleet managers expected *significant benefits* because it encourages other individuals and fleets to convert to EVs, creates improved air quality and health, and reduces noise pollution. Additionally, three of five fleet managers expected some benefits from encouraging others to convert to EVs, improved air quality and health, improved driver comfort/convenience, and increased fleet flexibility.

Other benefits mentioned in open-ended questions were increased transit ridership and gaining experience with new technologies.

Table 47. PG&E EV Fleet Program Benefits Expected from Electrification in EY2022

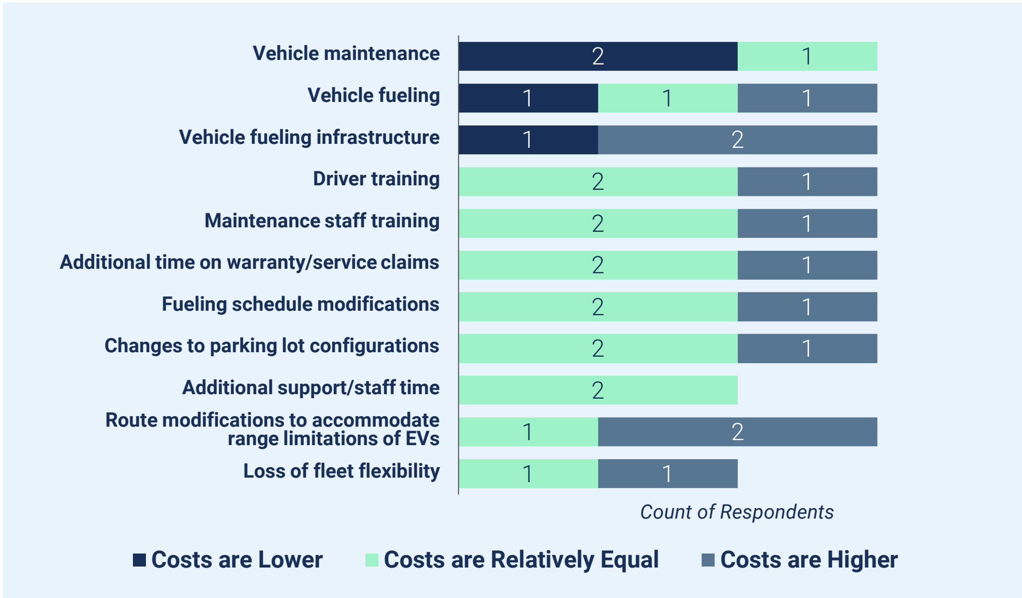
Benefits	Significant Benefits	Some Benefits	No Benefits	Not Sure
Encourages other individuals/fleets to convert to EVs	1	3	-	1
Improved air quality/health	1	3	1	-
Reduction in noise pollution	1	2	1	1
Improved driver comfort/convenience	-	3	1	1
Increased fleet flexibility	-	3	1	1

Source: Fleet Manager Survey Question D1. "What ancillary benefits do you think will be realized for your community/fleet as a result of electrifying?" (n=5)

Figure 86 summarizes responses to managers' observed costs associated with operating and maintaining EV fleets. Two of the three managers said vehicle maintenance costs were *lower* following fleet electrification. Vehicle fueling and fueling infrastructure each had one manager indicate *lower* costs (n=3 each). For most cost categories, two of three fleet managers said that costs are *relatively equal* since electrifying their fleets. Two of the three fleet managers said costs are *higher* for vehicle fueling infrastructure and for route modifications to accommodate EV range limitations**.**

[71] The Evaluation Team received responses from five PG&E fleet managers, but the sample size (n) denoted in the following tables and charts may differ because fleet managers could skip questions and response options. Despite the Evaluation Team's efforts to improve the response rate through multiple rounds of outreach and increased survey incentives, the fleet manager survey did not reach the target response number, which limits the insights that can be gleaned with this smaller sample size.

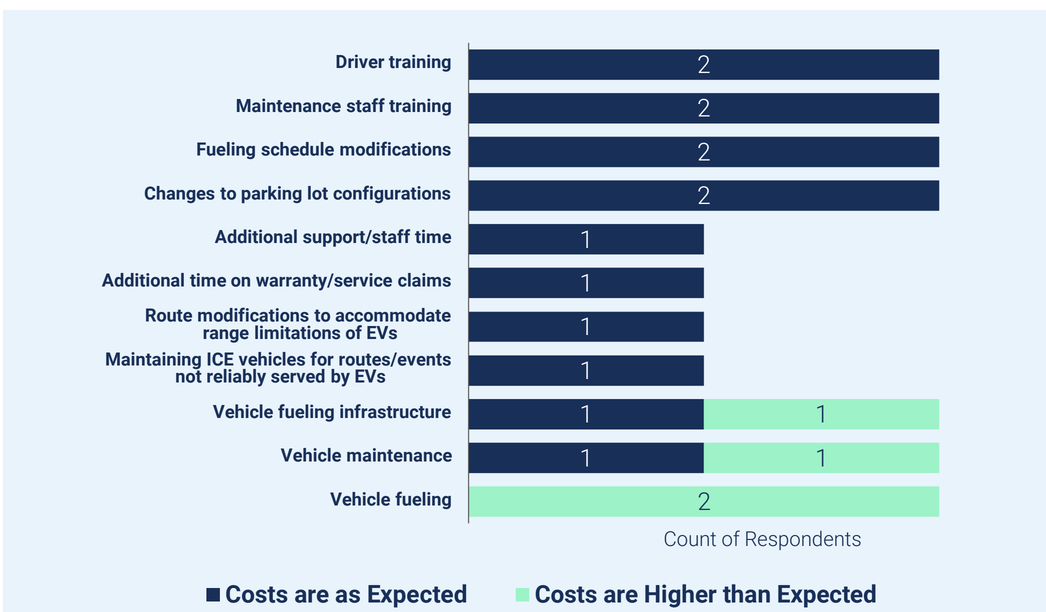
Figure 86. PG&E EV Fleet Program Changes since Electrification in EY2022



Source: Fleet Manager Survey Question E1. "Please think about all the costs associated with operating and maintaining your fleet. For each cost type shown below, please estimate how much the cost has changed since transitioning your fleet to EVs." (n's=2 and 3)

The Evaluation Team also asked fleet managers to what extent they expected operational and maintenance cost changes. As shown in Figure 87, both managers who answered this question said that differences in costs *are as expected* across the various cost categories.

Figure 87. PG&E EV Fleet Program Differences in Electrification Cost Expectations in EY2022



Source: Fleet Manager Survey Question E2. "Have these operational and maintenance costs been what you expected?" (n's=1 and 2)

Fleet managers were split on vehicle maintenance and fueling infrastructure, with one reporting that cost differences are *as expected* and one reporting that costs are *higher than expected.* Both managers reported that vehicle fueling costs are *higher than expected*, indicating that managers are seeing lower cost savings with EV charging than they anticipated.

Deep Dive Fleet Manager Interviews

The Evaluation Team conducted deep dive interviews with three PG&E fleet managers to assess the co-costs and co-benefits of transportation electrification for fleets and for fleet drivers. During the interviews, fleet managers noted several costs:

- **EV durability.** One manager said there have been durability issues with certain parts of heavy-duty vehicles (specifically brackets and hydraulic pumps) not withstanding harsh working environments, which has led to an increase in staff time spent finding replacement parts and navigating international suppliers. This has been especially challenging due to recent supply chain constraints. Another fleet manager also noted some more minor durability issues with non-battery parts, such as windshield wiper motors.
- **Charging equipment installation.** While installing charging equipment, one fleet encountered underground buried equipment that made permitting complicated with the county.
- **EV range and charging duration.** One fleet manager said that generally their EVs have enough range to make it through most of their shifts, but still require some opportunity charging. Another fleet is already looking to upgrade their charging equipment: their current L2 chargers are slow, and they are interested in moving to DCFC equipment to speed up the rate of charging, without altering the actual amount of usage, to improve their operations.
- **Charging equipment malfunctions.** Another fleet manager has experienced more serious and ongoing challenges with charging infrastructure, with some chargers being inoperable for weeks at a time.

Despite some of these initial challenges in electrification, all fleet managers conveyed an overall positive experience with electrified fleets. One manager mentioned an adjustment period for their EVs, saying that drivers' opinions of EVs were not initially favorable but, due to an improved driving experience and the lack of diesel fumes, drivers now have a positive opinion.

Fleet Driver Surveys

The Evaluation Team also fielded surveys with participating fleet drivers and received five responses from one fleet. Fleet drivers reported benefits such as improved air quality, reduced noise pollution, and an improvement in comfort or convenience. Drivers also noted difficulties with insufficient vehicle range and maintenance requirements.

Highlights

- All five surveyed fleet managers cited benefits including the belief that their adoption encourages other individuals and fleets to convert to EVs, improved air quality and health, reduced noise pollution, improved driver comfort and convenience, and increased fleet flexibility.

- Two of two fleet managers said the cost met their exceptions across categories such as driver training, maintenance staff training, fueling schedule modification, and charges to parking lot configuration.
- Two of three fleet managers said vehicle maintenance costs were lower after electrification.
- Fleet managers cited EV durability, charging equipment installation, range, and charging equipment malfunction as the primary costs.

Total Cost of Ownership

The Evaluation Team conducted a cost analysis on 20 school bus sites enrolled with fully closed out finances as of December 31, 2022, including EY2021 and EY2022 sites. Other market sectors beyond school buses are not presented in this section because they had fewer than 15 sites, which does not meet minimum requirements for maintaining customer privacy.

Of the 20 school bus projects, all but one installed exclusively L2 chargers (the other had a mix of DCFC and L2 ports). Port count varied between sites, from three to 24 ports per site. Sites averaged eight ports.[72] Installed capacity averaged 168 kW across the 20 sites. The number of planned vehicles to be supported by the sites (per the Vehicle Acquisition Plans) varied from 8 to 40, with a mean of 18.9 vehicles.

Figure 88 shows the distribution of site-level costs of the 20 school bus sites. The horizontal lines of the boxes in Figure 88 show the 25th, 50th, and 75th percentile of sites. The "x" represents the mean site cost. The three panels in Figure 88 are defined as follows:

- **All-in Costs.** The total cost of capital and installation borne by PG&E and the customer, calculated by summing actual TTM cost paid by PG&E, estimated BTM cost shared between the customer and PG&E, [73] and estimated EVSE costs shared between the customer and PG&E.[74]
- **Ratepayer-Funded Costs.** All site costs borne by PG&E, calculated by summing actual TTM cost paid by PG&E, BTM rebate paid by PG&E,[75] and estimated EVSE rebate paid by PG&E.[76]

---

[72] In this section, port count refers to the number of ports in the customer application.

[73] Because not all BTM costs provided to the Evaluation Team are actual BTM costs, the Evaluation Team used actual BTM costs from 10 school bus sites in SCE's Charge Ready Transport program, which average $18,659 per L2 port and $20,709 per DCFC port.

[74] EVSE equipment costs are estimated by the Evaluation Team using an assumption of $3,000 per port for L2 ports and $45,000 per port for DCFC ports.

[75] Values for BTM costs align with Table 9 of PG&E's 2022 SB 350 Report for "Rebate amount applied for customer-side infrastructure." Number reflects maximum infrastructure rebate offered for sites that have not yet applied for rebates, which may vary significantly from actual infrastructure rebate amount paid.

[76] EVSE rebates paid by PG&E are assumed by the Evaluation Team to be 50% of the $3,000 per port for L2 ports and $45,000 per port for DCFC ports.

- **Utility Infrastructure Costs.** Site costs borne by PG&E for TTM and BTM rebates.[77]

Figure 89 shows average all-in costs for the 20 school bus sites. TTM is the largest cost across the sites, followed by BTM, then EVSE. Together, the average all-in TTM, BTM, and EVSE costs sum to $364,942.[78]

Figure 88. PG&E EV Fleet Program Costs Organized by Three Perspectives, Across 20 School Bus Sites

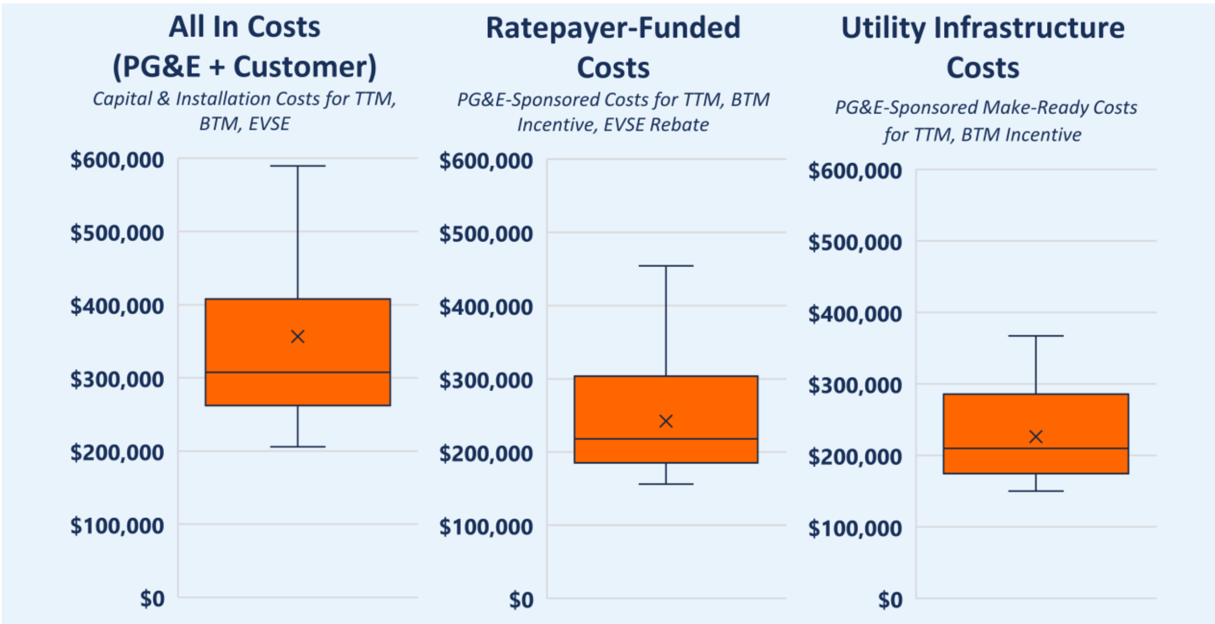
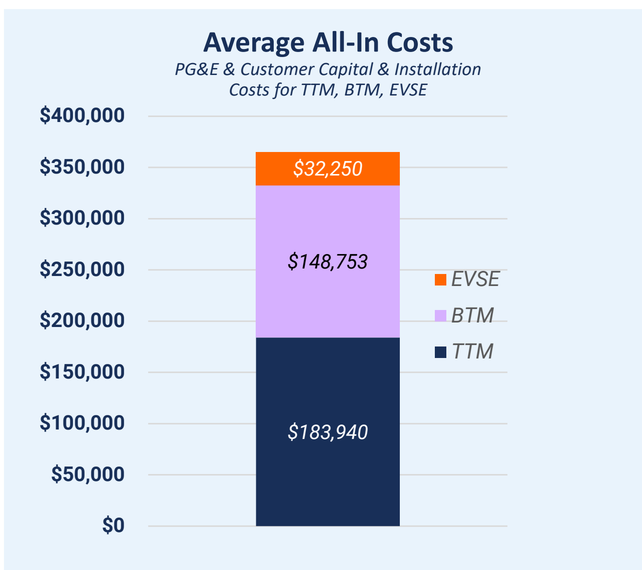


Figure 89. PG&E EV Fleet Program Average All-In Costs Across 20 School Bus Sites

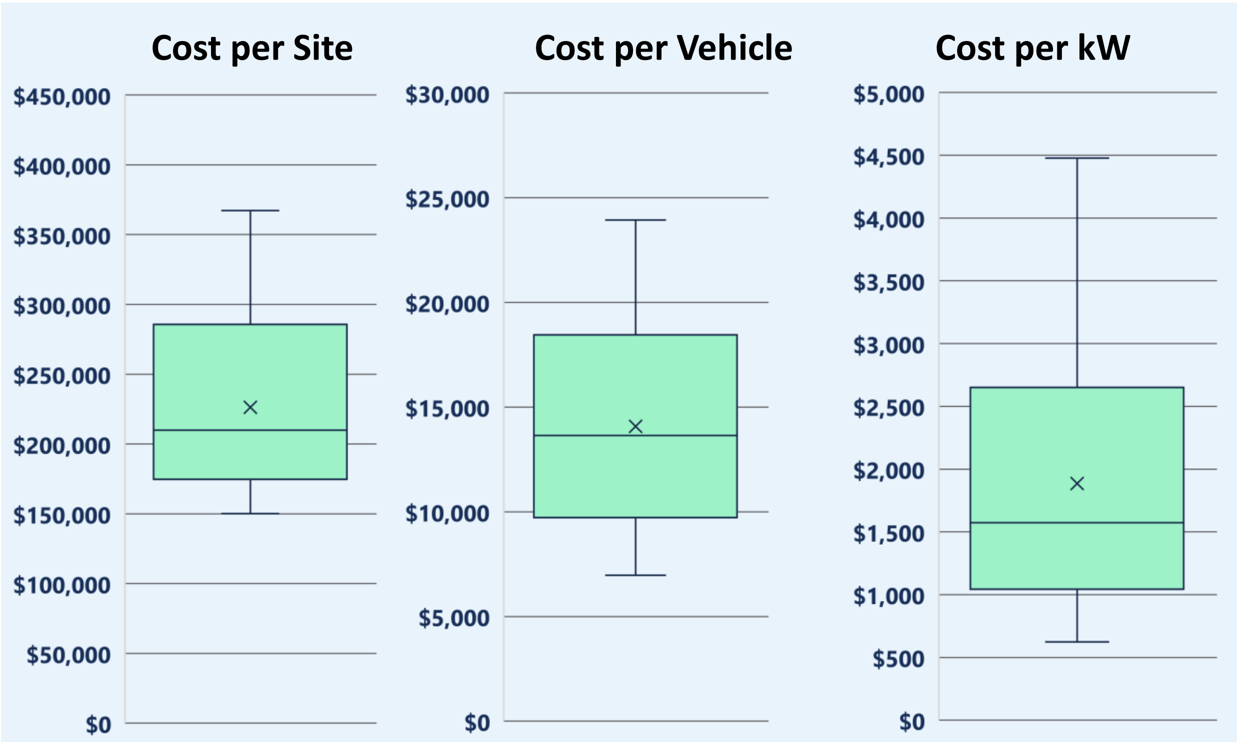


[77] Values are the same as the Ratepayer-Funded Costs, without the inclusion of the EVSE estimates.

[78] Calculated by summing all TTM, BTM, and EVSE costs borne by PG&E and the customer then dividing by 20 sites.

Figure 90 shows the distribution of utility infrastructure costs (corresponding to the far-right panel in Figure 88) presented per site, per vehicle, and per kW. The average cost of TTM and BTM borne by PG&E across sites was $226,209 per site,[79] $14,076 per vehicle,[80] and $1,886 per kW.[81]

Figure 90. PG&E EV Fleet Program, Utility Infrastructure Cost per Site, per Vehicle, per kW for 20 School Bus Sites



Highlights

- All-in Costs paid by the customer and PG&E vary widely between sites, with an average of $364,942 per site. TTM was the largest cost across the sites, followed by BTM, then EVSE.
- The average cost of PG&E-sponsored TTM and BTM across sites was $226,209 per site, $14,076 per vehicle, and $1,886 per kW.

[79] Calculated by summing all TTM and PG&E-sponsored BTM costs and dividing by the number of sites. As noted above, BTM costs align with Table 9 of PG&E's 2022 SB 350 Report for "Rebate amount applied for customer-side infrastructure." Number reflects maximum infrastructure rebate offered for sites that have not yet applied for rebates, which may vary significantly from actual infrastructure rebate amount paid.

[80] Calculated by summing all TTM and PG&E-sponsored BTM costs and dividing by the sum of all vehicles.

[81] Calculated by summing all TTM and PG&E-sponsored BTM costs and dividing by the sum of installed capacity.

Grid Impacts

The Evaluation Team evaluated grid impacts for the EV Fleet program. This analysis was based on energy consumed at operational charging stations installed through the program in EY2022 combined with charging session data from the EVSPs. Table 48 presents a summary of the estimated EV Fleet program grid impacts.

Table 48. PG&E EV Fleet Program Grid Impacts Summary in EY2022

Impact Parameter	CY2022		Program to Date	
	Actual EY2021 + EY2022	Annualized EY2022 [a]	Actual PTD	10-Year Projection PTD [b]
Operational Sites	41	13	41	41
Electric Energy Consumption, MWh	3,867	[redacted]	5,889	51,501
On-Peak MWh (4 PM to 9 PM) (and % of total)	1,041 (26.9%)	[redacted] (28.7%)	1,639 (27.8%)	14,192 (27.6%)
Maximum Demand, kW (with date and time)	2,228 (12/7/22 11:45 AM)	[redacted] (12/12/22 8:15 AM)	2,228 (12/7/22 11:45 AM)	N/A
Maximum On-Peak Demand, kW (with date and time)	2,090 (12/6/22 6:00 PM)	[redacted] (12/7/22 4:15 PM)	2,090 (12/6/22 6:00 PM)	N/A

[a] Includes 13 sites for this EY2022 estimate based on annualized AMI data; one site did not have any usage in 2022.
[b] Includes 41 sites for this program-to-date estimate based on annualized AMI data; one site did not have any usage in 2022.
Note: values for population of less than 15 sites are redacted

The remainder of this section reports findings on actual monthly consumption and maximum demand load curves. Figure 91 shows total monthly consumption of electricity for all operational sites in 2021 and 2022 for the EV Fleet program. Energy consumption in the second half of each year steadily increased followed by a bit of a decline during the summer corresponding to school re-openings due to the large number of school bus sites participating in the program.

Figure 92 shows the electric transportation load as new EV Fleet sites came online and older ones continued to operate. Load is calculated based on average demand for a 15-minute interval of utility meter data. The low marks typically correspond to reduced weekend operation. In 2022, demand increased by roughly 1 MW compared to that observed in 2021, reaching a maximum of 2.2 MW in November and December of 2022. For comparison, approximately 11 GW of charging capacity has been installed at EV Fleet sites, based on data collected from site visits.

Figure 91. PG&E EV Fleet Program Monthly Electricity Consumption, Program-to-Date Sites

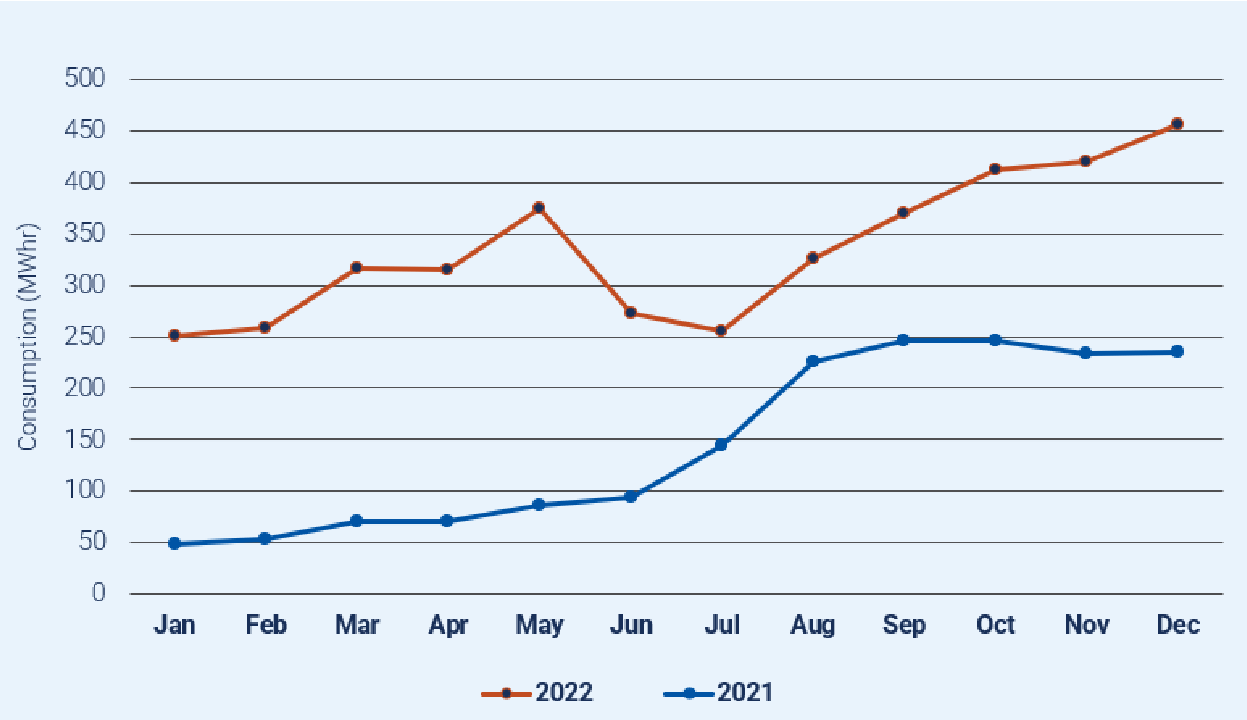
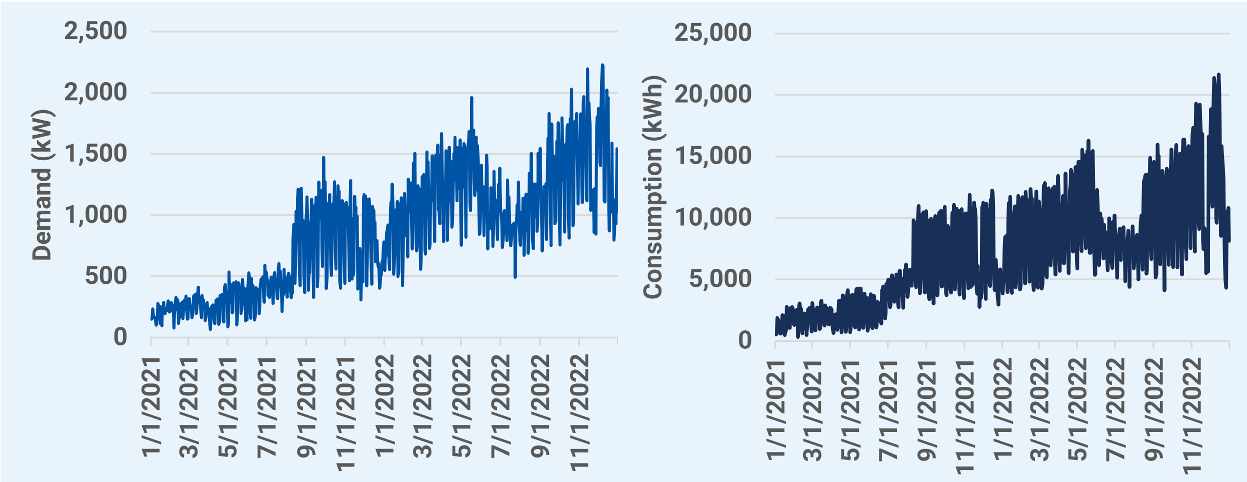


Figure 92. PG&E EV Fleet Program Daily Maximum Demand and Consumption, Program-to-Date Sites



A few considerations were also discussed in the *Site Visits* section of this report:

- Not all vehicles have been delivered
- Of the vehicles delivered, not all are reliably operating
- Many sites are still conservatively operating vehicles so as to not exceed range
- Some sites installed charging ports for anticipated vehicles they have not yet ordered

Figure 93 illustrates the combined load shape for all EV Fleet sites on one of the highest demand days of 2022: December 8. This is heavily influenced by the average school bus load curve, shown in Figure 95. This figure shows charging directly after morning and afternoon routes. Overall EV Fleet program load grew in 2022 by around 700 kW (50%) since 2021, with the highest demand occurring during (or near) the 4 PM to 9 PM period. However, much of the maximum demand at night was due to non-school bus fleets charging, which is attributable to unique operational schedules.

Figure 93. PG&E EV Fleet Program Load Curve on December 8, 2022, Program-to-Date Sites

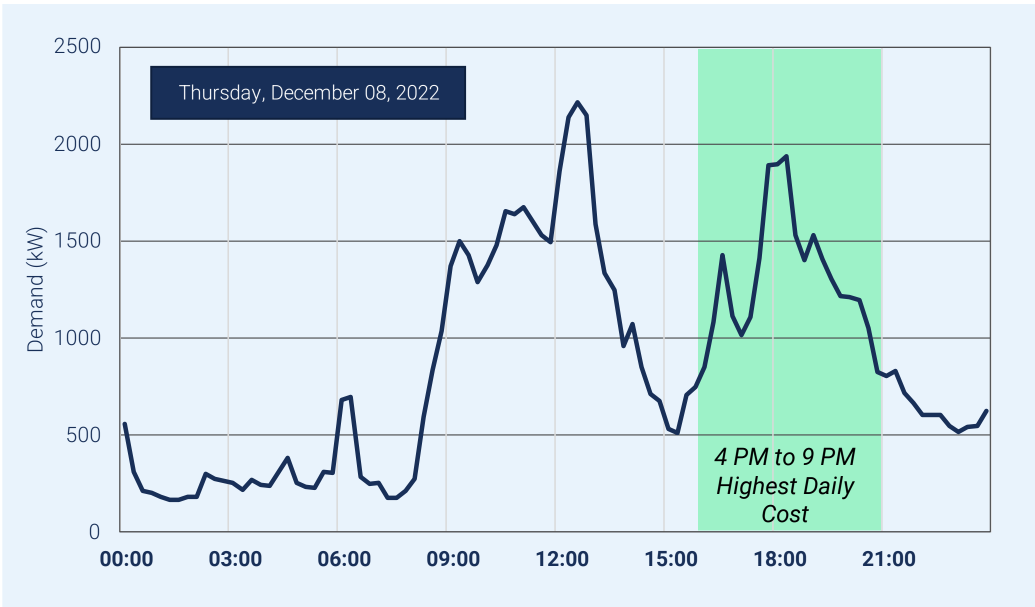
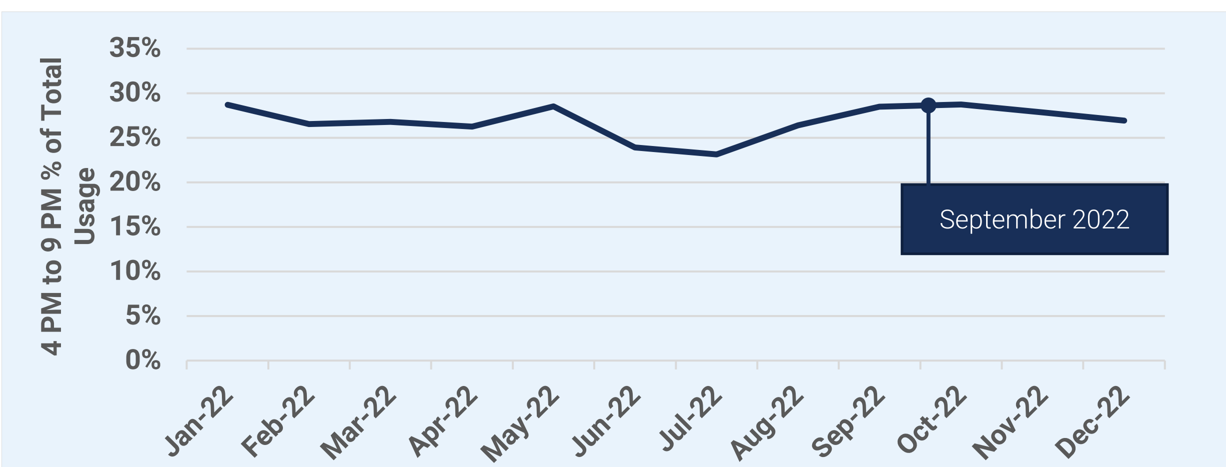


Figure 94 shows that overall monthly EV Fleet program consumption in 2022 during the 4 PM to 9 PM period ranged from 22% to 29% on average. This indicates that several fleets had high on-peak usage that is detrimental to cost and contributes to the congestion on the grid.

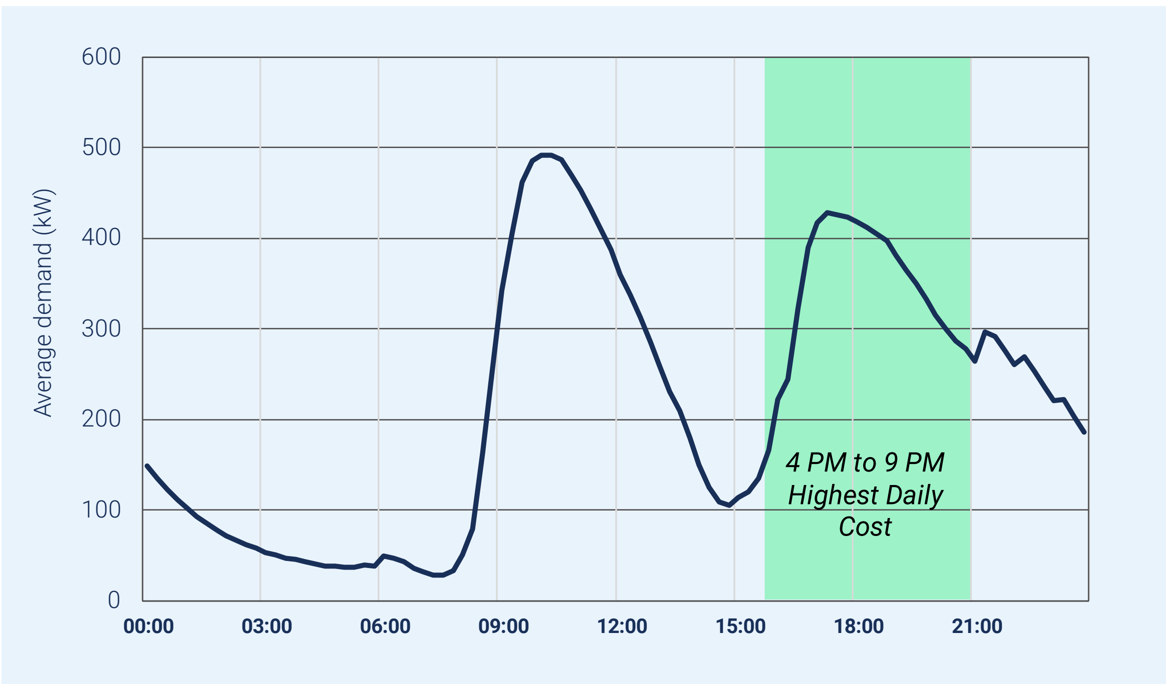
Figure 94. PG&E EV Fleet Program Monthly Proportion of Energy Use 4 PM to 9 PM, Program-to-Date Sites



School bus operations across the state shared many characteristics, including similar duty cycles, similar EV battery capacities, and similar parking dwell times, all of which resulted in similar load curves. However, our analysis of individual school bus fleets revealed differing trends and opportunities.

Figure 95 shows that, on average, school bus charging reaches maximum demand in the morning, often coincident with least-cost and lowest-emissions electricity. However, there is substantial and early equal demand taking place between the costliest 4 PM to 9 PM period. This is an unnecessary electricity expense that increases TCO for school bus operators.

Figure 95. PG&E EV Fleet Program School Bus Charging Average Weekday Load in 2022, Program-to-Date Sites



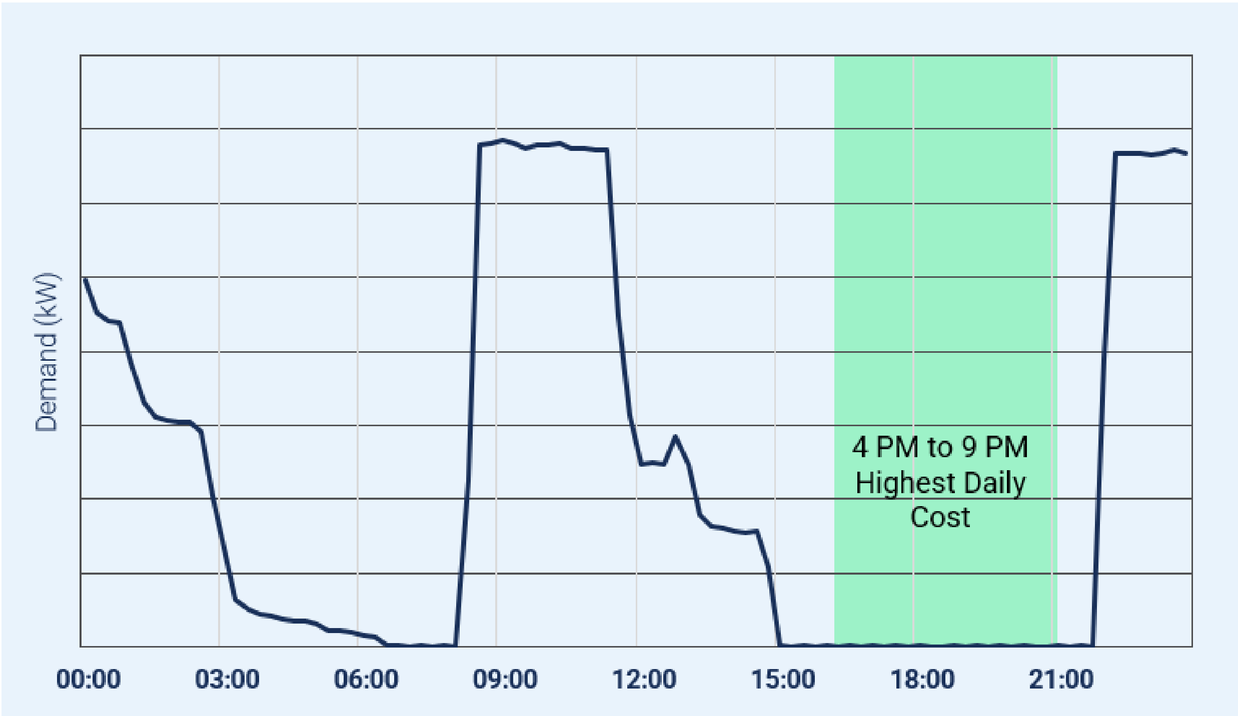
The Evaluation Team periodically reviews data on a site-by-site basis throughout the year to identify sites that appear to be implementing load management. The Evaluation Team's site visits and our discussions with fleet managers offers some context around intentions regarding load management. During our EY2022 site visits, just one PG&E customer expressed an interest in load management and described an entirely manual process they use in which buses are plugged in after 9 PM to avoid charging during the high-cost time period. This site has a unique situation in which staff are on the site in the evening. Initially this customer believed their EVSP was capable of providing automated load management, but this turned out not to be the case. The site operator is now considering a new EVSP with automated load management capabilities.

Of the total 41 EY2021 and EY2022 operating sites, four clearly exhibited the use of load management, albeit with some differences. Load management is evident in two ways:

- Load spiking significantly around 9 PM
- Low monthly proportion of energy consumed between 4 PM and 9 PM, often below 10%

Figure 96 shows the load profile of an EV Fleet program site that exhibits the use of load management. In this example, electric loads peak between 9 AM and 12 PM, then drops precipitously until 3 PM, at which point they falls to zero until 9 PM, and then ramp up rapidly.

Figure 96. PG&E EV Fleet Program Example of Customer Using Load Management in 2022



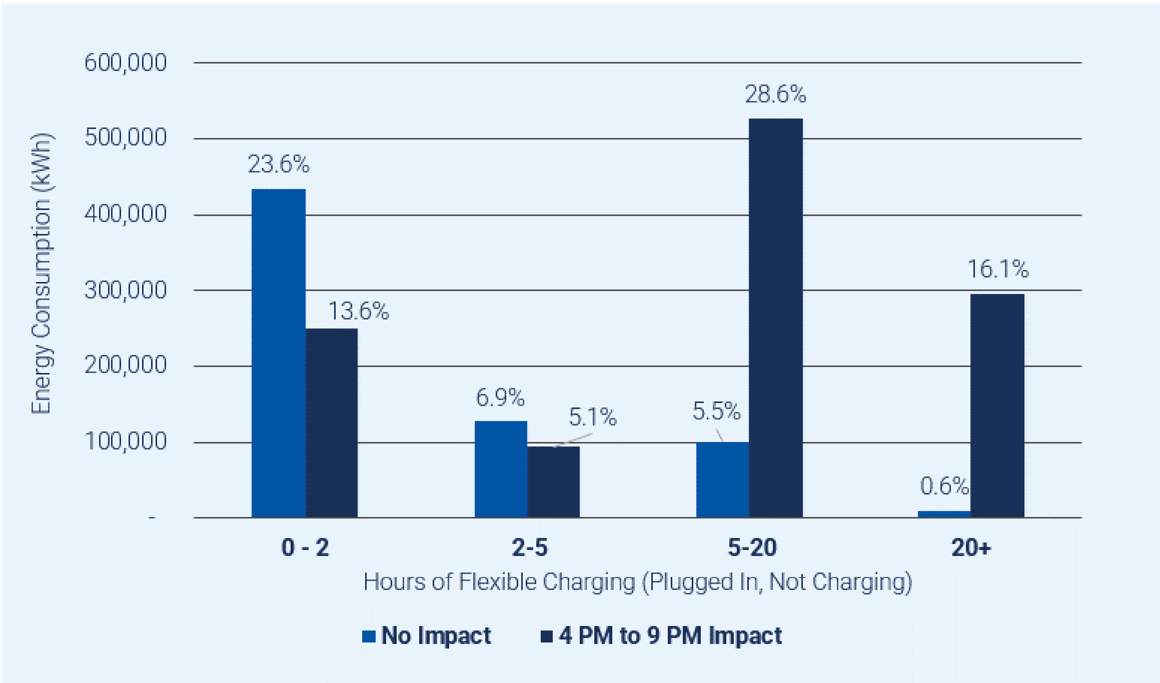
The Evaluation Team used charging session summaries from EVSPs to assess potential flexibility for when charging sessions consumed energy. Flexibility can be inferred by analyzing the amount of time a vehicle remains connected to a charging port beyond the point at which the vehicle is fully charged.

Figure 97 shows results of our charging flexibility analysis of school buses across all Utility programs. This analysis revealed that about 50% of charging energy and 40% of charging sessions (not pictured) overlapped with the peak rate period from 4 PM to 9 PM. These sites appear to have sufficient flexibility, based on idle time once charging is completed, to avoid consuming energy during this period. This indicates that most school bus charging can be better optimized. Load management strategies could be implemented to allow site operators to shift much of this consumption to other lower cost (and reduced emissions) time periods. To a similar extent, non-school bus charging patterns indicate that about 30% of charging sessions during the 4 PM to 9 PM peak rate period have enough charging flexibility to avoid this time period by implementing load management (not pictured).

As part of the EVSP data collection process, the Evaluation Team frequently communicates with EVSPs to verify site activity in cases of discrepancy with the Utility AMI data for individual sites. During these conversations the Evaluation Team has often been able to discuss load management capabilities and usage trends.

Nearly every EVSP involved in the EV Fleet program provides reliable data. However, in 2022 it was discovered that not all EVSPs were offering load management to site operators. Of the EVSPs that do provide load management, there is a mix of those that provide all-inclusive load management versus providing it on a tiered or a subscription basis.

Figure 97. PG&E, SCE and SDG&E MDHD Programs
School Bus Charging Flexibility, Program-to-Date Sites



Interoperability between hardware, software, and vehicles has presented an additional challenge that can make load management impractical or difficult to implement. EVSPs are pursuing a variety of business models, and there is variability in communication from the EVSP to a fleet operator and in their ability to participate in load management.

Most EVSPs do provide reporting functions to fleet operators if they choose to use it. As discussed in the *Site Visits* section of this report, many fleet operators are unaware of their consumption trends and resultant energy costs. Often a customer's finance office receives Utility bills but does not share this information with their fleet operators, who could compare such data against other fuel types in their fleet. The Evaluation Team uses energy trends as discussion points during site visits if operations have started. Many fleets had not seen their electricity usage and cost data prior to the Evaluation Team's site visits.

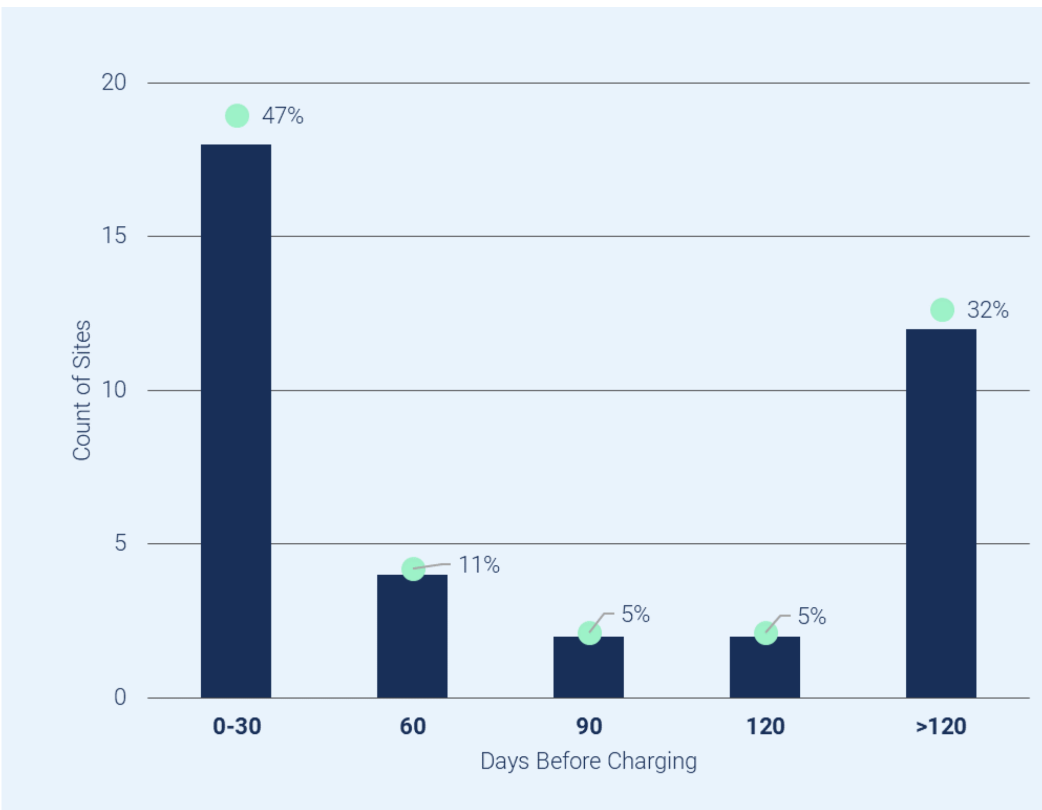
In terms of energy cost, the larger fleets with consumption in excess of 20 MWh per month often pay less than $0.30 per kilowatt-hour. They may have multiple daily operational shifts and charging sessions that makes it possible to minimize charging during the 4 PM to 9 PM period. Medium-sized sites that consume 5 MWh to 20 MWh monthly tend to pay over $0.30 per kilowatt-hour. Sites with less than

5 MWh of monthly consumption appear to have energy costs that are inverse to usage (less usage means higher cost), with less consumption to spread over fixed fees, such as capacity subscription.

There appears to be a significant opportunity for most fleets to substantially alter their energy charging patterns to use more lower-cost energy. This opportunity is based on the Evaluation Team's analysis of load flexibility from observation of load patterns and from discussions with site operators during site visits and deep dives.

AMI data has shown that sites in general take substantial time to commence operations and then to stabilize or mature. Figure 98 summarizes the duration between the time that Utility meter is set (the site is energized) and when charging begins. While charging begun within 30 days of energization at 45% of sites, a significant number of sites took much longer. Anecdotally, supply chain issues were identified as a significant reason for this delay. Based on these trends, many of the EY2022 projects (activated in 2022) that did not exhibit significant energy usage in 2022 are anticipated to ramp up and stabilize their consumption trends in 2023.

Figure 98. PG&E EV Fleet Program Number of Days Sites are Energized before Charging Begins



Highlights

- Most sites are not using load management. There appears to be a significant opportunity for most fleets to substantially alter vehicle charging patterns and reduce their monthly charging costs.

- Nearly 40% of school bus charging sessions overlapped with the 4 PM to 9 PM period but have sufficient flexibility to delay charging until a less costly time.
- Load management can offer significant customer operational cost savings (for example, shifting afternoon school bus charging load after 9 PM could save up to 50% on monthly energy costs).
- Extended timelines for EV deployment (in comparison to VAP) and reliability issues have resulted in much lower energy consumption than anticipated.
- While nearly 50% of sites began vehicle charging within 30 days of power availability, more than 30% took over 120 days, often driven by supply chain issues.

Petroleum Displacement

The Evaluation Team modeled petroleum displacement from vehicle electrification enabled by PG&E's EV Fleet program. The Evaluation Team used DGE for reporting purposes. Transit bus primarily use CNG fuel, which means that the Evaluation Team needed to convert their natural gas consumption into DGE units based on the fuel's energy content.

Table 49 summarizes petroleum displacement for the EV Fleet program for EY2022, including estimated annualized impacts for EY2022 and a 10-year forecast. More than 1,200,000 miles of on-road vehicle travel resulted in the displacement of more than 200,000 DGE on an annualized basis. The results are reported for the five market sectors represented in the program, the majority of which were heavy-duty vehicles followed by school bus. For market sectors with fewer than 15 customers, the EY2022 and program-to-date results are shown in aggregate. Only school busses have more than 15 sites in total.

Table 49. PG&E EV Fleet Program Petroleum Displacement Summary

Market Sector	Usage		Petroleum Displacement (DGE)		
	EY2022 Sites Annualized (kWh) (n=13) [a]	EY2022 Sites Annualized (miles, hours) (n=13)	EY2022 Sites Annualized (n=13)	PTD Sites Actuals (n=41)	PTD Sites 10-Year Projection (n=41)
Forklifts					
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus				203,992	1,087,786
Transit Bus					
Total		**1,263,449 miles**	**207,437**	**647,621**	**4,393,353**

[a] Includes 13 sites for this EY2022 estimate based on annualized AMI data; one site did not have any usage in 2022.
Note: values for population of less than 15 sites are redacted

Highlights

- The 13 operational EY2022 sites resulted in an annualized impact of over 200,000 gallons of displaced petroleum.
- Over a 10-year period these sites, in combination with those from EY2021, will result in displacing almost 4.4 million gallons of petroleum.

Greenhouse Gas and Criteria Pollutant Impact

The Evaluation Team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service because of the EV Fleet program. The Evaluation Team first developed ICE counterfactuals for common market sectors, then calculated the emissions associated with these vehicles under conditions that otherwise matched the EVs to provide a baseline. Although EVs have no tailpipe emissions, the fossil fuel power plants that supply electricity to the EV chargers emit GHGs and criteria pollutants, and the magnitude depends on the time that energy is consumed.

Table 50 summarizes GHG impacts for the EV Fleet program for three time periods: (1) estimated annualized reductions that reflect what the program would have saved in EY2022 if all EY2022 activated sites had been fully operational for all 12 months, (2) actual program to date reductions, and (3) a 10-year projection based on annualized data.

Table 50. PG&E EV Program Fleet GHG Reductions Summary

Market Sector	Usage		GHG Reduction (MT)		
	EY2022 Sites Annualized kWh (n=13) [a]	EY2022 Sites Annualized Use (n=13)	EY2022 Sites Annualized (n=13)	PTD in Actuals (n=41)	PTD 10-Year Projection (n=41)
Forklifts					
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus				1,739	9,646
Transit Bus					
Total		**1,263,449 miles**	**1,660**	**5,810**	**38,554**

[a] Includes 13 sites for this EY2022 estimate based on annualized AMI data; one site did not have any usage in 2022.
Note: values for population of less than 15 sites are redacted

Table 51 shows the estimated reductions in local emissions from the tailpipes of ICE vehicles that were displaced through this program, including hydrocarbons (HC) from off-road forklifts and heavy-duty vehicles. Local emissions reductions estimates are relatively small in EY2022. For the program to date, the largest impacts were observed in the heavy-duty vehicle sector, which has substantial usage, followed by forklifts, which have poor emissions profiles.

Table 51. PG&E EV Fleet Program Local Emissions Reductions, Program-to-Date Sites

Market Sector	Program-to-Date Sites (n=41) in Actuals				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Forklifts					
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus	-	4.1	3.9	18.4	529.4
Transit Bus					
Total	**504.3**	**68.6**	**61.5**	**576.2**	**37,689.0**

Note: values for population of less than 15 sites are redacted

Table 52 shows the same information as above but on an annualized basis for EY2022 sites only. It represents localized emissions reductions if the sites had been fully operational for the entire year. This annual estimate for the first year is the base for the 10-year reduction projection.

Table 52. PG&E EV Fleet Program Local Emissions Reductions Summary, Annualized EY2022 Sites

Market Sector	EY2022 Sites (n=13) Annualized				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Forklifts	-	-	-	-	-
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus					
Transit Bus					
Total	**-**	**2.5**	**2.4**	**33.5**	**20,883.8**

Note: values for population of less than 15 sites are redacted

Table 53 shows the 10-year projection of local emissions reductions.

Table 53. PG&E EV Fleet Program Local Emissions Reductions Summary – 10 Year Projection, Program-to-Date Sites

Market Sector	Program-to-Date Sites (n=41), 10-Year Projected Impact				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Forklifts					
Heavy-Duty Vehicles					
Medium-Duty Vehicles					
School Bus	-	25.6	24.4	110.9	3,044.0
Transit Bus					
Total	**4,227.5**	**355.9**	**320.3**	**4,850.4**	**548,318.0**

Note: values for population of less than 15 sites are redacted

Table 54 shows counterfactual vehicle GHG emissions, emissions from the electricity used to charge the EVs, and GHG emissions reductions and percentage change. Table 55 shows the net reductions of NO_x emissions from using EVs based on the counterfactual and Utility emissions. The Evaluation Team estimated a total GHG reduction of 84% for EY2022 sites, relative to the counterfactual, and a NO_X reduction of 65%. Heavy-duty vehicles and transit bus increase NO_x when electrified due to the relatively carbon intensive imported (from out of state) electricity generation mix when the vehicles are charging and the very low NO_x emissions of the counterfactual vehicles in these two market sectors, which use CNG in some cases. In balance, the sites reduced local (tailpipe) emissions. For program to date sites, there is an estimated 85% reduction in GHG emissions and 77% reduction in NO_x emissions.

Table 54. PG&E EV Fleet Program Counterfactual GHG Reductions

Market Sector	EY2022 Sites (n=13) Annualized GHG (MT)				Program-to-Date Sites (n=41) GHG (MT)			
	Counter factual	Utility	Reduction	% GHG Reduction	Counter factual	Utility	Reduction	% GHG Reduction
Forklifts	-	-	-					
Heavy-Duty Vehicles								
Medium-Duty Vehicles								
School Bus					2,158.2	419.4	1,738.8	81%
Transit Bus								
Total	**1,983.3**	**322.9**	**1,660.3**	**84%**	**6,843.7**	**1033.9**	**5,809.8**	**85%**

Note: values for population of less than 15 sites are redacted

Table 55. PG&E EV Fleet Program Counterfactual NO_x Reductions

Market Sector	EY2022 Sites (n=13) Annualized NO_x (kg)				Program-to-Date Sites (n=41) NO_x (kg)			
	Counter factual	Utility	Reduction	% NO_x Reduction	Counter factual	Utility	Reduction	% NO_x Reduction
Forklifts	-	-	-	-				
Heavy-Duty Vehicles								
Medium-Duty Vehicles								
School Bus					1,900.9	407.5	1,493.4	79%
Transit Bus								
Total	**905.7**	**319.3**	**586.4**	**65%**	**4,417.3**	**1006.5**	**3,410.8**	**77%**

Note: values for population of less than 15 sites are redacted

Figure 99 shows the annual program net electricity generation mix matched with the hours that the EVs were charging. The CAISO grid mix varies from moment to moment depending on factors such as the level of total demand for power on the grid and availability of fossil generation versus variable renewable resources such as solar and wind. At this early stage of the program, it appears that the vehicles were not charging predominantly during the peak hours of solar output. Over 15% of the grid mix is comprised of electricity imports, which do not vary by time of day, but match the resource mix purchased for the California grid.[82]

Based on the real-time grid conditions when the charging occurred, the overall energy mix was about 52% zero-emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 33% natural gas. Emissions reductions from these sites over 10 years should increase as the grid becomes cleaner. Notably, the increased use of managed charging will reduce emissions as more EVs charge during off-peak times and when the grid is supplied with more renewable resources such as solar.

82 The power associated with imports comes from a mixture of renewables, hydro, nuclear, and natural gas power plants located outside of California (https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation).

Figure 99. PG&E EV Fleet Program Annualized Net Electricity Mix in 2022, EY2022 Sites

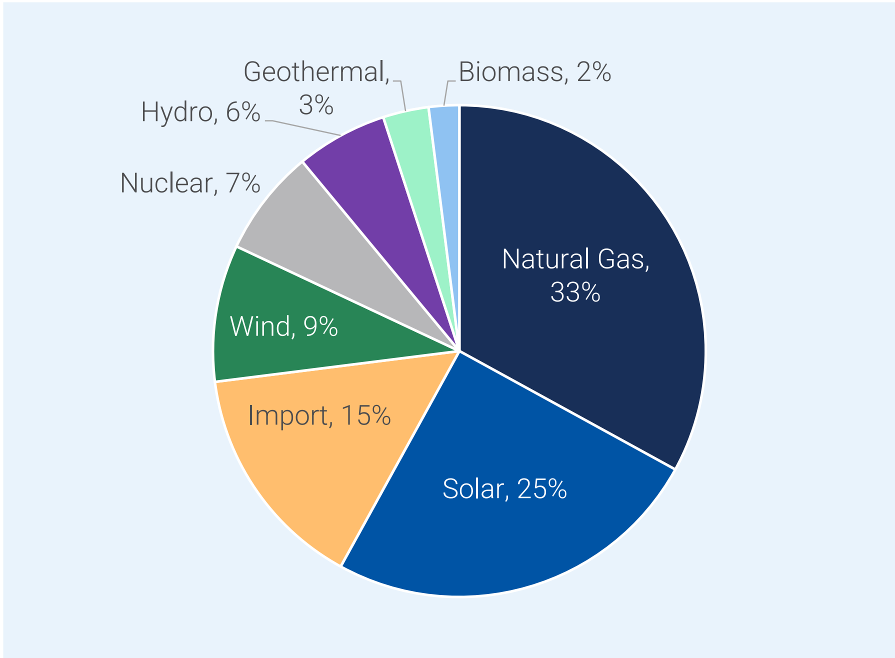
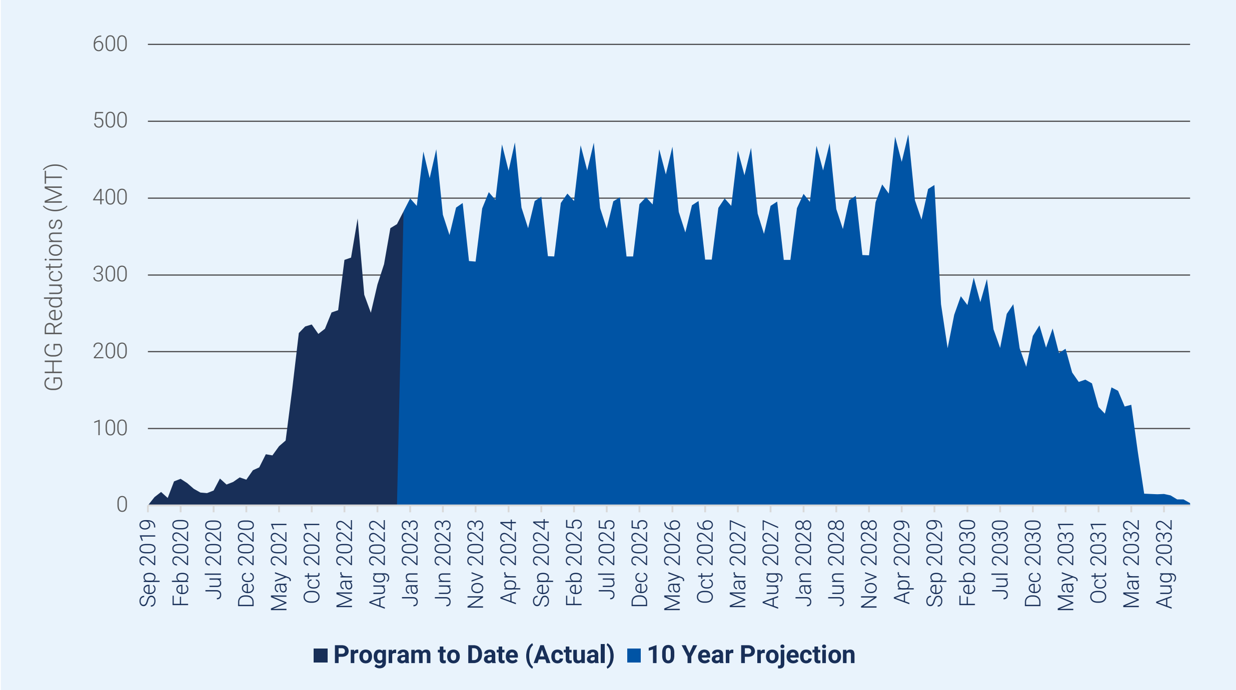


Figure 100 shows how program GHG reductions have increased to date and are expected to grow over time for EY2021 and EY2022 activated sites. The analysis period ranges from the date that the first site in the program was activated through the end of 2022. The analysis incorporates the net reduction (counterfactual emissions minus utility emissions) for each fleet within the PG&E EV Fleet program. Program to date emission reductions are shown in dark navy while anticipated benefits based on annualization are presented in royal blue. As each site has its own starting date of operation, the 10-year sunset for each site is observed as a gradual tapering off of program benefits between 2029 and 2032. While each year's operations appear similar, there are several key factors driving the variations such as seasonality of utility generation sources (high utility emissions will appear as a dip on the curves), holidays occurring on weekends versus weekdays, and sites that became operational late in 2022 having predicted operations year-round in future years.

Figure 100. PG&E EV Fleet Program GHG Reductions, Historic and Forecasted, Program-to-Date Sites



Highlights

- For EY2022 sites, analysis of annualized data estimated an 84% reduction of GHGs and a 65% reduction in NO_X emissions.
- The local emissions analysis for these sites estimated that the highest impact was the reduction of CO (annualized reduction of 20,000 kg and a projected 10-year reduction of nearly 550,000 kg).
- Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 52% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 33% natural gas.

Health Impacts

The Evaluation Team calculated public health impacts (benefit or cost) of reductions in criteria pollutants from vehicle electrification. Pollutants included in the analysis are primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, including NO_x, SO_2, NH_3, and VOCs. The analysis only considers tailpipe emissions reductions, rather than the full lifecycle emissions (power plant emissions). The Evaluation Team used the U.S. EPA's COBRA to evaluate the health benefits associated with the emissions reductions. COBRA estimates the benefits at the county level for the county in which emissions are reduced. It also estimates the effect on all counties in the United States due to the transport of emissions. This analysis includes only the effects of the emissions reductions in California. The

Evaluation Team disaggregated the county-level effects to estimate the potential health benefits of projects for DACs and non-DACs. [83]

The total value of the health benefits associated with the emissions reductions is between $130,258 and $293,191. Table 56 shows the cumulative health benefits for counties in California associated with the emissions reductions realized by the electrification of EY2021 and EY2022 PG&E EV Fleet sites.

Table 56. PG&E EV Fleet Program California Health Benefits for EV Fleet, Program-to-Date Sites

Health Endpoint	Change in Incidence (Annual Cases)		Monetary Value (Annual, 2023 dollars)	
	Low	High	Low	High
Mortality	0.009	0.021	$127,701	$289,307
Nonfatal Heart Attacks	0.001	0.008	$160	$1,486
Infant Mortality	< 0.000	< 0.000	$856	$856
Hospital Admits, All Respiratory	0.002	0.002	$97	$97
Hospital Admits, Cardiovascular	0.002	0.002	$128	$128
Acute Bronchitis	0.017	0.017	$13	$13
Upper Respiratory Symptoms	0.299	0.299	$16	$16
Lower Respiratory Symptoms	0.210	0.210	$7	$7
Emergency Room Visits, Asthma	0.004	0.004	$3	$3
Asthma Exacerbation	0.312	0.312	$29	$29
Minor Restricted Activity Days	8.345	8.345	$900	$900
Work Loss Days	1.419	1.419	$349	$349
Total Health Effects	-	-	**$130,258**	**$293,191**

At the site level, the heavy-duty vehicle market sector has the highest health benefits overall, followed by the school bus, forklift, medium-duty vehicle, and transit bus market sectors. Heavy-duty vehicle sites also had the highest health benefits on a per-site basis, followed by forklift, school bus, medium-duty vehicle, and transit bus sites.

As part of this analysis, the Evaluation Team also examined the health benefits within DACs. The COBRA tool only produces outputs at the county level, so the Evaluation Team disaggregated the monetized health impacts by census tract using the relative population from the most recent American Community Survey. For example, a census tract with 10% of the county's population was allocated 10% of the monetized health benefits. The Evaluation Team then estimates the total benefits allocated to DACs and non-DACs. The approach implicitly assumes that the benefits of emissions reductions are distributed evenly throughout the county. If the sites are located in DACs, and the emissions reductions are greater in the tracts near the sites, this approach would understate the potential benefit to DACs. Additional information about emissions dispersion within counties is needed to provide more precise estimates of the health benefits to DACs and non-DACs.

83 DAC Census Tracts are defined as those included in in the SB535 Disadvantaged Communities List (2022), this includes the DAC categories for CalEnviroScreen 4.0 Top 25%, CalEnviroScreen 4.0 High Pollution Burden Score and Low Population Count, and 2017 Disadvantaged Community (CalEnviroScreen 3.0 only).

The largest portion of health benefits were in San Joaquin County, which had 32% of the total benefits, followed by Contra Costa County (11%), Alameda County (9%), Stanislaus County (8%), and Santa Clara County (5%). Overall, 25% of the benefits are in DACs.

Highlights

- Cumulative health impact results for counties in California realized by the electrification of EY2021 and EY2022 EV Fleet sites in terms of monetary benefits range from $130,258 for the low estimate and $293,191 for the high estimate.
- Sites in the heavy-duty vehicle market sector have the highest health benefits overall as well as on a per-site basis.
- The largest health benefits were in San Joaquin County, which had 32% of the total benefits, followed by Contra Costa County (11%), Alameda County (9%), Stanislaus County (8%), and Santa Clara County (5%).
- Overall, 25% of the benefits are in DACs.

Net Impacts

As part of the net impacts analysis, the Evaluation Team estimated program effects on participants to exclude impacts from actions that participants would have taken without the program (freeridership) and to include any program-attributable indirect impacts on participants (participant spillover) and nonparticipants (market effects). The Evaluation Team conducted three separate analyses to assess net impacts from the MDHD programs.

Enhanced Self-Report

The Evaluation Team based our approach for the MDHD program enhanced self-report NTG analysis on information obtained as part of in-depth surveys with participating fleet managers. The Evaluation Team conducted the survey via an online survey platform, Qualtrics, and delivered the survey using email contact information provided by PG&E. The Evaluation Team used the CPUC nonresidential customer self-report NTG framework as the base to develop the MDHD fleet manager NTG methodology approach.[84] The *Methodology* section details the MDHD fleet manager self-report NTG methodology. The Evaluation Team estimated the core component of the CPUC NTG methodology through three separate program attribution index (PAI) project scores. The Evaluation Team used three separate sets of questions to assess the three components of the core NTG ratio, with each PAI score on a 0.0 to 1.0 scale representing a different way of characterizing the PG&E EV Fleet program influence. The analysis included fleet manager responses from four of the 12 participating sites that were sent the survey.[85]

The Evaluation Team calculated the resulting self-report NTG for each project, prior to accounting for participant spillover, as the average of the PAI-1A, PAI-2, and PAI-3 score values. One minus the final

---

84 California Public Utilities Commission, Energy Division. February 20, 2015. *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Nonresidential Customers.*

85 Two transit sites, one distribution site, and one school bus site completed the survey.

core NTG ratio of 0.46 equals the 0.54 freeridership ratio for the EV Fleet program. The participant spillover analysis found that none of the surveyed sites reported electrifying more of their fleet since participating in the EV Fleet program, without the benefit of funding from the PG&E program or where their PG&E program participation was important in this additional purchasing decision. The resulting participant spillover ratio is 0.00. The final program level NTG ratio of 0.46 equals one minus the freeridership ratio plus the participant spillover ratio. These score values are presented in Table 57, along with the average final core NTG for the surveyed PG&E EV Fleet program sites.

Table 57. PG&E EV Fleet Program MDHD NTG Analysis Results in EY2022

Fleet Manager Survey Completes (n)	Average of PAI-1A Score NTG	Average of PAI-2 Score NTG	Average of PAI-3 Score NTG	Average of Final Core NTG	Freeridership Ratio	Participant Spillover Ratio	Final NTG Ratio
4	0.54	0.31	0.53	0.46	0.54	0.00	0.46

Highlight

- EY2022 program-level freeridership ratio is 0.54 with a 0.00 participant spillover ratio, which resulted in a program level NTG ratio of 0.46.

Truck Choice Model

The Evaluation Team assessed the impacts of the Utility MDHD programs using a modified version of the Truck Choice Model, developed at the University of California–Davis.[86] The model mimics new vehicle purchase decisions made by MDHD fleet operators when accounting for lifecycle vehicle and operating costs and human preferences. Notable barriers to electric MDHD vehicle adoption—such as vehicle availability of specific market sectors—is not captured in the model. The Evaluation Team calculated new MDHD adoption for four market sectors—transit bus, school bus, medium-duty delivery trucks, and heavy-duty delivery trucks (short-haul)—for 2025, 2030, and 2035. The Evaluation Team developed three scenarios that vary based on who pays for the TTM and BTM infrastructure for electric MDHD vehicles, thereby isolating the impact of the TTM and BTM expenses on the vehicle purchase decision, all else equal:

- **Scenario 1: No Utility Support.** No Utility support for TTM or BTM. The fleet operator pays for the BTM costs, including EVSE installation and EVSE capital expenses.
- **Scenario 2: TTM Support.** Utility provides support for TTM infrastructure as required by AB 841, but the fleet operator pays for the BTM costs, including EVSE installation and EVSE capital expenses.

86 University of California–Davis Institute of Transportation Studies (Miller, Marshall, Qian Wang, and Lewis Fulton). 2017. *NCST Research Report: Truck Choice Modeling: Understanding California's Transition to Zero-Emission Vehicle Trucks Taking into Account Truck Technologies, Costs, and Fleet Decision Behavior*." Research Report UCD-ITS-RR-17-36.

- **Scenario 3: TTM + BTM Support.** Utility provides support for both TTM and BTM infrastructure, including partial rebates for EVSE installation and capital expenses.

Table 58 shows new MDHD vehicle adoption for the three scenarios and four market sectors. The difference between scenarios within a market sector is the impact of Utility-sponsored TTM or TTM+BTM infrastructure. For example, for school buses in 2025, the difference between the No Utility Support and TTM+BTM Support scenario is 26% (29% - 3%) which implies—under the assumptions in the model—that Utility support for TTM and BTM infrastructure will increase electric school bus adoption by 26%.

Table 58. PG&E EV Fleet Program EV Sales Shares for Each Segment as a Function of the Three Trajectories

Market Sector	2025	2030	2035
School Bus			
No Utility Support	3%	21%	40%
TTM Support	11%	45%	74%
TTM + BTM Support	29%	69%	92%
Transit Bus			
No Utility Support	1%	41%	84%
TTM Support	41%	80%	100%
TTM + BTM Support	44%	99%	100%
Medium-Duty Delivery			
No Utility Support	0%	0%	0%
TTM Support	2%	5%	7%
TTM + BTM Support	33%	63%	65%
Short-Haul			
No Utility Support	0%	0%	0%
TTM Support	1%	5%	9%
TTM + BTM Support	9%	30%	43%

The results illustrate that new electric MDHD vehicle adoption increases substantially across market sectors when TTM and TTM+BTM support is provided. Results also demonstrate the importance of the HVIP program, California's vehicle incentive program. For market sectors with high HVIP incentives relative to the new vehicle cost, like transit bus, adoption rates are higher than for other market sectors that have lower relative incentives compared to new vehicle cost, like short haul.

There are several reasons for using caution when interpreting these results. For example, HVIP and LCFS funding levels vary year to year based on decisions in the state government or market fluctuations in the LCFS credit market. Additionally, the Evaluation Team intentionally ignored California's ACT and ACF regulations, which mandate the sale and purchase of zero-emission MDHD vehicles. This allowed us to isolate the impact of only the TTM and BTM costs. Finally, as noted above, results do not reflect certain known barriers to electric MDHD vehicle adoption, like vehicle availability, which would dampen the trajectories.

Highlights

- In scenarios in which fleet operators have no financial responsibility for TTM or BTM infrastructure expenses (TTM+BTM Support Scenario) and have no external constraints or requirements on vehicle purchases (such as vehicle availability and ACF purchase requirements), results of the Truck Choice Model suggest that Utility TTM and BTM programs are critical in changing the adoption trajectory of MDHD vehicles.
- Factors that are not easily captured in the model (such as ACF regulation, switchgear wait times, and vehicle availability) could change the trajectories.

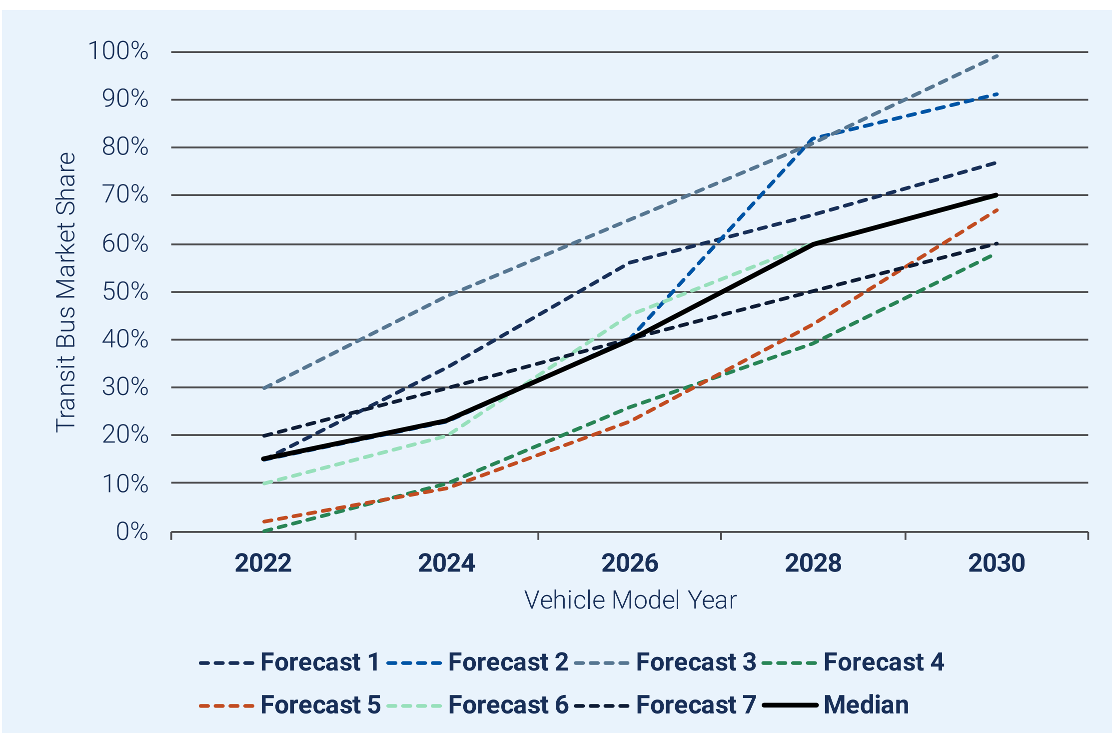
Market Effects

The market effects analysis assesses structural long-term changes in the TE market by comparing actual market activity to what would have happened in absence of the programs.

Transit Bus Electrification Market Share Baseline

The Evaluation Team developed a baseline market share forecast of electric transit bus in California through vehicle model year 2030 based on two rounds of input from the Delphi process. This baseline represents electrification in the transit bus market in California in the absence of Utility incentives. Figure 101 shows the individual curves from the first round of input (Round 1), along with the median curve. Note that the horizontal axis indicates vehicle model year and only applies to *new vehicles*, not to the entire statewide vehicle stock.

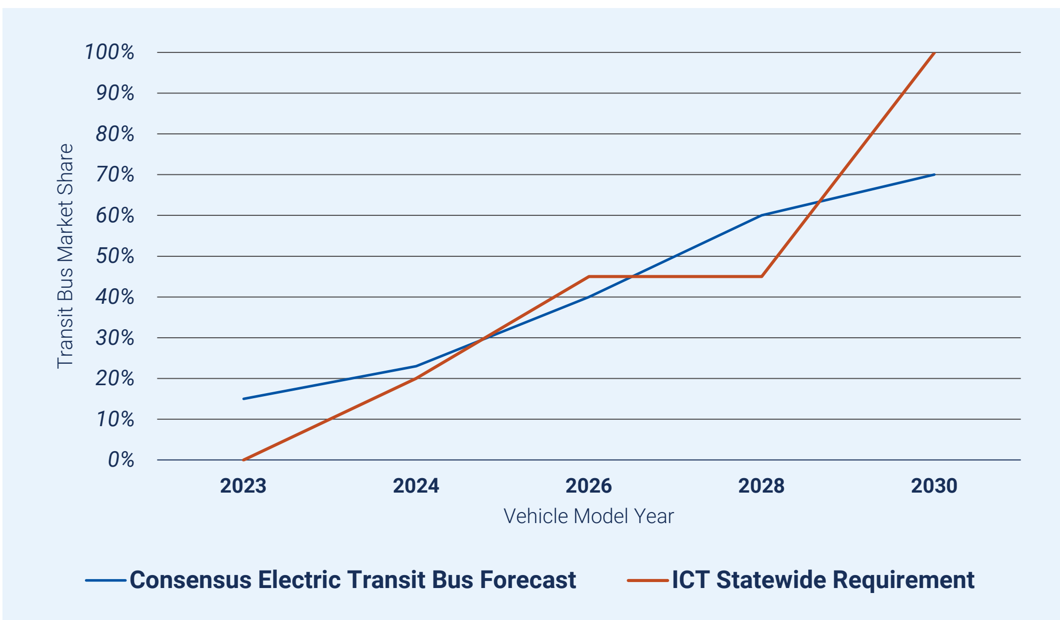
Figure 101. Delphi Panel's Round 1 Baseline Electric Transit Bus Adoption Forecasts



Despite the range in Round 1 forecasts, there was general agreement within the Delphi panel that the electric transit bus market will experience relatively linear growth over the next several years and will reflect most of the overall transit bus market by 2030. In Round 2, five of seven panelists agreed with the median or consensus forecast, while two panelists submitted new forecasts and rationales. As described in the *Methodology* section, the forecasting rounds continue until a majority consensus is reached. Since over half the panelists were in agreement after Round 2, the median forecast is considered the final consensus result. Figure 102 shows the final consensus estimate compared to the zero-emission transit bus sales schedule from the ICT regulation. The ICT regulation specifies calendar year purchase requirements (where a certain percentage of all new vehicle purchases must be zero-emission) for California public transit agencies.[87]

The consensus trajectory generally aligns with the ICT requirement for 2024 and 2026. It stays above the ICT required level for 2028 but falls short of the 100% requirement for 2030, possibly because the ICT regulation allows for flexibility in how transit agencies meet purchase requirements. Hydrogen fuel cell bus are also considered zero emission under ICT.

Figure 102. Delphi Panel's Electric Transit Bus Baseline Market Share Forecast



Of the two experts who did not agree with the median, one said the market share will grow faster than the median forecast starting in the mid-2020s due to headwinds against the fossil fuel industry, increased public support for electrification, and compliance with the ICT requirements. The other dissenting expert said the median forecast is too aggressive and that the electric transit bus market share will grow at a slower rate due to supply chain constraints (specifically that there are many

87 The ICT regulation specifies different sales requirements for small (<100 bus) and large (>100 bus) transit agencies. The Evaluation Team used the statewide requirement in our analysis, which assumes similar turnover at large and small transit agencies.

competing demands for these batteries, such as for use in LDVs). While deriving the majority consensus forecast achieved the main goal of the Delphi panel, panelists' supporting rationales also contain valuable qualitative information. Aggregating the supporting comments revealed deeper insights into factors that panelists predict will accelerate or impede transit bus electrification in California.

One panelist specifically cited the $1.3 billion in annual Federal Transit Administration grants for low- and zero-emission bus and infrastructure that is expected over the next five years. Another panelist projected that starting in the 2026 to 2028 timeframe, the TCO for many transit bus will achieve cost parity, which will drive up market penetration. Another noted that EV penetration will likely continue to increase with technology improvements, cost reductions, and competition in the transit EV market.

One panelist noted that without continued funding support at the federal and state levels, such as CARB's HVIP program, transit agencies may struggle to electrify larger proportions of their fleets. It will be particularly challenging to finance new bus if existing bus are still mid-lifecycle and not up for replacement. Buses are typically retired on a 12-year cycle; however, transit agencies may be down-sizing their bus fleets due to increased micro-transit and demand response service, which could alter vehicle replacement timing and subsequently slow the speed of adoption. Rationales for forecasts with lower and slower market growth included the possible lack of manufacturer compliance and the persistence of late adopters due to technology concerns.

Although this study only considered battery electric transit bus market share, two panelists also mentioned hydrogen fuel cell technology. Fuel cell bus could potentially allow the ICT requirement to still be met without achieving 100% battery electric bus market share in the transit bus segment by 2030. Fuel cell bus may become an attractive option if battery supply remains constrained. One expert noted that the advancements in and adoption of hydrogen will aid battery electric technology, specifically using hydrogen as an energy storage technology to support high-powered EVSE.

The fact that the consensus forecast falls short of ICT requirements in 2030 shows that experts believe it will be challenging for transit agencies to scale all-electric fleets to the ICT regulation levels without additional support. The consensus forecast represents the market share of electric transit bus in the *absence* of California Utility incentives. In conclusion, panelists agreed that transit agencies may struggle to scale up charging infrastructure and electrify larger proportions of their fleets to meet the later ICT requirements without either financial incentives and support from various sources, including Utilities, or the help of other ZEV technologies such as fuel cell bus.

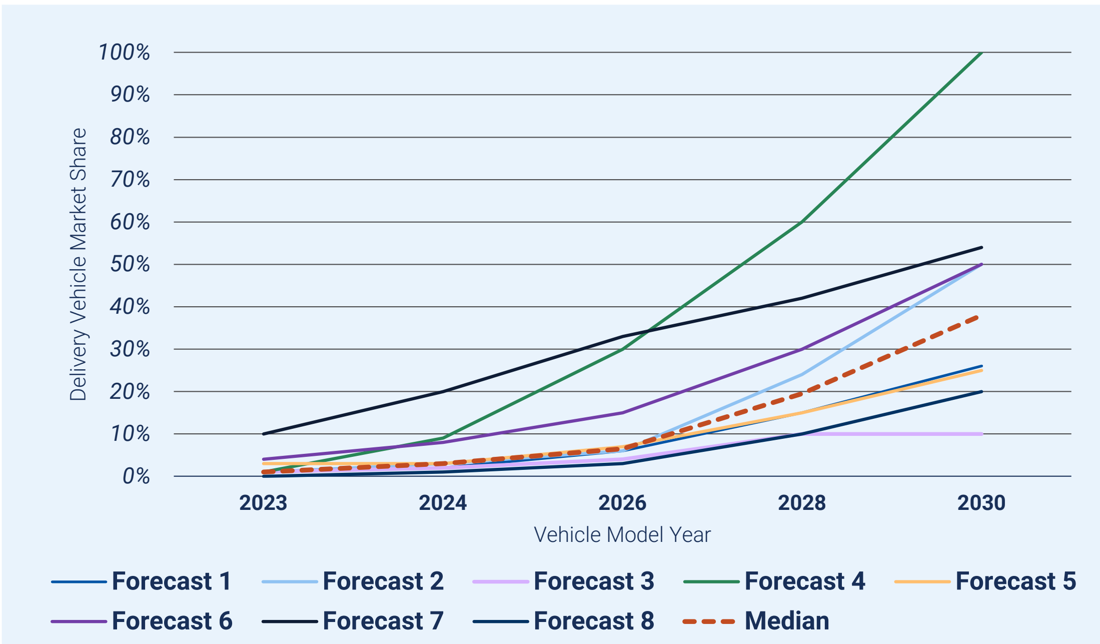
Highlights

- The consensus forecast for electric transit bus market share in California generally aligns with the ICT regulation requirements for 2024 and 2026 but falls short of the 100% level for 2030.
- Increased availability of funding is the primary factor in transit agencies meeting the initial purchase requirements of the ICT regulation, while economics will drive adoption starting in the mid- to late-2020s due to battery technology improvements, cost parity with diesel bus, and technological advances in charging infrastructure.

Delivery Vehicle Electrification Market Share Baseline

The Evaluation Team forecasted the baseline market share of electric delivery vehicles in California through vehicle model year 2030 following two rounds of input from the Delphi process. For this study the delivery vehicle market sector is defined as cargo vans, step vans, and box or straight trucks operating last-mile parcel delivery. Figure 103 shows the individual curves from the first round of input (Round 1), along with the median curve. Note that the horizontal axis indicates vehicle model year and only applies to *new vehicles*, not to the entire statewide vehicle stock.

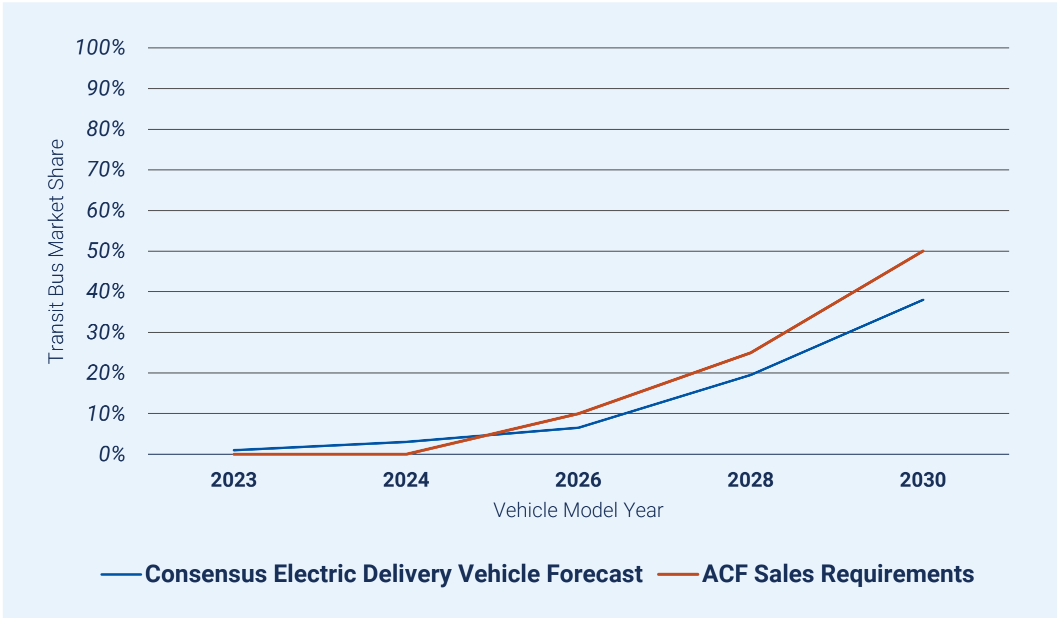
Figure 103. Delphi Panel's Round 1 Baseline Electric Delivery Vehicle Adoption Forecasts



The Round 1 forecasts contain a few outliers, but in general panelists agreed that the electric delivery vehicle market will increase slowly until a tipping point in the mid-2020s when growth accelerates. In Round 2, five of eight panelists agreed with the median or consensus forecast, while three panelists submitted new forecasts and rationales. As described in the *Methodology* section, the rounds continue until a majority consensus is reached. Since over half the panelists were in agreement after Round 2, the median forecast is considered the final consensus result. Figure 104 shows the final consensus estimate compared to the zero-emission sales schedule for last-mile delivery vehicles from the ACF regulation. The ACF regulation imposes targets beyond those of the ACT regulation for fleets, businesses, and public entities that own or operate MDHD vehicles in California. The ACF regulation specifies calendar year purchase requirements (that a certain percentage of all new vehicle purchases must be zero-emission) for certain fleet sectors that are well-suited for electrification, including parcel delivery vehicles.[88]

[88] Parcel delivery vehicles are included in the ACF sales requirements for Milestone Group 1, which is composed of box trucks, vans, bus with two axles, yard tractors, and light-duty package delivery vehicles.

Figure 104. Delphi Panel's Electric Delivery Vehicle Baseline Market Share Forecast



Of the three experts who did not agree with the median, two decreased their projections while one increased their projection. The rationales for decreased projections warn of supply constraints on the battery market and the high costs of installing charging infrastructure. Battery supply will be in competition for use in LDVs, and the necessary grid improvements for high penetration rates will take significantly more time than accounted for in high adoption predictions, as permitting alone can take years. Delivery depots that house dozens to hundreds of vehicles will need massive electrical upgrades, and the costs of installing charging infrastructure will not be covered by EV energy savings alone, especially because charging will likely occur during peak periods. The panelist who increased their forecast argued that Class 2b trucks and vans will increasingly dominate the parcel delivery segment and are well-suited for electrification given their lower power requirements.

While deriving the consensus forecast achieved the main goal of the Delphi panel, panelists' supporting rationales also contain valuable qualitative information. Aggregating the supporting comments revealed deeper insights into factors that panelists predict will accelerate or impede delivery vehicle electrification in California.

The median trajectory shows the electric delivery vehicle market falling short of the ACF sales requirements, which start in 2025. Panelists noted several reasons this segment could struggle to meet the ACF targets:

- Three panelists mentioned infrastructure costs in particular as a major concern.
- One panelist mentioned the potential of grid congestion and questioned whether California Utilities can build out new grid capacity before existing distribution grid capacity is too constrained.
- From the fleet operator perspective, another panelist noted that high infrastructure costs will absorb all the financial benefits of fleet electrification and fleet operators will not see any return on investments.

Other rationales included a slow ramp-up of production, the lack of market-ready options, and the fact that electric delivery trucks have yet to definitively demonstrate being reliable and durable for demanding work requirements. Two panelists also mentioned market contractions and the potential of a global recession, which could have a negative impact on the uptake of EVs across all applications.

Three individual forecasts were more optimistic and showed the ACF requirements either being met or exceeded. These panelists cited the increasing availability of models from national OEMs and incentive programs like the CARB's HVIP program that help to make delivery vehicles cost-competitive with their ICE counterparts. They noted that this segment is well-positioned for electrification by having predictable routes along relatively shorter distances in urbanized environments and the ability to charge overnight at depots (similar to transit bus).

After submitting their forecasts, the Evaluation Team asked the panelists about the impacts of the ACF and ACT requirements and Utility incentive programs on the electric delivery vehicle market share through 2030. Two panelists said that both the CARB regulations and Utility programs are accelerating the market. According to one expert, it is because of California's suite of ZEV-supportive policies that roughly half of all zero-emission trucks and bus sold in the U.S. and Canada are sold in the state of California. Without the CARB regulations, this panelist would have reduced their forecast by 50%.

Panelists also agreed that Utility programs are having a positive impact on electric delivery vehicle sales. Experts noted several benefits of the Utility programs, including the investments and partnerships to deploy truck-specific public charging and fast-tracking the installation of depot charging. Given that the consensus forecast represents the market share of electric delivery vehicles in the *absence* of Utility incentives, a potential 10 percentage bump from these programs could be the difference in delivery fleets meeting or missing ACF requirements.

Highlights

- The baseline forecast for the electric delivery vehicle market share falls short of ACF sales requirements, which start in 2025. This shortfall is due to high infrastructure costs, competition with the light-duty market for battery supply, grid congestion, a slow ramp-up in the production of market-ready options, and the impacts of market contractions.
- The ACF and ACT requirements and Utility incentive programs are helping to accelerate the electric delivery vehicle market.

4.1.3. Lessons Learned

The Evaluation Team identified a number of lessons learned from EY2022. These lessons, presented with key supporting findings and recommendations, may be applied to future program years and to other similar efforts. Note that these lessons and findings were derived from a limited number of program participants across most but not all market sectors. Additional insights will be gained as more sites are completed in the coming years.

The EV Fleet program is progressing well towards its EVs supported goal, but lags behind its goal for number of sites.

In EY2022, 14 sites with 148 new charging ports were activated supporting 184 vehicles based on customer VAPs for activated sites. An eTRU site was activated in EY2022, bringing the total market sectors to six (forklifts, eTRUs, medium-duty vehicles, school bus, heavy-duty vehicles, and transit bus). As of the end of 2022, 42 sites have been activated with 345 charging ports to support 505 additional vehicles electrified.

The 158 signed contracts in the EV Fleet program to date support 3,050 vehicles, meeting 23% of the program's *per se reasonableness* goal of 700 sites and support 47% of the program's *per se reasonableness* goal of 6,500 additional vehicles electrified. The total of 270 customer applications could satisfy approximately 39% of the program's site goal and would support roughly 4,600 MDHD vehicles, which could satisfy 71% of the program's electrified vehicles goal.

Overall program spending is ramping up slowly, however program spending on DAC sites exceeds targets.

PG&E spent $10.4 million of the EV Fleet program budget in EY2022, bringing total spending to $35.9 million out of $236.3 million of the approved program budget, or 15% of available funding. Thirty-nine percent of PG&E EV Fleet program spending on infrastructure for financially closed out sites to date has been on DAC sites, exceeding the 25% program target. Additionally, in the program to date sites, 38% of sites, 50% of charging ports, and 49% of vehicles are in DACs.

The EV Fleet program is having a measurable impact on petroleum displacement, GHG emissions reductions, criteria pollutant emissions reduction, and health benefits.

The 14 activated EY2022 sites achieved an annualized impact of over 200,000 gallons of petroleum displaced, and program to date sites are expected to displace nearly 4,400,000 gallons of petroleum over a 10-year period. The EY2022 activated EV Fleet program sites resulted in an 84% reduction in GHG emissions relative to counterfactual vehicles, while sites in the program to date have achieved an 85% reduction. Annualized GHG emissions reductions from EY2022 sites was 1,660 MT and 39% in DACs.

To date, the EV Fleet program has reduced GHG emissions by 5,810 MT and activated sites are expected to reduce GHG emissions by 38,554 MT over a 10-year period. The total value of the health benefits associated with the emission reductions in the program to date is between $130,258 and $293,191. The overall energy mix contained about 52% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear). Emissions impacts could be greater through the use of greater load management, specifically by enabling vehicles to avoid charging during peak rate periods while taking advantage of periods with a higher mix of renewable generation.

PG&E improved customer education and outreach efforts and saw an increase in the total program applications.

Through its EV Fleet program website, PG&E provides several market sectors–specific informational resources to appeal to and educate potential fleet customers, including program materials, information on incentives and rebates per vehicle and charger, eligibility requirements, and tools such as an EV Fleet Charging Guidebook and a fuel switching rate calculator. Four of the six surveyed fleet managers reported hearing about the program directly from PG&E, and five out of five responding fleet managers were very satisfied with their experience working with PG&E staff. PG&E staff also reported that onboarding specialists have been the most effective outreach method for potential applicants and additional onboarding specialist support is planned for EY2023.

TTM and BTM infrastructure costs continue to vary widely between project sites. Program participants continue needing Utility infrastructure incentives.

Across 17 financially closed out school bus sites in the program to date, utility spending on infrastructure averaged $344,585 per site, $32,914 per vehicle, and $2,514 per kW, when including TTM and BTM infrastructure but excluding EVSE cost. These values include both L2 and DCFC sites. Average TTM costs are $187,246 per site. Vehicles in the EV Fleet Program average 10,742 VMT per annum, resulting in lifetime operational cost savings of approximately $26,000 in comparison to conventional ICE vehicle (10-year NPV). These savings alone are unlikely to cover the purchase price increment of an EV at present.

As the EV Fleet program continues to evolve, program participants and EVSPs report high satisfaction with the program and PG&E.

Five out of five responding fleet managers rated themselves as *very satisfied* (3) or *somewhat satisfied* (2) with the program and four of six responded that they were *very likely* to recommend the program to others or had already recommended that program, noting excellent support from PG&E staff. Environmental benefit, rebates and incentives for charging infrastructure, and expected maintenance cost savings were reported as the strongest motivators for program participation. Both responding fleet managers who withdrew from the EV Fleet program also rated the program favorably.

EVSPs also agreed that there is sufficient demand from fleet owners to warrant expanding the EV Fleet program with additional technical assistance and incentive funds. All four EVSPs noted that Utilities are good partners in deploying infrastructure and that EV Fleet is well implemented.

Program timelines continue to be longer than expected and site costs and supply chain delays continued to be a challenge.

The median start-to-fish duration is 784 days for all EY2022 activated sites and is 557 days for all activated sites in the program to date. For program to date activated sites, Design and Permitting is the longest phase, with a median of 265 days, or nearly 50% of implementation timelines. EVSPs and program staff noted that delays from switchgear procurement were the most important driver in overall project delays, as well as changes. Switchgear cannot be ordered until completion of Phase 4 of the project and delivery regularly takes over 70 weeks, while transformers can take up to 40 weeks. EVSPs also noted that while PG&E has been a strong project partner, additional staffing could expedite the site analysis process. Fleet operators reported that delays were also driven by vehicle availability and several sites had not yet received some or all of expected vehicles at the time of site visits.

Installed EV ports are underutilized, the majority of fleet operators are not actively employing load management, and many do not have access to their charging trends or cost data.

Over 6 MW of new charging capacity was activated in EY2022, bringing the total installed charging capacity to nearly 11 MW. However, peak daily demand never exceeded 2,300 kW, or approximately 20% of available capacity. Many fleet operators had not yet received some or all of their vehicles, leading to chargers being underutilized. There may be an opportunity to increase the number of vehicles per charging port in future years to maximize program impacts and reduce vehicle TCO, though chargers will have higher usage as vehicles are received and integrated into fleet operations at higher rates.

In the EV Fleet program to date, only four of 41 observed sites exhibited the use of load management, shown by sharp increases in load beginning after 9 PM, when the highest cost period ends. During EY2022, between 23% and 29% of all fleet charging took place between 4 PM and 9 PM on a monthly basis, resulting in negative impacts on operational costs and grid congestion. About 30% of non–school bus fleet charging sessions also have enough flexibility to avoid charging during the highest-cost period, which will improve TCO for fleet operations, reduce grid impacts, and reduce emissions from vehicle charging.

Not all EVSPs offer load management programs, and utility bills may not be made available to fleet operators to understand the cost impacts of time of use. During site visits, many fleet operators reported it being the first time they had seen their own usage information, and almost every operator had a disconnect between what they expected the electricity to cost versus actual historical costs. However, most fleet operators are aware of time-of-use pricing, regardless of not knowing their own usage trends and costs. Successful load management occurred when the EVSP was financially responsible for its application.

> **Recommendation: PG&E should review current processes around communicating load management to ensure customers are maximizing monetary and emissions savings.**

The Evaluation Team identified several challenges to the implementation of load management in this report related to awareness, operational constraints, knowledge of rate structure, and organizational capacity. Following site energization, PG&E should review customer usage data over six to 12 months of operations and follow up with sites that exhibit opportunities for better load management. The Evaluation Team's interactive dashboard (a PG&E-facing tool not publicly accessible) provides key metrics on customer load management performance that can be leveraged to highlight site-level charging behavior and opportunities for monetary and emissions savings.

There was general consensus among market experts that the EV market share for transit bus and delivery vehicles will increase over time, but that Utility programs are critical to meet deployment targets.

The market forecast for electric transit bus market share in California aligns with ICT requirements through 2025 but falls short of 100% by 2030. The increased availability of funding is expected to be the primary driver for transportation agencies to meet purchase requirements. Experts forecasted the electric delivery vehicle market share to fall short of ACF sales requirements in 2025, driven by high infrastructure costs, battery market competition, and product availability. EVSPs and fleet operators both identified Utility incentives as a key mechanism to reduce the barrier to electrification presented by high EV costs and the high cost of installing EV charging infrastructure.

4.2. *Schools and Parks Pilots*

4.2.1. Overview

This overview provides a detailed description of the PG&E Schools and Parks Pilots as well as summaries of the Pilots' implementation process, performance metrics, program materials and budget summary, and a major milestone timeline. Following the overview, the Evaluation Team presents the EY2022 findings and lessons learned.

Pilot Description

Schools Pilot: Through its Schools Pilot, PG&E has offered the direct installation of and incentives for installing six L2 charging ports at K–12 schools within its service territory. The Pilot is designed to offer L2 charging infrastructure at schools and educational facilities in support of California's electrification goals. In the original Decision 19-11-017, PG&E projected to install these chargers across 22 sites. While PG&E will build and maintain the EV service connection and supply infrastructure for all sites, the equipment can be owned by either PG&E or the site host. Where PG&E owns the equipment, the site works with a pre-approved EVSP to help manage equipment operations. Where the site host chooses to own the equipment, they receive a rebate of up to $11,500 (L2 single) or $15,500 (L2 dual) for the charger purchase. In all cases, the site host must enroll in a time-of-use (TOU) rate. PG&E also provides educational materials to promote awareness of the newly installed EVSE and benefits of EVs, available to all schools in PG&E's service area.

Schools Pilot Targets

- 4 or 6 L2 charging ports at each site
- 22 schools
- 40% in DAC locations

Schools Pilot Design Goal

Offer L2 charging infrastructure at schools and educational facilities.

Parks Pilot: Through its Parks Pilot, PG&E offers the direct installation of L2 chargers and DCFC in state parks and beaches within its service territory. Staff designed the Pilot to install new chargers that enable state parks and beaches to charge the EVs in their own fleet in addition to staff and patron LDVs. In Decision 19-11-017, PG&E projected two standard site designs: one with four L2 charging ports at three locations and one with two L2 ports and two DCFC ports at two locations. Per the Decision, PG&E expected to offer off-grid charging at five sites that have sufficient capacity to support charging but where upgrading the existing electric infrastructure would be cost-prohibitive given the distance from electric infrastructure. For all sites, PG&E is the owner of the chargers, but will contract with the customer of record to maintain the equipment and manage the charger electricity costs. In addition to chargers, PG&E will post educational signs around the chargers to raise awareness among park and beach patrons of being able to charge at more state park and beach locations across the state.

Parks Pilot Targets

- 40 L2 and 3 DCFC charging ports
- 15 state parks and beaches
- 25% in DAC locations

Parks Pilot Design Goal

Encourage state parks and beaches to charge their own EV fleets and to offer charging to staff and patrons with LDVs.

Implementation

As interested customers become aware of either Pilot—through PG&E marketing efforts, solicitations from EVSPs, word-of-mouth, or directly from a PG&E account manager—they can choose to submit an application as the first step in the implementation process (parks may not submit an application as the first step of their program participation). Figure 105 provides detail on the process of taking a site from application to construction. Note that the Contract Issuance step is slightly different for the Parks Pilot, since the DPR expects to approve a Master Participation Agreement that will apply to all state parks in PG&E service territory participating in the Parks Pilot. Each individual site will have site addendums to the master agreement based on specific site needs and designs.

Figure 105. PG&E Schools and Parks Pilot Implementation Process

APPLICATION RECEIVED

1. *PG&E reviews site for initial program viability*
2. *PG&E sends informational program materials*

IN-DEPTH VALIDITY REVIEW

1. *PG&E Project Delivery team conducts desktop review*
2. *PG&E program team decides whether to move site forward in process*
3. *If favorable site validity review outcome, PG&E requests initial meeting with customer*

PRELIMINARY SITE DESIGN

1. *PG&E coordinates with engineering contractor to schedule site walk with customer*
2. *Engineering contractor drafts preliminary design*
3. *PG&E conducts internal stakeholder meeting to determine if site should move forward in program*

CONTRACT ISSUANCE

1. *If favorable internal stakeholder meeting, PG&E issues contract and preliminary site design to customer*
2. *Parties sign contract and site moves to PG&E's Project Delivery team*

SITE DESIGN

1. *Project Delivery team oversees design contractor throughout final design process*

PRECONSTRUCTION

1. *Design contractor works with Project Delivery team and customer to apply for TTM and BTM permits*
2. *PG&E and customer execute easement*
3. *PG&E orders long-lead material*

CONSTRUCTION

1. *PG&E and construction contractor host preconstruction meeting*
2. *Contractor breaks ground on site*

Program Performance Metrics

The EY2022 data included the number of sites for the Schools Pilot, location of sites, DAC status of sites, and days by application phase. PG&E did not have any Parks Pilot sites activated or constructed in EY2022. Table 59 provides the count of PG&E Schools Pilot sites by completion status in EY2022 and program to date.

Table 59. PG&E Schools and Parks Pilot Complete Site Count by Status in EY2022

Site Status	EY2022	Program to Date
Utility Construction Complete	1	1
Activated	1	1
Operational	1	1
Closed Out	0	0

Figure 106 shows the site location and DAC status for the one PG&E Schools Pilot site that is activated and operational.

Figure 106. PG&E Schools and Parks Pilot Activated Charging Locations

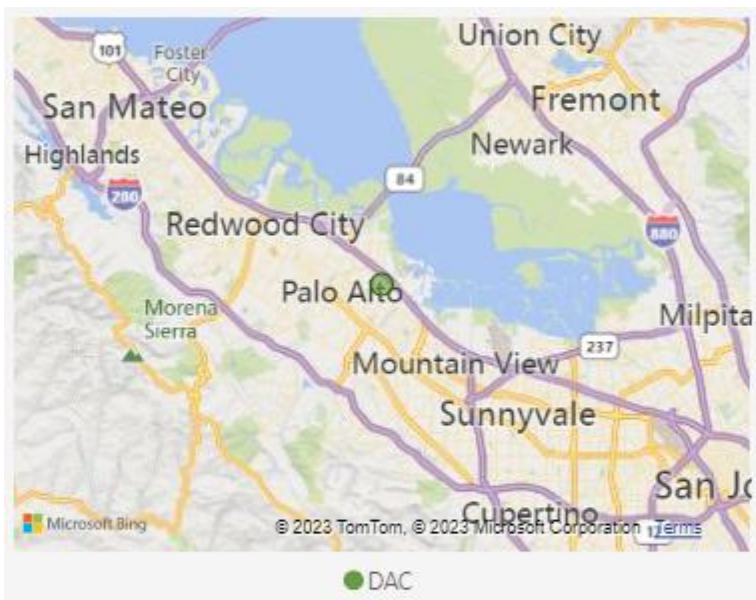


Table 60 presents site-level data for the Schools Pilot, showing DAC activation status and number of chargers for the one activated site in EY2022 and for the program to date. The one activated site has six ports.

Table 60. PG&E Schools Pilot Activated Site Data

Pilot	EY2022			Program to Date		
	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports
Schools	1	0	6	1	0	6
Total	**1**	**0**	**6**	**1**	**0**	**6**

The median number of days by phase for one activated site in the Schools Pilot ranged from 15 days for Activation to 245 days for Construction Complete ().

Table 61).

Table 61. PG&E Schools Pilot Median Number of Days by Phase

Phase Status	EY2022 Number of Days
Application Reviewal	20
Site Assessment	27
Contract Issuance	51
Design and Permitting	111
Construction Complete	245
Activation	15

Program Materials Summary

Schools and Parks Pilots: PG&E staff maintains information about the Pilots on their website (see Figure 107).[89] The website includes several types of relevant information about the two Pilots for prospective site hosts:

- Pilot program summary
- Ownership options and rebates
- Vendor information
- Rebate information
- Criteria for participation
- Partnerships
- Contact information

[89] Information is included in the "Electric Vehicle Programs and Resources" section of PG&E's website: https://www.pge.com/en_US/small-medium-business/energy-alternatives/clean-vehicles/ev-charge-network/electric-vehicle-charging/electric-vehicle-programs-and-resources.page

The webpage also included frequently asked questions from prospective EV users.

Figure 107. PG&E EV Programs Webpage

Schools Pilot: In EY2022 PG&E staff provided information to site host staff about the PG&E Schools Pilot curriculum.

SEI staff also presented information on the Schools Pilot to school administrators and site host decision-makers summarizing the decision, options, rebates, and criteria for participation. Figure 108 shows an example slide from that presentation.

Figure 108. PG&E Schools and Parks Pilot Example Slide from PG&E Staff Presentation

Schools Pilot Curriculum: In EY2021, PG&E staff worked to secure a third-party vendor to design an educational curriculum for the Schools Pilot, awarding the contract to Strategic Energy Innovations (SEI). The curriculum covers topics related to transportation electrification and is meant to build awareness of the benefits of EV adoption. PG&E and SEI staff finalized this curriculum in EY2022 and made it available to all schools in PG&E's service territory, not just those participating in the Schools Pilot. Though PG&E plans on conducting a marketing and awareness push for the curriculum in EY2023, engagement and training started in EY2022. In EY2022, the curriculum was shared with about 110 teachers overall. SEI connected directly with 12 school sites in July and August 2022 to introduce the curriculum and answer any preliminary questions. They also hosted a formal live training on October 20, 2022, which was attended by five representatives from three different participating schools. In addition to the training, SEI can complete instructional support meetings with teachers, and did so for two teachers in November 2022.

The curriculum is structured as a set of lesson plans broken out by clustered grade levels. Table 62 shows the learning objectives of each lesson for each grade level.

Table 62. PG&E Schools and Parks Pilot Curriculum Learning Objectives

Grade(s)	Lesson Title	Learning Objectives
K-2	Moving Around	In this introductory lesson, students learn about the role of transportation in moving around people and goods. Students will explore the connection between transportation and energy and begin to understand that different modes of transportation rely on different amounts and sources of energy. Students will identify and assess different modes of transportation, including different ways of getting to school. This lesson includes an option extension, a game which can be played at any point throughout the unit. Plan for an additional 5-10 minutes with the extension game included.
	Tailpipe Trouble	Students will learn that transportation is a major source of pollution due to ICEs. They will compare emissions from different modes of transportation, identifying cleaner and dirtier options and technologies.
	Pollution Solutions	Students will identify ways to reduce transportation emissions through different habits and through cleaner technologies. Using flashcards, they will explore different sustainable transportation solutions, Then, they will connect available solutions to their daily lives.
	Clean Air Community	In this lesson, students explore relationships between design, the built environment, and modes of transportation. They will identify features needed for decarbonizing the transportation sector, using the campus as a living lab.
3-5	Tailpipe Trouble	Students explore different modes of transportation. They will measure and compare emissions from different modes of transportation, drawing connections between fossil fuels, transportation, and climate change.
	Pollution Solutions	Students identify ways to reduce transportation emissions through different habits, cleaner technologies, and better infrastructure. They will assess various “pollution solutions” and connect these solutions to their daily lives.
	Clean Air Community	Students explore relationships between design, the public spaces, and modes of transportation. They will identify public features that encourage sustainable transportation, using the campus as a living lab.
	Clean Air Champions	Students will learn about making change through advocacy and peer education. They will identify a clean air issue in their campus community and identify a strategy for making change, for example through peer education, outreach, and letter-writing. Students can choose from prompts and or develop their own ideas before championing their initiatives.
6-8	Environmental Impacts of Carbon	Students consider global CO_2 emissions, calculate their personal carbon footprint, and discuss ways to reduce their personal emissions.
	Decarbonizing Transportation	Using their understanding that decreasing carbon is vital, students will learn different types of decarbonized transportation.
	Transportation Equity[a]	Students will make the connection between decarbonized transportation accessibility and equity through exploration of Oakland’s ZEV plan and an alternative fuel map.
	Future Directions	Students will have a chance to review the concepts in the previous lessons and will be able to apply their knowledge to design their own clean air community.
9-12	Transportation & Environment	This lesson will provide an introduction to the transportation sector’s effect on climate, with a focus on passenger vehicles.
	Passenger Vehicles: Clean and Dirty Technology	This lesson will overview how a 4-stroke ICE and a BEV work.
	Transportation Equity	This lesson will explore online tools in order to demonstrate the equity concerns associated with a transition to ZEVs.
	Sustainable Mobility Around the World	This lesson will explore best practices in transitioning to sustainable mobility, using top-performing cities and countries around the world.

Note: These objectives were sourced directly from the Educator Guide Unit Outline.

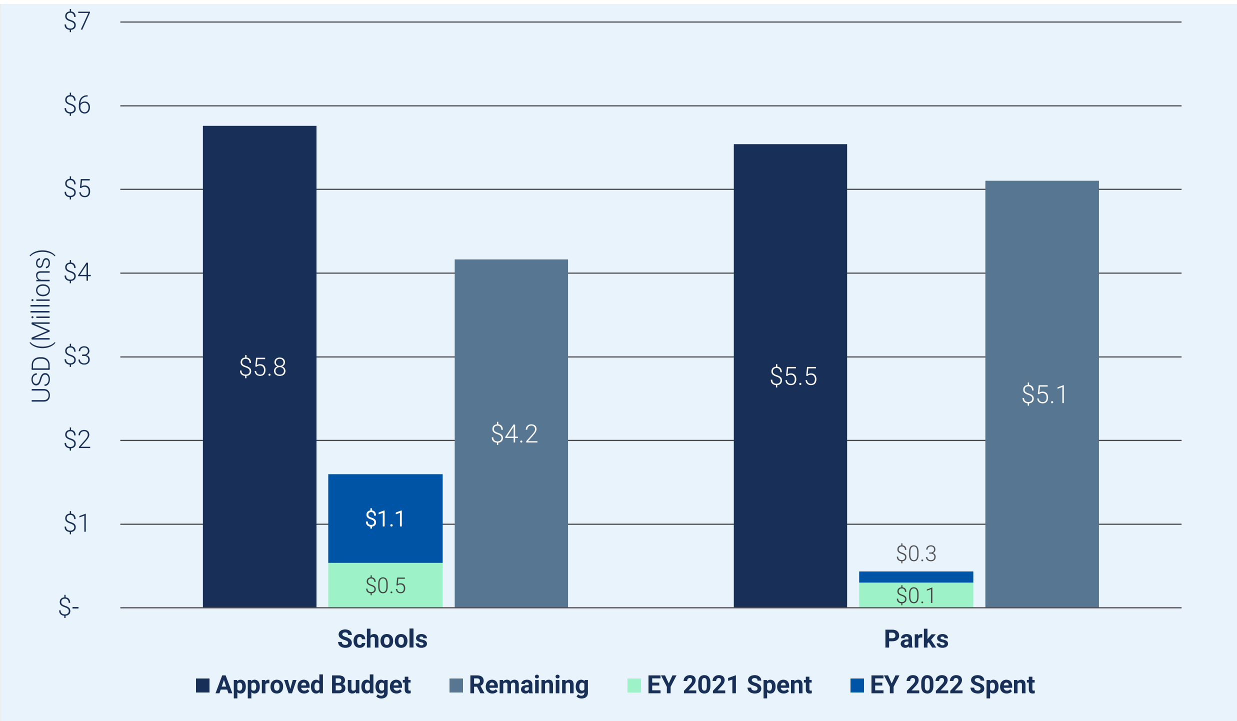
[a] This is an optional lesson and activity.

Parks Pilot: PG&E staff did not develop any specific marketing materials for the Parks Pilot during EY2022, as they focused their efforts on working directly with the California State Parks.

Budget Summary

As shown in Figure 109, from program inception through PG&E spent $1.6 million out of the $5.76 million approved for the Schools Pilot and about $400,000 out of the $5.54 million approved for the Parks Pilot. Schools Pilot spending increased in EY2022 as construction activity increased. Parks Pilot spending decreased compared to EY2021 as PGE&E and the DPR focused on negotiating a Master Participation Agreement.

Figure 109. PG&E Schools and Parks Pilot Budget Remaining versus Spend through EY2022

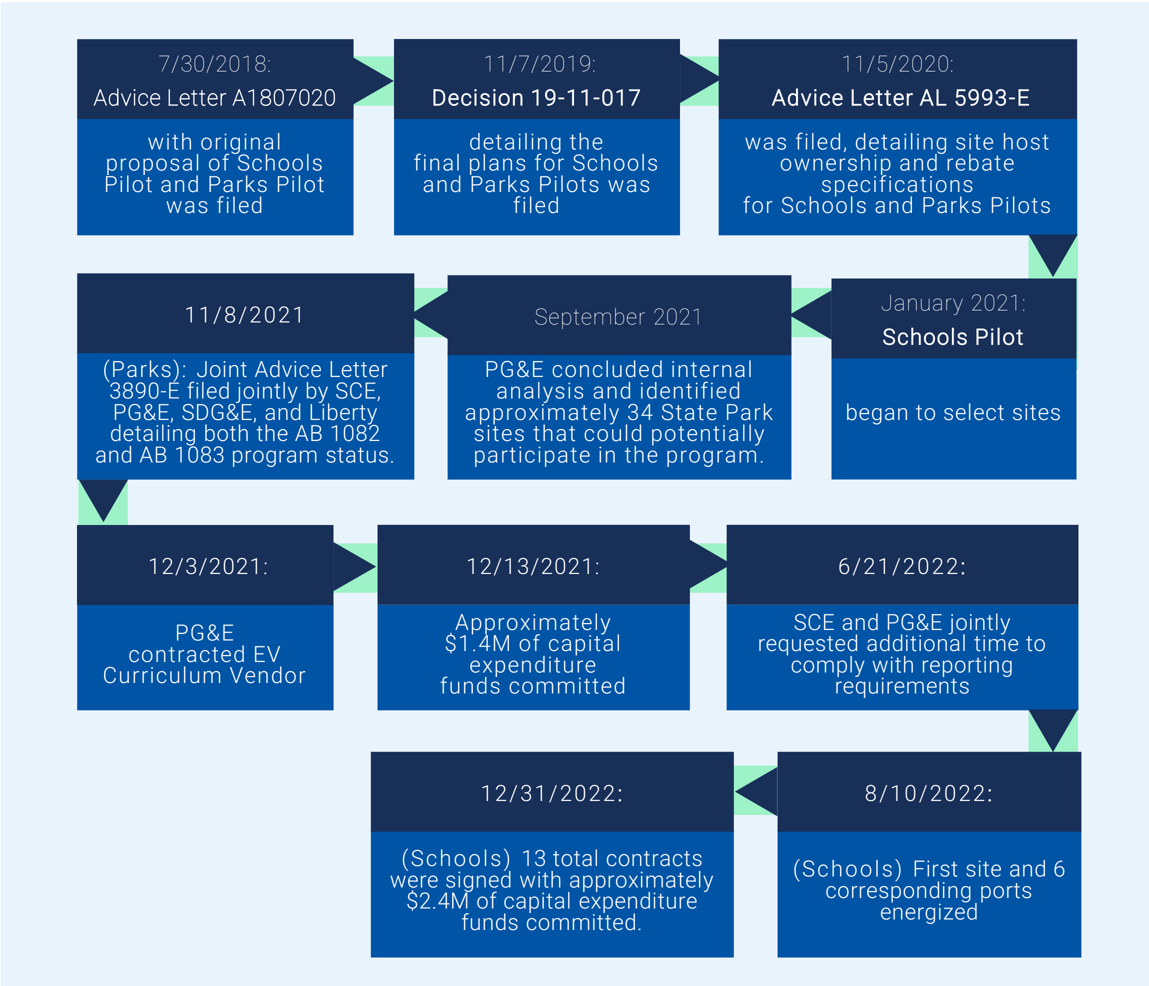


Timeline

On June 21, 2022, PG&E and SCE jointly requested additional time to comply with reporting requirements due to their lack of committed projects. The CPUC denied this request, stating that not having sites or programs was not sufficient justification for an extension, as the Utilities could report on the rationale for the lack of sites instead.

There were no other milestones or advice letters in EY2022, and PG&E staff were focused on communicating with site hosts and personnel at constructing sites. Figure 110 presents key milestones for the PG&E Schools and Parks Pilots.

Figure 110. PG&E Schools and Parks Pilot Timeline of Key Milestones



4.2.2. Findings

As discussed in the *Overview* section, the PG&E Schools Pilot had a single activated site, and the Parks Pilot did not have any sites activated and operational in EY2022. While the Evaluation Team did complete a visual site visit of the single school site during this reporting period, the first round of impacts (including incremental EV adoptions, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, and health impacts) will be completed as part of the EY2023 analysis and reporting. This report provides limited insights based on staff interviews, which are provided below.

Utility Staff Insights

In addition to monthly check-in calls with key PG&E staff to discuss the status of the Schools and Parks Pilots, the Evaluation Team conducted a close-out interview with staff in March 2023 to review overall Pilot challenges and successes in EY2022. In the following section, these challenges and successes are grouped by those that apply to both Pilots, followed by those that only apply to one Pilot.

Schools Pilot and Parks Pilot

In EY2021, staff reported that a common challenge was the expected cost for each site being higher than anticipated. In particular, staff noted that opportunity costs had been trending significantly higher as site costs were higher than anticipated. Staff confirmed that this continued into EY2022, ultimately reducing the number of sites that made it through the desktop review process. Four challenges impacted the Pilots in EY2022:

- **Construction Labor Costs and Supply.** Staff noted that construction labor costs have increased as inflation has risen. In addition, continued from EY2021, it has been difficult to secure a sufficient labor force since COVID-19, and labor costs surrounding trenching and upgrading transformers have increased.
- **Additional Design Considerations.** Site costs increase when aspects of the design need to be added solely to comply with the Americans with Disability Act (ADA).
- **Material Costs.** Most materials are generally more expensive than originally anticipated in 2018 (when the Pilot funding caps were decided).
- **Supply Chain Delays.** Staff confirmed that supply chain delays, which started as a result of COVID-19, continue to be a challenge.

Schools Pilot

In addition to the shared challenges outlined above regarding increased costs, PG&E staff reported one additional Schools Pilot–specific challenge:

- **Seasonal Access.** During EY2022, the preferred timeframe for construction to occur during school breaks caused delays since PG&E had to accommodate school building schedules for when students would generally not be on campus.

PG&E staff also noted concerns over the level of renewed effort it will take to subscribe the rest of their sites, considering the timing of their marketing:

- **Single, Initial Marketing Push.** As planned, PG&E staff conducted one round of marketing during the launch of the Schools Pilot. Though early on the pipeline looked promising to meet participation goals, by the end of EY2022, with further analysis, it became clear that numerous projects in the pipeline were not going to be cost-effective. PG&E staff realized they may have to conduct another marketing push to revitalize interest and support Pilot participation.

In EY2021, PG&E Pilot staff emphasized that a key barrier to participation for the Schools Pilot was the challenges schools were facing with balancing priorities due to the COVID-19 pandemic, when teachers had overwhelming workloads and needed to prioritize student safety. In EY2022, PG&E staff were able to overcome this barrier and move the Schools Pilot forward for several reasons:

- **Long-Term Engagement.** Over the course of implementing the Schools Pilot, PG&E Pilot staff have worked with some schools for over one full calendar year. This kind of long-term engagement poses two benefits:
  - **Expanded Capacity.** Schools are now less burdened with balancing the demands of COVID-19 and can focus more on other initiatives such as the Schools Pilot. PG&E staff said its

longer-term engagement with schools before and after the pandemic started paying off in EY2022, as school staff had newly available capacity and renewed interest in the Pilot.

    - **Customer-Specific Expertise**. At the start of the Pilot, PG&E staff had trouble navigating the complex school decision-making processes. In EY2022, PG&E staff were much more adept at navigating the processes and did not encounter as many delays when dealing with newer school sites.

- **Selected Accessibility.** In EY2021, PG&E staff noted that many K–12 schools were concerned about student safety if chargers are always accessible to the public (even during school hours). Therefore, PG&E staff offered alternative participation options that allowed the schools to keep the chargers limited to private use by faculty, staff, and/or parents (depending on the school's preference). PG&E continued to offer this policy and it was used by newly participating schools in EY2022.

In EY2022, PG&E successfully chose a curriculum vendor, SEI. PG&E worked with SEI to develop the curriculum for K–12 students on topics related to transportation electrification to build awareness of the benefits of EV adoption. The curriculum included lesson plans and activities for students, which are outlined in Table 62. In addition, staff negotiated with SEI to use the curriculum in all schools, not just Pilot participating schools, with a nominal contract. This pre-authorization allowed them to save costs when using the curriculum throughout their entire territory.

Parks Pilot

As noted in the EY2021 report, PG&E had initially intended to sign a collective Utility master agreement with the DPR. With shifts in the approach in EY2022, PG&E staff noted three challenges with implementing the Parks Pilot:

- **Separating State-Level Negotiations.** Though the plan in EY2021 was for all Utilities to enter into a collective participation agreement with DPR, in EY2022, the Utilities ultimately separated their efforts and PG&E started coordinating with DPR's state-level office independently.
- **Staff Turnover.** When the DPR staff transitions occurred, PG&E staff had to re-orient the new staff member on the purpose of the Pilot, all steps completed to date, and next steps needed. Staffing challenges caused PG&E to start from the beginning of the process to address preferences of the new staff.
- **Negotiations between Legal Teams.** After PG&E staff helped orient new DPR staff to the contracting process, the PG&E and DPR legal teams still need to work out the final decisions on which parties assume responsibility for costs, liabilities, and risks. Despite ongoing negotiations in EY2022, PG&E and DPR were unable to come to an agreement. However, Pilot staff are hopeful for a contract agreement in EY2023.

Highlights

- As site construction continued in EY2022, site costs and delays continued to be a challenge for site construction in the Schools Pilot.
- In EY2022, PG&E staff were able to leverage learnings from EY2021 about schools' decision-making process and priorities and it improved the implementation process for both existing participants and newly enrolled participants.
- PG&E successfully developed the Schools Pilot curriculum.
- Though contract negotiations with the DPR were not completed in EY2022, PG&E staff are hopeful for an agreement in EY2023.

4.2.3. Lessons Learned

The Evaluation Team identified a number of lessons learned from EY2022. These lessons, presented with key supporting findings and recommendations, may be applied to future Pilot years and to other similar efforts.

Schools Pilot Only

Unexpected market impacts and site design requirements continue to result in higher-than-expected site costs and create barriers to participation.

PG&E began the Schools and Parks Pilots during the COVID-19 pandemic. COVID-19 had unprecedented economic impacts across nearly every market, driving up costs for materials and labor and disrupting supply chains. These changes were so significant that the estimates PG&E had created for Decision 19-11-017 (which mandated the Schools and Parks Pilots at their determined funding levels) did not reflect the actual costs for implementation. These struggles continued into EY2022 with inflation impacts and were compounded by additional factors that were identified as sites were constructed, such as increased costs from site design aspects that needed to be added solely to comply with the ADA. These elevated costs caused an unexpectedly high number of procedural cost flags to trigger during the application review process, ultimately reducing the number of sites that made it through the desktop review process.

There can be a steep learning curve for implementing this Pilot, as it targets specific customers with nuanced decision-making needs; however, developing a greater understanding of customers dynamics through long-term relationships can help PG&E overcome some of these challenges as the Pilot matures.

In EY2021, Pilot implementation was slower than anticipated as PG&E staff started to learn about the schools' complex decision-making structures. For example, staff learned that approval must often come from the school board (which, in some cases, means the site may be open to scrutiny and public comment) or from specific personnel who may not work at the site. These multiple layers add complication and time to the enrollment and implementation processes. Though PG&E staff began forming strategies and adaptations to navigate these complex structures in EY2021, the lack of clarity and variability between districts meant that the planning for each project took significantly more time than expected. However, in EY2022, with their growing expertise, PG&E staff were more easily able to maneuver these complex decision-making structures. For example, PG&E staff are better able to anticipate and address concerns (such as for student safety if chargers were accessible to the public) of newly enrolling schools.

Parks Pilot Only

Sufficient time must be built into Pilot implementation planning when anticipating contract negotiations between two or more large organizations.

The plan for the Parks Pilot in EY2021 was for all Utilities to enter into a collective participation agreement with the DPR. However, the PG&E legal team was not comfortable with the terms of the final master agreement that had been drafted for joint use. Therefore, in EY2022, the Utilities ultimately separated their efforts and set out to establish independent agreements with DPR. In part, this need for independent agreements was due to staff turnover, which meant a pause in furthering negotiations while new DPR staff were oriented to the status of the agreement documents. In addition, PG&E and DPR's legal teams in general have had trouble agreeing to terms around responsibilities for certain costs, liabilities, and risks. However, at the end of EY2022, PG&E Pilot staff were hopeful for an agreement to be developed in EY2023 given the progress that was completed.

4.3. *EV Fast Charge Program*

4.3.1. Overview

This overview provides a detailed description of the PG&E EV Fast Charge program and summaries of the program implementation process, program performance metrics, program materials and budget summary, and a major milestone timeline. Following the overview, the Evaluation Team presents the EY2022 findings and lessons learned.

Program Description

Per Decision 18-05-040, PG&E staff designed the EV Fast Charge program to support the installation of DCFCs at high-priority locations to encourage transportation electrification and minimize grid impacts. Staff designed the program to support PG&E customers, and EV drivers in general, by providing fast charging make-ready infrastructure, ultimately accelerating the adoption of EVs. Specifically, staff designed the program to help meet a portion of PG&E's estimated need for fast chargers in its service area by 2025, reduce driver range anxiety, and increase access to charging for all customers, especially those lacking ready access to home charging, those who need charging stations in transportation corridors for longer trips, or those who participate in ridesharing. In EY2022, PG&E staff revised the original goal of 52 sites to target 30-40 EV Fast Charge sites to reflect the rising costs per site and revised the port count forecast to be between 156 and 200.. PG&E staff met with the CPUC Energy Division in February of 2022 to discuss the revision which was accepted.

EV Fast Charge Targets

- 30-40 sites
- 25% in DAC locations

Through the program, PG&E provides turnkey make-ready EVSE. This make-ready buildout includes design, permitting, construction, and installation of all electric infrastructure from the Utility connection point to the charger stub. PG&E owns and maintains the infrastructure on the Utility side of the customer meter (electrical infrastructure to the meter panel), also known as TTM infrastructure. PG&E also designs, constructs, installs, owns, and maintains the customer side of the meter infrastructure (electrical infrastructure from the panel to the EV charging interconnection point), also known as BTM infrastructure. PG&E will not install, own, or maintain the DCFCs. In addition, the program design provides multiple business models and flexibility for site hosts and operators: PG&E's customer of record at fast charge sites may be the site host, an EVSP, or another third party. To be eligible for the program, a site must be available 24x7 and install chargers with a minimum output of 50 kW. Customers must cover the cost of the charger, installation, and all ongoing O&M related to the charger for a minimum of five years from the time of activation. Finally, to encourage equitable EVSE installation, sites located in DACs are also eligible for a rebate of up to $25,000 for EVSE.

EV Fast Charge Design Goal
Support installation of DCFCs at high-priority locations.

Implementation

Since the first EVSP request for qualifications in July 2019, there have been a total of 17 qualifying EVSPs, with vendors submitting a program application for 10 of those EVSPs. After the first site solicitation in August 2019, there were three more solicitations through July 2021, for a total of four solicitations. There were no additional solicitations in EY2022.

PG&E uses of an online application platform to facilitate the selection process. The application portal requests detailed information about the site, the site host, and the EVSE owner. The information in the application allows PG&E to verify basic eligibility requirements, apply initial scoring of the site against the program's scorecard, and start infrastructure assessments. As part of the eligibility screening process, PG&E staff conducted a phone screen with each potential site host. Staff refined the phone screening process over the course of implementing the program, such as by adding questions or making sure site host decision-makers were included in the call (not just a potential contact at the actual site).

Example Screening Questions

- "Do you understand what the program is and what it will—and will not—provide?"
- "Who is getting the Low Carbon Fuel Standard credits?"
- "Which stakeholders will need to review the contract? Have they been engaged?"
- "How long will it take to sign the contract?"

New in EY2022, PG&E provided the opportunity for site hosts to contribute funding to their sites if the project exceeded PG&E's funding limits.

After an EVSP engages with a potential customer, the implementation process begins, as detailed in Figure 111.

Figure 111. PG&E EV Fast Charge Program Implementation Process

INITIAL AGREEMENT

1. *EVSP partner applies on behalf of customer via online portal*
2. *Site host submits consent form*
3. *PG&E reviews paper application materials*

APPLICATION AND INITIAL ELIGIBILITY SCREENING

1. *EVSP partner applies on behalf of customer via online portal*
2. *Site host submits consent form*
3. *PG&E reviews paper application materials*

DETAILED ELIGIBILITY SCREENING

1. *PG&E scores the eligibility of each project on a standard scorecard*
2. *PG&E, property owner, site host decision-maker, and EVSP partner join screening call to discuss additional details*
3. *PG&E selects the top sites to move forward in the program*

SITE WALK AND DESIGN

1. *PG&E conducts site walk*
2. *PG&E determines if the site can be completed within the budget cap*
3. *PG&E completes project preliminary design*
4. *Site host reviews and approves preliminary design*

CONTRACTING

1. *PG&E issues contract*
2. *Site host reviews and commits to contract*
3. *PG&E finalizes site design*

CONSTRUCTION AND ACTIVATION

Program Performance Metrics

The EY2022 data included the number of sites for the EV Fast Charge program, location of sites, DAC status of sites, and days by application phase. Five sites were activated in EY2022, for a total of nine active sites in the program. Table 63 provides the count of PG&E EV Fast Charge program sites by completion status in EY2022 and program to date.

Table 63. PG&E EV Fast Charge Program Complete Site Count by Status

Site Status	EY2022	Program To Date
Utility Construction Complete	8	12
Activated	5	9
Operational	5	9
Closed Out	2	6

Note: For different site status categories site counts reported for EY2022 may include sites from EY2021. For example, a site activated in EY2022 could have been reported as construction completed in the EY2021 Evaluation Report.

Figure 112 shows the locations of EY2022 five activated and operational EV Fast Charge stations in PG&E territory broken out by DAC status. Two sites are inside DACs while three sites are outside DACs.

Figure 112. PG&E EV Fast Charge Program EY2022 Site Locations

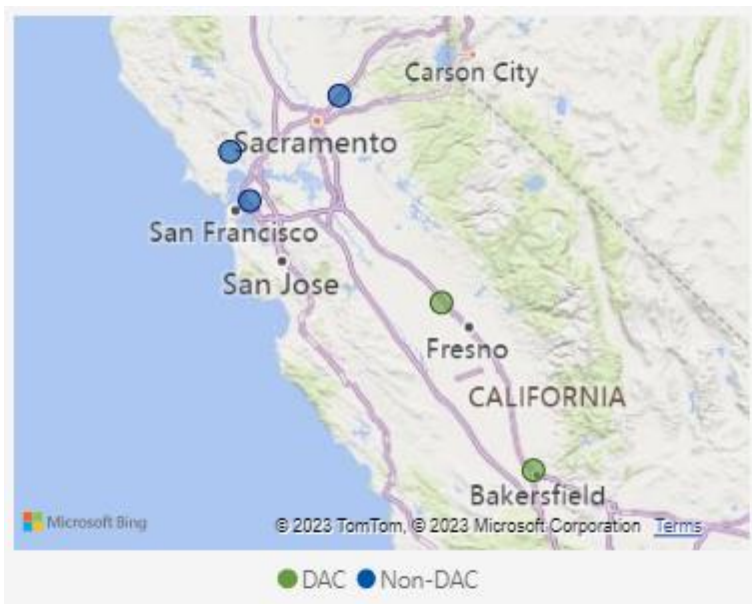


Table 64 presents site-level data for the EV Fast Charge program, showing DAC activation status and number of chargers for the five activated site in EY2022 and program to date. The number of ports ranges from four to seven per site, with a total of 23 ports activated in EY2022 and 39 ports activated program to date.

Table 64. PG&E EV Fast Charge Program Activated Site Data

Program	EY2022			Program to Date		
	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports
EV Fast Charge	2	3	23	5	4	39
Total	**2**	**3**	**23**	**5**	**4**	**39**

The number of days for application reviewal, site assessment, and contractor issuance phases were reduced in EY2022 compared EY2021, while the number of days for design and permitting, construction completion, and activation increased.

Table 65 shows the median number of days by phase for EY2021 and EY2022. Cycle times for different phases changed between the years for a variety of reasons, including the number of applications received and some process changes in the site selection process. PG&E distribution engineers were added to the site assessment phase in EY2021 to check site designs, which impacted cycle times for projects completed in EY2022.

The contract issuance phase was shorter in EY2022 as customers were encouraged to review the contract earlier in the process. There was an additional change in the calculation for median number of days for the design and permitting phase compared to the construction phase which resulted in a more accurate representation of the breakout between those two phases (numbers presented in Table 65 differ from the ones in the EY2021 Report, shown in parentheses in Table 65).

Table 65. PG&E EV Fast Charge Program Median Number of Days by Phase

Phase Status	EY2021 Median Number of Days	EY2022 Median Number of Days	Program-to-Date Number of Days
Application Reviewal	43 (59)	84	84
Site Assessment	58 (42)	63	63
Contract Issuance	104 (105)	32	89
Design and Permitting	260 (154)	416	311
Construction Complete	51 (149)	49	49
Activation	8 (8)	85	29

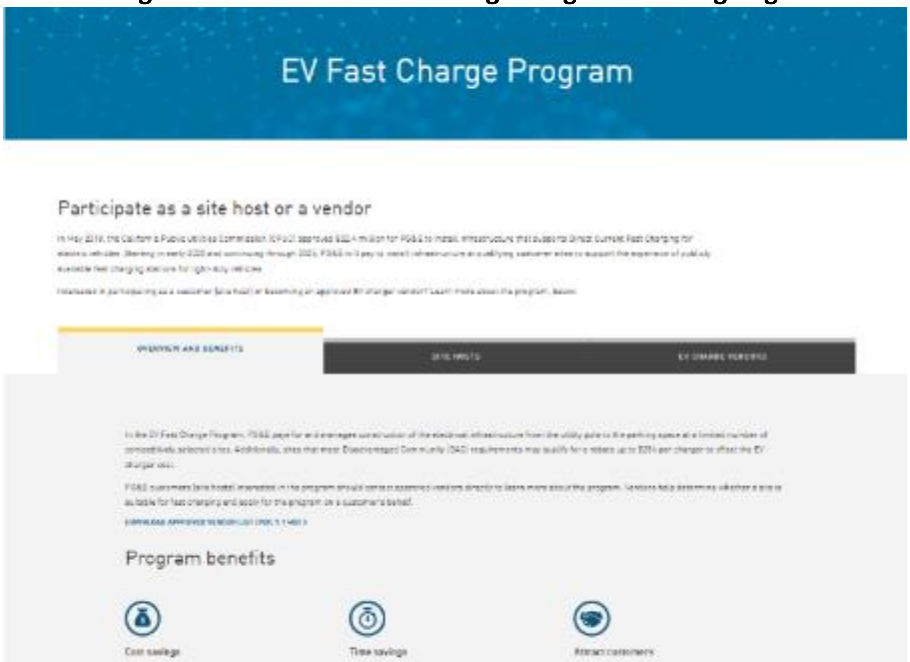
Program Materials Summary

In EY2022, PG&E staff maintained a webpage outlining details of the EV Fast Charge program.[90] The webpage provides a program overview, information for site hosts, and information for vendors. PG&E staff tracked key activities related to the EV Fast Charge webpage in EY2022: there were 5,522 page views, 4,801 site visits, and 3,828 unique visitors.

Figure 113 shows the webpage and details related to the program overview and benefits for site hosts and vendors. The site includes frequently asked questions about program participation, costs and ownership, and the application process.

90 Pacific Gas and Electric Company. 2023. "EV Fast Charge Program." https://www.pge.com/en_US/large-business/solar-and-vehicles/clean-vehicles/ev-charge-network/ev-fast-charge.page

Figure 113. PG&E EV Fast Charge Program Landing Page

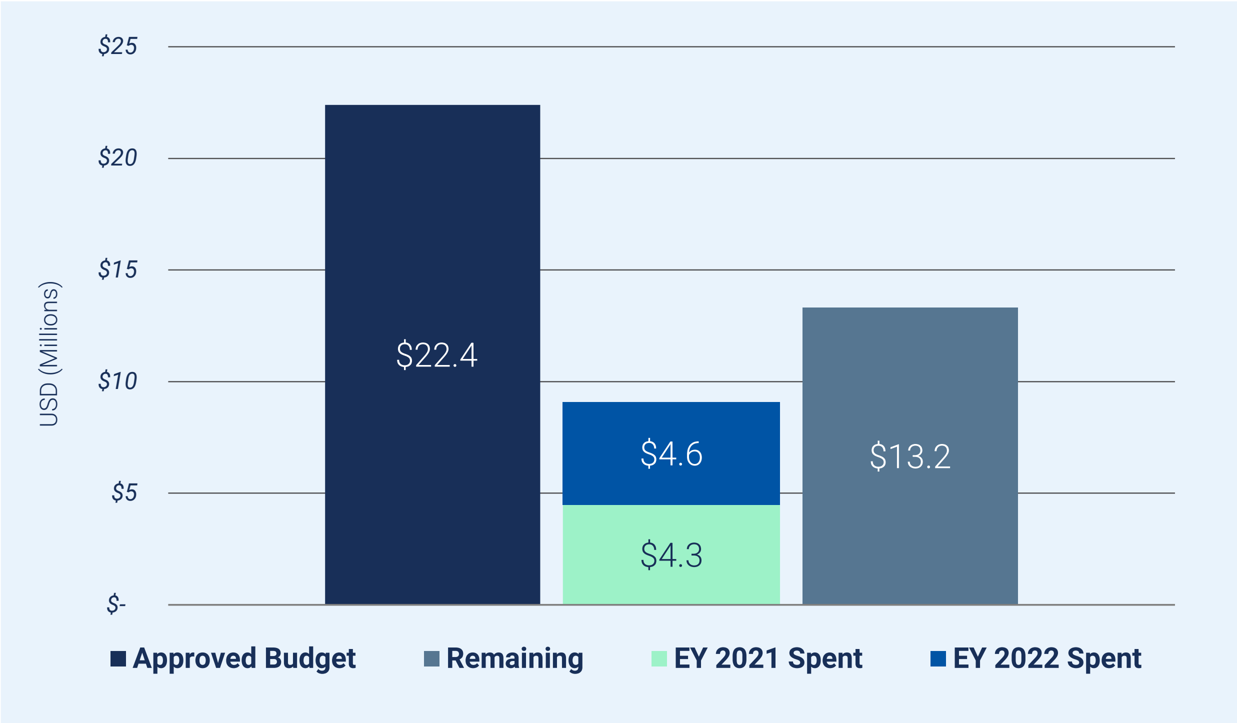


Also available on the website, staff maintained several different types of ME&O materials, created in EY2021, aimed at both potential site hosts and EVSP partners. For EVSP partners in particular, PG&E EV Fast Charge staff developed summaries for each solicitation with key information and an onboarding presentation with program details. Several items were available to both site hosts and EVSPs: information sheets about the program, approved products, and an application prep sheet.

Budget Summary

As shown in Figure 114, from program inception through PG&E spent $8.9 million out of $22.4 million of the EV Fast Charge program budget. Program spending was $4.3 million in EY2021 and $4.6 million in EY2022.

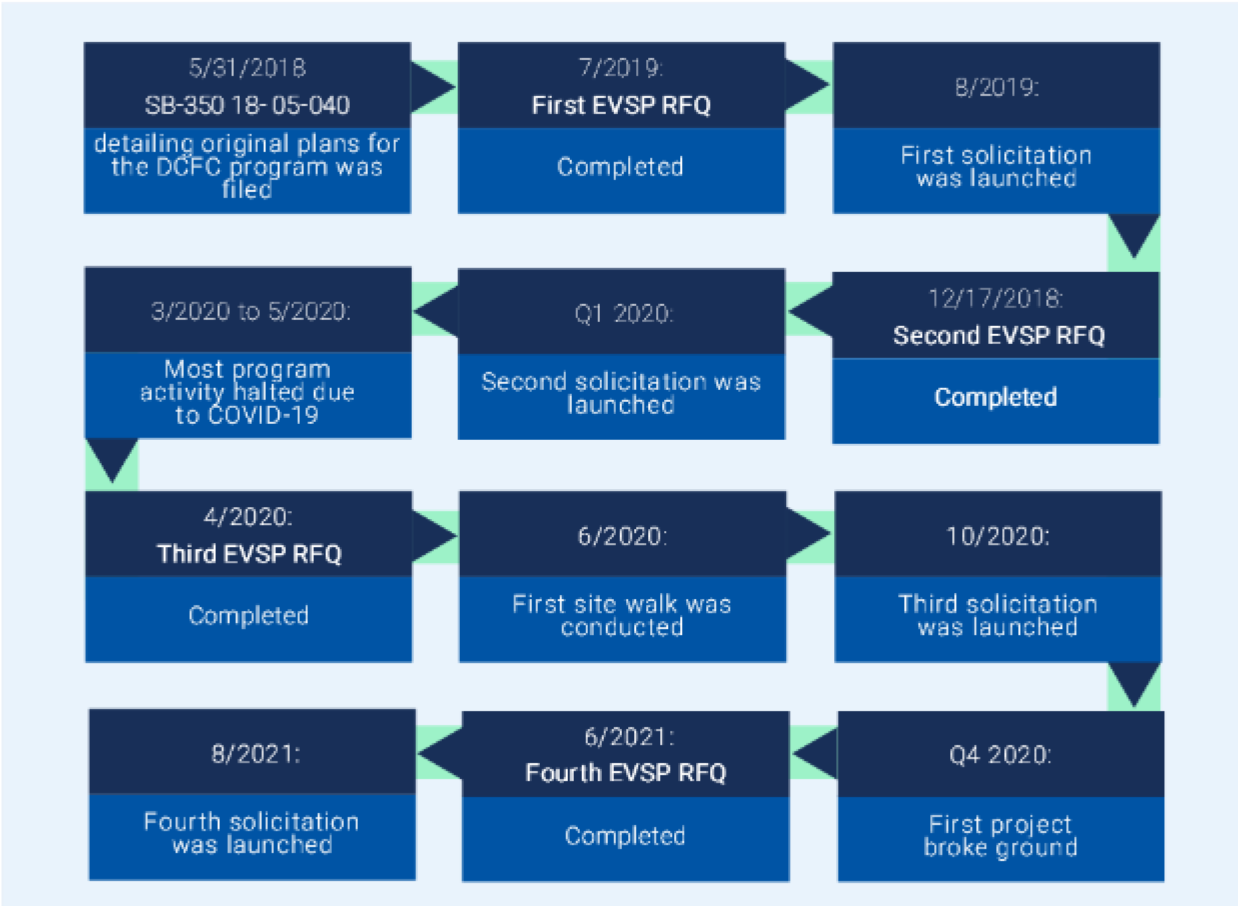
Figure 114. PG&E EV Fast Charge Program Budget Remaining versus Spending through EY2022



Timeline

In EY2022, the EV Fast Charge program was under full implementation and did not have any notable formal milestones such as Advice Letters. Program staff were focused on acquiring interested site hosts and constructing sites. This involved site evaluations, issuance of contracts, developing new cost contribution methods from site hosts and reassigning EVSPs. Program staff had established their selection of sites before EY2022 and did not need to spend additional funding on request for qualifications/site solicitations. Figure 115 illustrates key program milestones from the inception to end of 2022.

Figure 115. PG&E EV Fast Charge Program Timeline of Key Milestones



4.3.2. Findings

The following section provides findings from analyses of incremental EV adoptions, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health impacts, TCO and from insights from Utility staff interviews.

Table 66 summarizes key impact parameters for EY2022 as well as the program-to-date. Annual estimates of impacts are provided for metrics calculated as part of the impact evaluation. Additionally, the table provides estimates of impacts across all sites included in the program population through the end of EY2022.[91]

91 For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

Table 66. PG&E EV Fast Charge Program Impacts Summary

Impact Parameter	EY2021 [a]	EY2022 [a]	EY2022 Percentage in DAC	Program-to-Date Actuals	Program-to-Date Actuals Percentage in DAC
Population of Activated Sites (#)	4	5	40%	9	56%
Sites Included in Analysis (#)	4	5	40%	9	56%
Charging Ports Installed (#)	16	23	35%	39	51%
Electric Energy Consumption (MWh)			7%		48%
Petroleum Displacement (GGE)	7,319	20,384	7%	21,055	49%
GHG Emissions Reduction (MT GHG) [b]	50	157	7%	153	49%
PM_{10} Reduction (kg)	0.27	0.80	7%	0.79	48%
$PM_{2.5}$ Reduction (kg)	0.24	0.74	7%	0.73	48%
ROG Reduction (kg)	4.7	12.7	7%	13.6	50%
CO Reduction (kg)	149	423	7%	441	49%

[a] Energy consumption, petroleum displacement, emissions reductions, and health benefits are based on annualized data. Program to date results in table are based on actual data (see the *Methodology* section for more details).
[b] GHGs include CO_2, CH_4, and N_2O multiplied by their respective GWP as defined by IPCC AR5 (see the *Methodology* section for more details).

Incremental EVs Adoption

The Evaluation Team estimated the effect of the public charging stations on EV adoption for neighboring populations[92] with a two-stage analysis: (1) historical analysis of public EV charging impacts on vehicle ownership and (2) analysis of ownership attributable to PG&E EV Fast Charge program investments. See the *Methodology* section for the details of Stage 1 analysis.

Using the impact estimates from the Stage 1 analysis, the Evaluation Team estimated the impact of PG&E investments in public charging on EV ownership. By the end of 2022, nine charging stations in PG&E's EV Fast Charge program were activated and operational. The Evaluation Team estimated the

---

92 There are two main channels through which the availability of public charging networks may affect EV purchases. The first is a network effect, through which EV owners gain increased access to the public charging stations because of the stations' placement at destinations such as workplaces, commercial establishments, schools, and parks. The availability of EV charging equipment at convenient locations (for midday charging away from home) is expected to increase the convenience of owning an EV (such as lessening range anxiety) and to increase the probability of EV ownership. The second channel is a neighborhood effect on the driving population living in areas neighboring the public EV charging stations. The availability of nearby charging infrastructure is expected to lower the cost of EV ownership by providing alternatives to home charging. It is expected that public EV charging will have the biggest impact on residents of multifamily buildings, many of whom will have limited access to EV charging equipment, or on low-income households, who may be unable to afford home EV charging equipment. We note that public charging access may lift EV ownership through both channels and that there may be positive interactive effects between the channels that lift the overall impact of public charging networks. The Evaluation Team focused on analyzing the second channel. We will analyze the impacts for the first channel separately when data become available.

impact of these stations on annual EV registrations in EY2022 as well as on program-to-date cumulative EV registrations.

Based on the composite measure of public charging access, the Evaluation Team calculated the change in access to public charging due to PG&E's investments for each census block group (CBG) where access was affected by the investments. As shown in Table 67, the program-to-date average change in access per affected CBG was 2.0, and the average increase in number of chargers (ports) was 1.3. For reference, the average change in access across all CBGs in California was 0.57 between 2015 and 2020. The average normalized EV annual registration per 1,000 households was 52.2 in the affected CBGs in 2020.

Table 67. PG&E EV Fast Charge Program Summary Statistics of Effects on CBGs

	CBG Mean (Standard Deviation)			
	Change in Composite Measure of Access	Change in Number of Chargers	Normalized Annual EV Registrations	Number of Households
EV Fast Charge program	2.01	1.33	52.05	448.70
	(3.15)	(1.93)	(57.36)	(318.92)
CBGs (N)	21	21	21	21

Notes: The values are averages for the CBGs whose access to public charging was affected by PG&E's investments. The changes are measured between 2020 and EY2022. The normalized EV registration are average annual values in the affected CBGs in 2020. The number of households are based on 2015–2019 American Community Survey (ACS). Sample standard deviations are in parentheses.

The Evaluation Team combined the OLS and Instrumental Variable 2-Stage Least Squares (IV-2SLS) regression estimates of the impact of public charging access from Stage 1 with the estimates of the CBG changes in public charging access and household counts to calculate the impact of PG&E'S EV Fast Charge investment on neighboring EV ownership.[93] The impacts of PG&E's investments in fast charging on EV registrations depends on how much the investments increased access in affected CBGs and the number of households in the CBGs.

Table 68 presents the estimates of annual and program-to-date EV registrations attributable to PG&E'S EV Fast Charge program investments.[94] Based on the OLS long differences model, PG&E's investments in the EV Fast Charge program stations increased EY2022 annual EV registrations by 0.4 vehicles and program-to-date cumulative EV registrations by 0.7 vehicles. Based on the IV-2SLS long differences model, PG&E's investments increased EY2022 annual EV registrations by 1.7 vehicles and program-to-date cumulative EV registrations by 2.5 vehicles. The IV-2SLS-based estimates are preferred because they account for the potential endogenous siting decisions of public charging (as public charging

---

93 In Stage 1 the Evaluation Team estimated the impact of public EV charging access on EV ownership. Stage 2 built on the Stage 1 analysis and was an attribution analysis for Utility specific investments. A notable benefit of this approach is that it can be applied to evaluations of other programs increasing EV charging access as well, which ensures methodological consistency.

94 The long differences model estimates indicate the impact of public charging on EV registration over five years. The Evaluation Team divided these estimates by five to annualize them.

infrastructure may be built in locations with expected low or high rates of EV adoption). These estimates assumed that the nine activated EV Fast Charge sites operate for a whole year.

Table 68. PG&E EV Fast Charge Program Registrations Attribution

	EY2022 Annual Increase of EV Registrations Caused by the Utility Program		Program-to-Date Cumulative Increase of EV Registrations Caused by the Utility Program	
	OLS	IV-2SLS	OLS	IV-2SLS
Fast Charge Program	0.37	1.70	0.73	2.49
	(0.08)	(0.38)	(0.13)	(0.60)

The table shows the EV registrations attributable to the utility investments in public charging infrastructure. The left panel shows the impacts of utility investments since 2020 on registrations in EY2022. The right panel shows the cumulative impacts of utility investments since 2020 on EV registrations in EY2021 and EY2022. The Evaluation Team based these estimates on the OLS and IV-2SLS long differences models. The Evaluation Team estimated the OLS long differences model using data for all CBGs in the analysis sample. We estimated the IV-2SLS long differences model for CBGs in the 20 largest California cities. The long differences estimates are five-year estimates, which the Evaluation Team divided by five to annualize. For each affected CBG, the Evaluation Team calculated the increase in annual registrations as the product of the regression-based access coefficient divided by five, multiplied by the change in composite public charging access from utility investments (between baseline 2020 and EY2022), multiplied by the number of CBG households (in thousands). Robust standard errors clustered at the block group level are in parentheses.

Both estimated EY2022 and program-to-date cumulative impacts of the EV Fast Charge program on EV registrations are small. Across all 21 affected CBGs, the total annual number of EV registrations is about 1,092 (21 * 52), so the EY2022 impact of the EV Fast Charge program, based on the preferred IV-2SLS regression estimate, lifts EV registrations by less than 0.2%, and program-to-date impact lifts EV registrations by less than 0.3%. The small, estimated impact of the EV Fast Charge program is likely attributable to the fact that many of the PG&E EV Fast Charging stations located along highway corridors and therefore in areas with few households. Of the 88 affected census blocks, 57 had no households according to the U.S. Census.

Highlights

- The EV Fast Charge program increased EV adoption for households neighboring the infrastructure (2.5 EVs in2022).
- While the EV Fast Charge program increased neighboring EV adoption, both EY2022 and program-to-date cumulative effects were small relative to baseline registrations.
- The impact of EV Fast Charge program was small likely due to the location of the charging stations in nonresidential areas, resulting in limited impacts for neighboring homes.

Site Visit Findings

The Evaluation Team visited all five EY2022 activated and operational sites, which represented three hardware-network combinations. These charging sites were primarily highway-adjacent gas stations with convenience stores in EY2022, while a few had other dinning and shopping venues nearby. Most of the sites were in locations where there was already DCFC within a few freeway exits, so potential users could choose a different provider based on availability, personal preference, familiarity, and charging fees.

While onsite, the Evaluation Team documented the number of DCFCs, connectors per charger, ADA accessibility, whether the charger was adjacent to (or near) the destination building, charger power, total installed charging power capacity, and transformer size (Table 69). The Evaluation Team also assessed signage, payment mechanisms, and mobile applications.

Table 69. PG&E EV Fast Charge Program Site Summary

Site	DCFC Ports	Connectors per Charger	ADA Accessible	Adjacent to or Near the Destination Building	Charger Power (kW)	Total Installed Charging Power Capacity (kW)
1	4	1 CHAdeMO, 1 CCS	1	Near	50	200
2	7	1 CHAdeMO, 1 CCS	2	Near	50	350
3	4	1 CHAdeMO, 1 CCS	1	Adjacent	62.5 (paired)	250
4	4	1 CHAdeMO, 1 CCS	1	Near	62.5 (paired)	250
5	4[a]	1 CHAdeMO, 1 CCS,	2[b]	Adjacent	100, 350	550

[a] While there are 6 ports at the site that can be powered simultaneously, there are only 4 parking spaces where the vehicles can charge. Two EVSE at the site can power both CCS and CHAdeMO connectors simultaneously but can only reach a single vehicle in the parking stall next to the charger.
[b] While not part of the EV Fast Charge project scope, an existing L2 charger next to the building was upgraded to a DCFC as a direct result of the program to meet ADA compliance for the site.

As shown in Table 69, each charger site has both a CHAdeMO and CCS connector. One site also has a Tesla connector that was installed previously outside the EV Fast Charge program. Although PG&E has future-proofed each site to accommodate 150 kW per port, to date no sites have required this amount of charging capacity. Based on the Evaluation Team's site visits, the charger capacity ranged from 50 kW to 350 kW per port.

Each site has ADA-accessible chargers, with two sites having chargers that are adjacent to the buildings (rather than just near the buildings). Figure 116 provides an example of an EV Fast Charge site that is adjacent to a building, and Figure 117 shows a site with chargers away from the building. As shown in the figures, chargers away from the building provide greater access to more vehicles at once.

Figure 116. PG&E EV Fast Charge Program Charging Site Adjacent to Building

Figure 117. PG&E EV Fast Charge Program Charging Site Away from Building

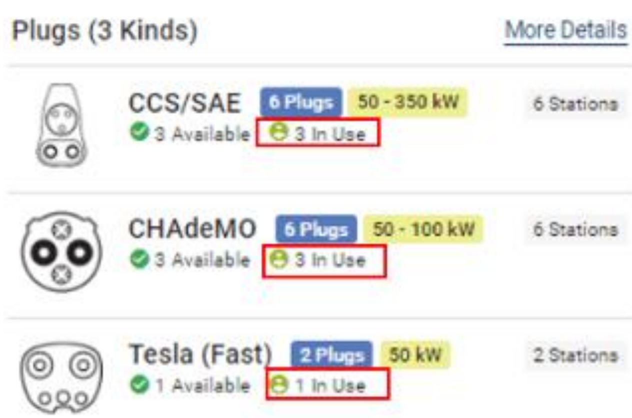
Each site had at least one parking space labeled for EV charging, but there was no other signage including stencils or signposts indicating parking was biased towards EV drivers needing to charge.

While EY2022 was the first year that EV Fast Charge chargers were required to have credit card readers, these readers were not functional at three of the sites (see Figure 118).

Figure 118. PG&E EV Fast Charge Program Examples of Newly Required Credit Card Readers for EY2022

All of the EY2022 sites can be located with multi-brand (such as plugshare.com) and network-specific mobile applications.[95] As shown in Figure 119, these applications offer the real-time status of each charging port and can be used to pay for and initiate a charging session.

Figure 119. PG&E EV Fast Charge Program Live Status of Available Charging Ports and Their Speed (kW)



95 The mobile applications by site are as follows:
Madera, CA ($0.35/kWh): https://www.plugshare.com/location/372222
Rocklin, CA ($0.49/kWh): https://www.plugshare.com/location/480280
Bakersfield, CA (TOU pricing from $0.38/kWh to $0.47/kWh): https://www.plugshare.com/location/320637
Sonoma, CA ($0.35/kWh): https://www.plugshare.com/location/462434
Berkeley, CA (cost is pending membership for 350 kW): https://www.plugshare.com/location/42914

Two of the nine activated sites to date include TOU pricing applicable to public drivers.[96] Figure 120 provides two PG&E EV Fast Charge pricing examples as well as an idle fee example.

Figure 120. PG&E EV Fast Charge Program Examples of Two Time-of-Use Prices and One Site with Idle Fees

Highlights

- Three of the five EY2022 sites visited had four DCFCs while one site had seven DCFC ports. One of the sites with 4 DCFCs allowed 6 ports to charge simultaneously but only 4 parking spaces could reach the chargers. All five sites had CHAdeMO and CCS connectors. All five sites also had at least one ADA-accessible charging spot. The installed charging power capacity per site ranges from 200 kW to 550 kW.
- Sites were primarily gas stations with nearby alternative (competitive) charging within a few-freeway exits.
- PG&E has future-proofed each site to accommodate at least 150 kW per port. Four of five sites made use of chargers with less than 150 kW per port, while one site included some chargers with up to 350kW.
- Sites had charger capacities ranging from 50 kW per port up to 350 kW per port.

Grid Impacts

The Evaluation Team estimated grid impacts for the EV Fast Charge program based on the power consumed by the five operational charging sites installed through the program in EY2022 and 4 sites that

[96] See the entry for Berkeley Whole Foods on the Plugshare website: https://www.plugshare.com/location/42914

were installed in EY2021 combined with charging session data from the EVSPs. Table 33 presents a summary of the estimated EV Fast Charge program grid impacts as an annualized estimate for EY2022 sites, and actual and 10-year forecasts for program to date sites.

Table 70. PG&E EV Fast Charge Program Grid Impacts

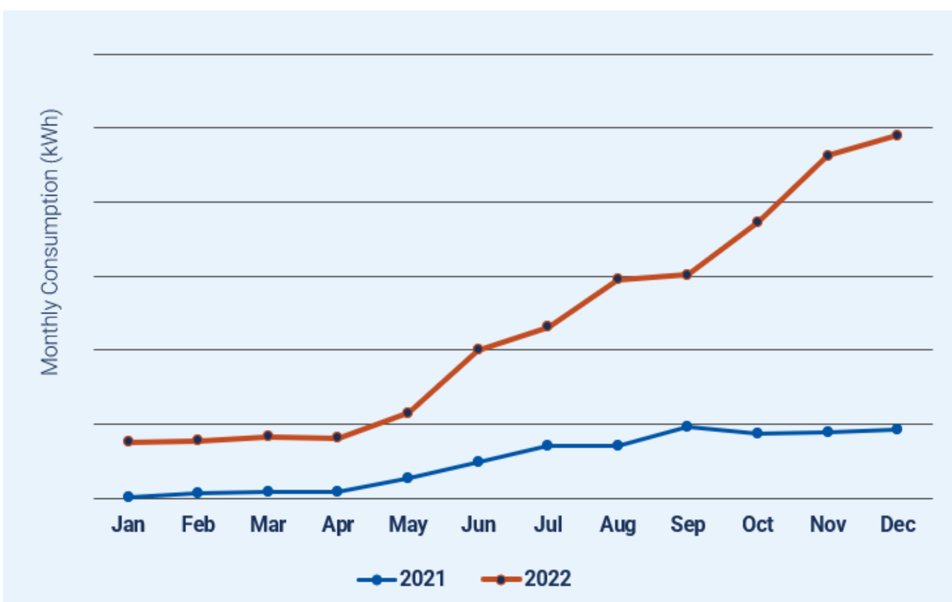
Impact Parameter	CY2022		Program to Date	
	Actual EY2021 + EY2022	Annualized EY2022	Actual PTD	10-Year Projection PTD
Operational Sites	9	5	9	9
Electric Energy Consumption, MWh	[redacted]			
On-Peak MWh (4 PM to 9 PM) (and % of total)	[redacted] (32.0%)	[redacted] (32.1%)	[redacted] (32.5%)	[redacted] (31.2%)
Maximum Demand, kW (with date and time)	[redacted]			
Maximum On-Peak Demand, kW (with date and time)				

Note: values for population of less than 15 sites are redacted

The remainder of this section provides findings on actual (not annualized) program to date monthly kWh usage from charging, daily consumption and maximum demand, average hourly demand, program load, and frequency of charging session.

Figure 121 shows total monthly electricity consumption for EV Fast Charge program to date sites. Consumption steadily increased throughout 2022 as new project sites became operational and sites activated in EY2021 had higher utilization.

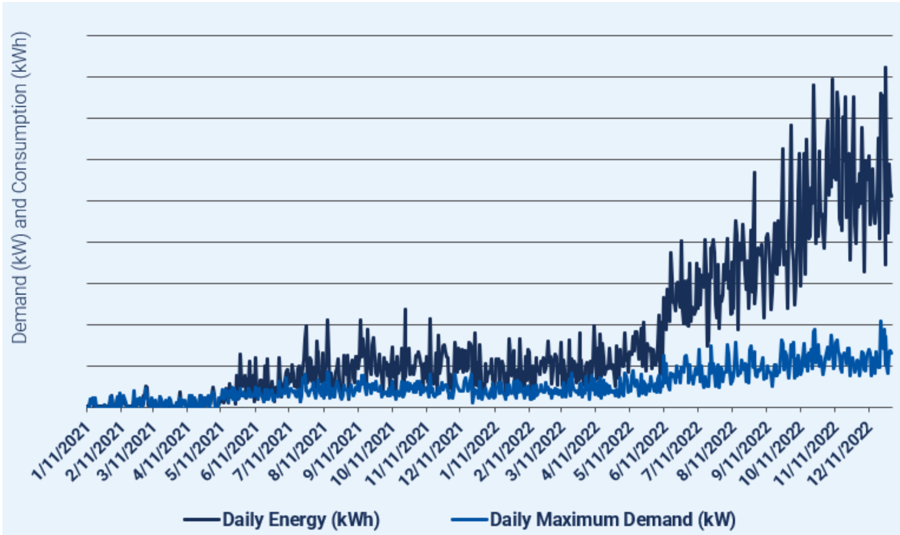
Figure 121. PG&E EV Fast Charge Program Monthly Consumption, Program-to-Date Sites



Note: Y-axis labels are hidden due to fewer than 15 sites

Figure 122 shows the highest daily consumption of all sites program to date occurred on December 26, far exceeding consumption in 2021. The higher consumption in 2022 reflects a combination of a greater number of operational sites and EY2021 sites that were being used more frequently. The nine activated sites reached a maximum demand on December 21, 2022.

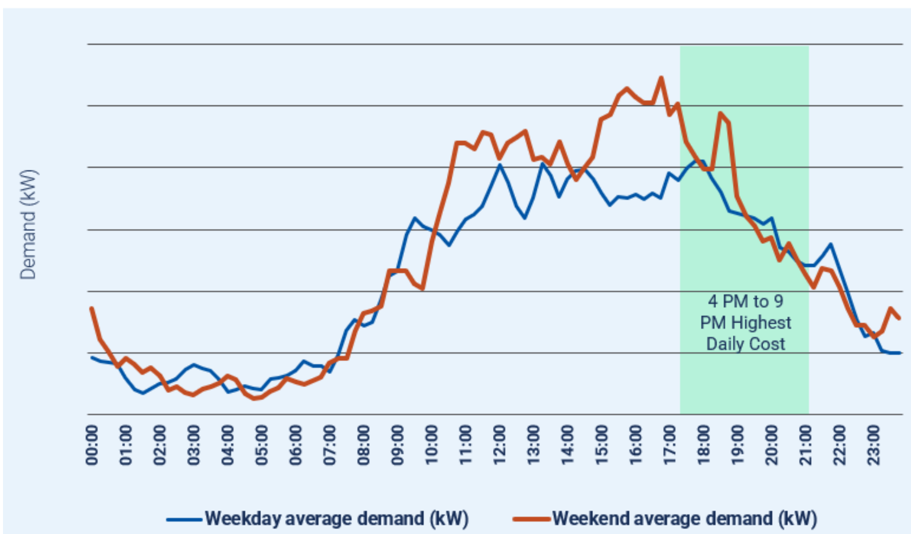
Figure 122. PG&E EV Fast Charge Program Daily Demand and Consumption, Program-to-Date Sites



Note: Y-axis labels are hidden due to fewer than 15 sites

Figure 123 shows weekday and weekend days with similar hourly trends, but with slightly higher demand on weekends. Most demand occurred between mid-afternoon and early evening. This corresponds to 33% of consumption occurring between 4 PM and 9 PM, which is the highest cost time period of the day.

Figure 123. PG&E EV Fast Charge Program Average Hourly Demand (kW) by Weekday and Weekend (Q4 2022)

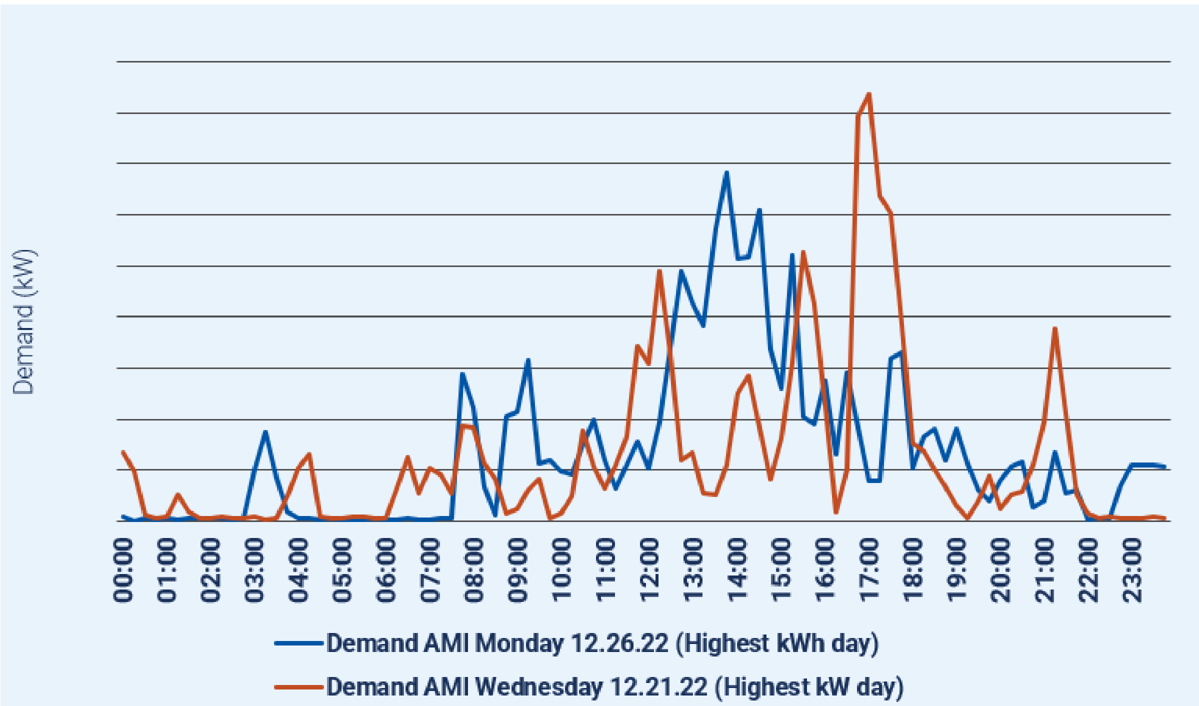


Note: Y-axis labels are hidden due to fewer than 15 sites

Figure 124 displays the actual demand for program to date sites from the two days representing the highest demand (kW) and highest consumption (kWh) for the EV Fast Charge program in 2022. Load factors and utilization rates may be partly a result of the sites being relatively new; it can take months to achieve significant gains in usage as local drivers begin to rely on the chargers.

Compared with the program to date sites average demand on weekday and weekend days shown in Figure 123, actual demand is significantly higher (to maintain customer confidentiality, actual kW and kWh are not shown). The higher consumption day had approximately 15% lower demand than the highest demand day. Charging at these sites declined after 6 PM and significantly decreased after midnight.

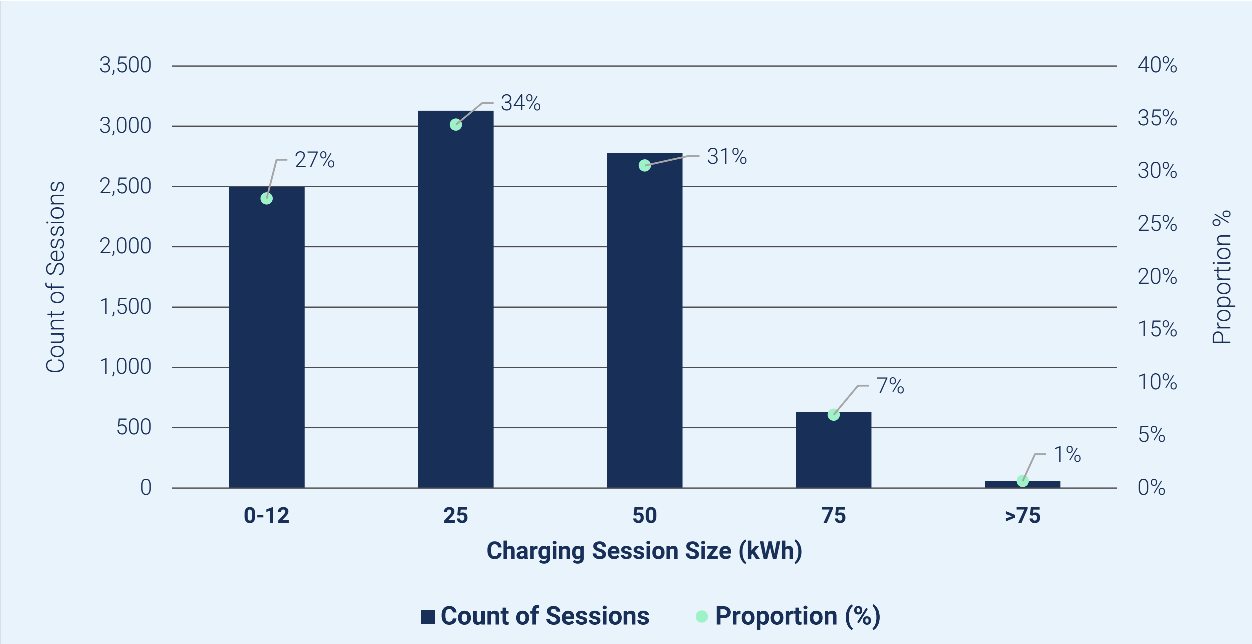
Figure 124. PG&E EV Fast Charge Program Highest Day of Demand and Consumption Load Comparison



Note: Y-axis labels are hidden due to fewer than 15 sites

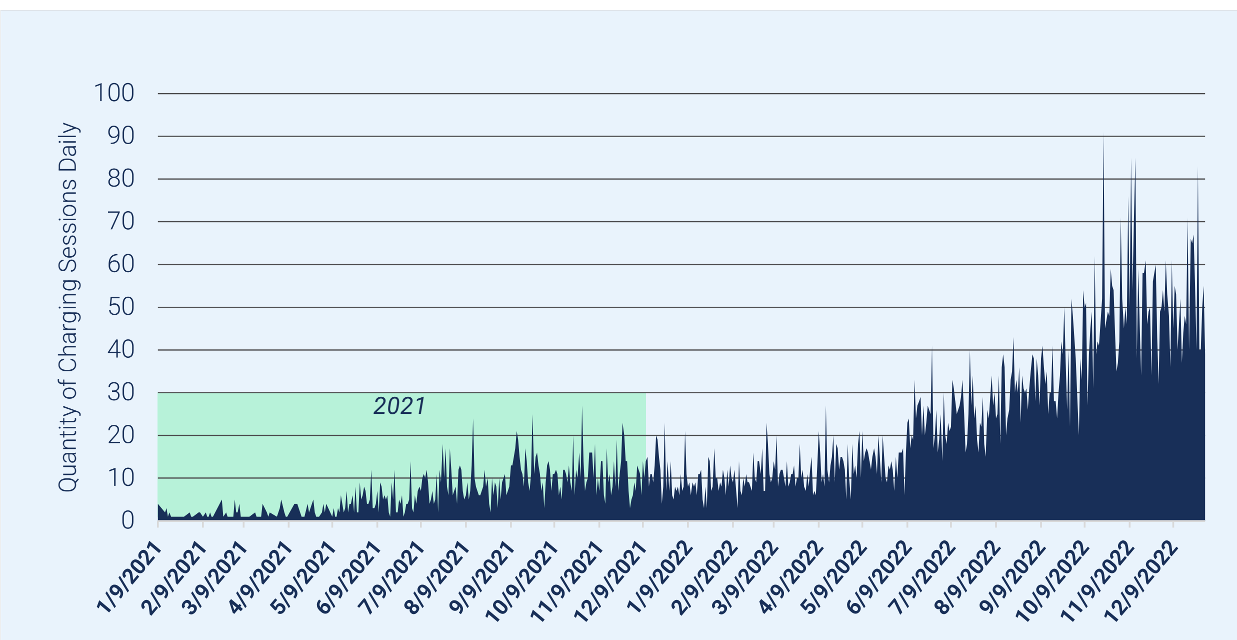
As shown in Figure 125, smaller charging sessions account for 60% of the data program to date (where 35% of sessions used up to 15 kWh and 25% of sessions used between 15 kWh and 25 kWh).

Figure 125. PG&E EV Fast Charge Program Frequency of Daily Charging Session Size (kWh)



As shown in Figure 126, daily charging sessions appear to be increasing through the end of the year. Across the program, charging sessions reached nearly 100 for some days in 2022, with nearly 7,500 sessions overall. This is a large increase from 2021, when there were only a few instances of 20 or more sessions per day. The prevalence of load spikes indicates the large range in number of charging sessions per day, ranging from 40 to over 80 throughout December 2022.

Figure 126. PG&E EV Fast Charge Program Charging Sessions by Day, Program to Date Sites



Highlights

- The number of daily charging sessions has continually increased as the new sites are activated. Across the program, the rate of daily charging approached 100 daily sessions toward the end of the year in 2022 with nearly 7,500 sessions overall. This is in contrast to 2021, when there were only a few instances of 20 or more daily sessions. The rate of daily charging sessions appears to still be growing.
- Daily consumption ramped up throughout 2022 reaching a peak on December 26, 2022.
- While weekday and weekend day charging have similar hourly trends, chargers had higher usage on weekends. Most demand occurred from mid-afternoon into the evening, which is the highest cost time period of the day.
- Overall, utilization is still rather low based on the load factor (a comparison of maximum demand to average demand; the most used site is approaching 10%) and based on utilization rates that appear to be increasing on a daily basis.

Petroleum Displacement

The Evaluation Team estimated program-induced petroleum displacement related to the five operational sites for EY2022 using three key pieces of information: electricity used for EV charging, resulting EV annual miles traveled, and equivalent annual counterfactual vehicle petroleum fuel consumption. Using this information, the Evaluation Team estimated the reduction in equivalent gallons of petroleum attributable to the PG&E EV Fast Charge program.

Table 71 presents the petroleum displacement resulting from the four operational EV Fast Charge program sites in EY2022, along with annualized and 10-year totals, by impact location (inside and outside DACs).

Table 71. PG&E EV Fast Charge Program Petroleum Displacement Summary

Market Sector	Usage		Petroleum Displacement (DGE)		
	EY2022 Sites Annualized kWh (n=5)	EY2022 Sites Annualized Miles (n=5)	EY2022 Sites Annualized (n=5)	PTD in CY21 + CY22 Actuals (n=9)	PTD 10-Year Projection (n=9)
Inside DAC	16,688	49,600	1,364	10,367	92,932
Outside DAC	232,091	691,799	19,020	10,688	202,231
Total	**248,779**	**741,399**	**20,384**	**21,055**	**295,162**

Highlights

- The five operational EY2022 sites resulted in an annualized impact of over 20,000 gallons of petroleum, with 7% of the impact within DACs.
- Over a 10-year period, the EY2021 and EY2022 sites combined will displace more than 295,000 gallons of petroleum.

Greenhouse Gas and Criteria Pollutant Impact

The Evaluation Team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service because of the EV Fast Charge program. The Evaluation Team first developed an ICE counterfactual baseline and then calculated the emissions associated with the operation of these vehicles for the same number of miles as the EVs would have traveled based on the electricity consumed. Although EVs have no tailpipe emissions, the fossil-fuel power plants dispatched by the California ISO that supply electricity to the EV charging stations release some GHGs and criteria pollutants.

Table 72 presents the GHG reductions resulting from the five operational EV Fast Charge program sites to date, along with annualized EY2022 and 10-year totals, by impact location (inside and outside DACs). Overall, the program resulted in an 80% reduction of GHGs relative to the counterfactual without the program, with 7% of the impact within DACs.

Table 72. PG&E EV Fast Charge Program GHG Reductions Summary

DAC	Usage		GHG Reduction (MT)		
	EY2022 Sites Annualized (kWh) (n=5)	EY2022 Sites Annualized (miles) (n=5)	EY2022 Sites Annualized (n=5)	PTD Sites in CY2021 + CY2022 Actuals (n=9)	PTD Sites 10-Year Projection (n=9)
Inside DAC	16,586	49,600	11	74	711
Outside DAC	231,343	691,799	146	78	1,619
Total	**247,929**	**741,399**	**157**	**153**	**2,329**

Of the local emissions, the program had the highest impact in reducing CO, resulting in an estimated annualized reduction of 423 kg and a project 10-year reduction of more than 7,800 kg (Table 73).

Table 73. PG&E EV Fast Charge Program Local Emissions Reductions

Emissions	EY2022 Net Reduction			Program-to-Date Net Reduction	
	Inside DAC	Outside DAC	Total	Actuals	10-Year Projected Impact
PM_{10} (kg)	0.05	0.75	0.8	0.79	11
$PM_{2.5}$ (kg)	0.05	0.69	0.74	0.73	10
ROG (kg)	0.85	12	13	14	244
CO (kg)	28	395	423	441	7805

The current mix of electricity generation sources from the CAISO grid used to support the PG&E EV Fast Charge program sites is shown in Figure 127.[97] Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 61% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 24% natural gas. With the CAISO grid adding more renewables to meet the Renewable Portfolio Standard, the GHG and criteria pollutant emissions will continue to decrease, although the mix supporting this charging already exceeds RPS goals.

---

97 The power associated with imports comes from a mixture of hydro, nuclear, coal, and natural gas power plants located outside the CAISO grid.

Figure 127. PG&E EV Fast Charge Program Net Electricity Mix, Annualized in EY2022

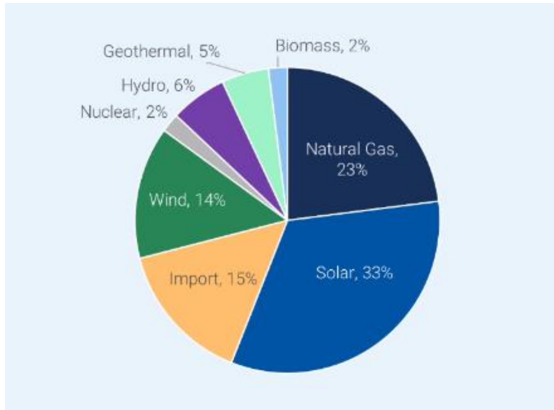
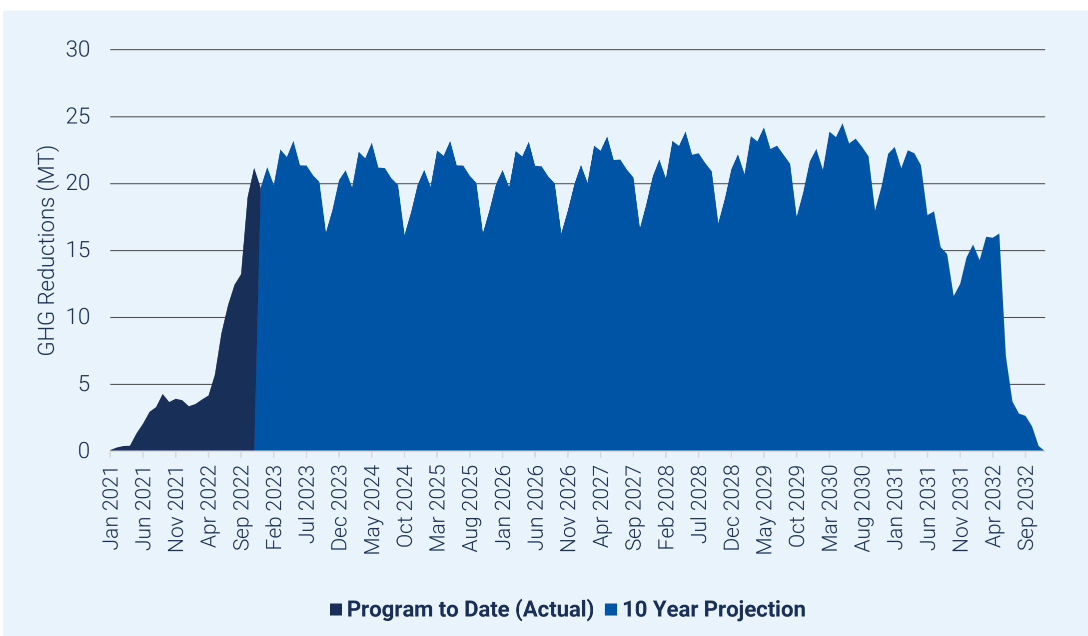


Figure 128 shows how program GHG reductions have increased to date and are expected to grow over time for EY2021 and EY2022 activated sites. The analysis period ranges from the date that the first site in the program was activated through the end of 2022. The analysis incorporates the net reduction (counterfactual emissions minus utility emissions) for each site within the PG&E EV Fast Charge. Program to date emission reductions are shown in dark navy while anticipated benefits based on annualization are presented in royal blue. As each site has its own starting date of operation, the 10-year sunset for each site is observed as a gradual tapering off of program benefits between 2031 and 2032. While each year's operations appear similar, there are several key factors driving the variations such as seasonality of utility generation sources (high utility emissions will appear as a dip on the curves), holidays occurring on weekends versus weekdays, and sites that became operational late in 2022 having predicted operations year-round in future years.

Figure 128. PG&E DCFC Program GHG Reductions, Historical and Forecasted, Program-to-Date Sites



Highlights

- The program resulted in an 80% reduction of GHGs relative to the counterfactual case in which there is no program, with 7% of the impact within DACs.
- Of the local emissions, the program had the highest impact in reducing CO, resulting in an estimated annualized reduction of 423 kg and a project 10-year reduction of more than 7,800 kg.
- Based on the real-time grid conditions when EV charging occurred, the overall energy mix contained about 61% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 24% natural gas.

Health Impacts

The Evaluation Team calculated public health impacts of reductions in criteria pollutants from vehicle electrification. Pollutants included in the analysis are primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, including NO_x, SO_2, NH_3, and VOCs. The analysis only considers tailpipe emissions reductions, rather than the full lifecycle emissions (e.g., power plant emissions). The Evaluation Team used EPA's COBRA to evaluate the health benefits associated with the emissions reductions. COBRA estimates the benefits at the county level for the county in which emissions are reduced. The Evaluation Team disaggregated the county-level effects to estimate the potential health benefits of projects for DACs and non-DACs.

The total value of the health benefits associated with the emissions reductions is between $1,336 and $3,007. Table 74 shows the cumulative health benefits for all impacted counties in California associated with the emissions reductions realized by the electrification of EY2021 and EY2022 PG&E EV Fast Charge sites.

Table 74. PG&E EV Fast Charge Program California Health Benefits for EY2021 and EY2022 Sites

Health Endpoint	Change in Incidence (Annual Cases)		Monetary Value (Annual, 2023 Dollars)	
	Low	High	Low	High
Mortality	0.0001	0.0002	$1,309	$2,963
Nonfatal Heart Attacks	< 0.0000	0.0001	$2	$17
Infant Mortality	< 0.0000	< 0.0000	$8	$8
Hospital Admits, All Respiratory	< 0.0000	< 0.0000	$1	$1
Hospital Admits, Cardiovascular	< 0.0000	< 0.0000	$2	$2
Acute Bronchitis	0.0002	0.0002	$0	< $0
Upper Respiratory Symptoms	0.0031	0.0031	$0	< $0
Lower Respiratory Symptoms	0.0022	0.0022	$0	< $0
Emergency Room Visits, Asthma	< 0.0000	< 0.0000	$0	< $0
Asthma Exacerbation	0.0032	0.0032	$0	< $0
Minor Restricted Activity Days	0.0920	0.0920	$10	$10
Work Loss Days	0.0157	0.0157	$4	$4
Total Health Effects	-	-	**$1,336**	**$3,007**

As part of this analysis, the Evaluation Team also examined the health benefits within DACs, which may be disproportionately burdened by sources of pollution (including air pollution from ICE vehicles). The

COBRA tool estimates effects at the county level, so the evaluation disaggregated the monetary health benefits by census tract using the relative population of each tract from the most recent American Community Survey. For example, a census tract with 10% of the county's population is allocated 10% of the value of the health benefits. The evaluation then estimates the total benefits allocated to DACs and non-DACs.[98] The approach implicitly assumes that the benefits of emissions reductions are distributed evenly throughout the county. If the sites are located in DACs, and the emissions reductions are greater in the tracts near the sites, this approach would understate the potential benefit to DACs. Additional information about emissions dispersion within counties is needed to provide more-precise estimates of the health benefits to DACs and non-DACs.

Most of the health benefits were in Alameda County which had 35% of the total benefits, followed by San Joaquin County (12%), Santa Clara County (4%), Sacramento County (7%), and Fresno County (6%). Overall, 20% of the benefits are in DACs.

Highlights

- The monetary health benefits from EY2021 and EY2022 PG&E EV Fast Charge sites range from a low estimate of $1,336 to a high estimate of $3,007.
- Most of the health benefits were in Alameda County which had 35% of the total benefits, followed by San Joaquin County (12%), Santa Clara County (4%), Sacramento County (7%), and Fresno County (6%).
- Overall, 20% of the benefits are in DACs.

Total Cost of Ownership

This section describes costs streams at the six EV Fast Charge sites from the program participant's perspective (i.e., the site host). The EVSE cost was not included due to unavailability of data but can be up to $140K per charging pedestal.[99] Only six sites were fully financially closed out (four for EY2021 and two for EY2022). All analysis below includes these six sites. The six sites had a mix of 50 kW, 62.5 kW, and 375 kW DCFC ports. In future evaluation reports when more sites have fully closed out financials, we hope to include a more robust lifecycle cost.

When considering the TTM, BTM, electricity, incentives (e.g., LCFS credits), the average EV Fast Charge site is slightly profitable for program participants with an estimated net present value (NPV) of $30,416 over 10 years. This TCO analysis does not include the cost of the charger and assumes an increase in EVSE utilization of 10% per year up to a maximum of double the initial utilization. The highest-use

---

98 DAC Census Tracts are defined as those included in in the SB535 Disadvantaged Communities List (2022), this includes the DAC categories for CalEnviroScreen 4.0 Top 25%, CalEnviroScreen 4.0 High Pollution Burden Score and Low Population Count, and 2017 Disadvantaged Community (CalEnviroScreen 3.0 only).

99 Nicholas, M (2019) "Estimating EV charging infrastructure costs across major U.S. metropolitan areas." Working Paper 2019-14, International Council on Clean Transportation (ICCT). https://theicct.org/publication/estimating-electric-vehicle-charging-infrastructure-costs-across-major-u-s-metropolitan-areas/

station we evaluated was charging a vehicle for roughly two hours per day on average. When the TCO analysis omits this high-use station, the average site has a NPV of $4,356. The low site count in this TCO analysis and variation in station utilization underscores the extreme caution readers should take when interpreting our findings. The Evaluation Team includes the TCO analysis as a benchmark for future evaluation years when we expect to have financial information of additional sites.

The value of the Utility incentives is significant, with the TTM investment averaging $41,804 per port and the BTM investment averaging $46,649 per port.

Highlights

- At the end of EY2022, six EV Fast Charge sites were fully closed out and able to submit cost data (four for EY2021 and two for EY2022).
- The average EV Fast Charge site had a negative cost—that is, a revenue to the site host—with a NPV of $30,416 over 10 years.

Utility Staff Insights

In addition to monthly check-in calls with key PG&E staff to discuss the status of the EV Fast Charge program, the Evaluation Team conducted a close-out interview with staff in March 2023 to review overall program challenges and successes in 2022.

Similar to EY2021, PGE&E staff reported seeing strong interest in the program throughout EY2022; however, staff noted several challenges they experienced in EY2022 with site selection and attrition:

- **Site Selection Alignment.** Program staff rely on site submissions from partnering EVSPs, which PG&E then analyzes to determine if the submitted sites are viable for the program. Throughout the implementation process, PG&E staff reported having to turn away many of the EVSP-submitted applications due to issues with cost-effectiveness constraints. Though this issue was previously noted in EY2021 and attributed to unexpected site costs (which continued to be a concern in EY2022), PG&E staff also wondered if the lack of project cost-effectiveness was related to a difference in understanding between PG&E and the EVSPs of desirable site characteristics. To assess this issue, PG&E staff asked all EVSP's to rank sites they submitted by what they anticipated to be the top scoring sites according to PG&E's criteria. An analysis after sites were evaluated showed that there was no correlation between sites that EVSPs thought would be a good fit for the program and those which PG&E determined to be a good fit.
- **Late-Stage Application Attrition.** PG&E staff noted sizable sunk costs in EY2021 and EY2022 due to program drop-outs at contracting stages of the application process after PG&E had already invested significant money in site walks and preliminary design. In EY2022 specifically, PG&E staff noticed a recurring issue with a single EVSP and its customers misrepresenting the level of commitment to participate in the program, resulting in several projects being dropped after a contract was issued. This may be due to gaps in the EVSPs confirming potential site hosts commitment as required under the steps within the initial agreement period (Figure 111).

These two challenges—disconnects between PG&E and EVSP regarding desirable site characteristics and late site host drop-outs—resulted in PG&E staff considering re-opening site solicitations in EY2023, if the eligible wait-listed sites do not achieve the program site goals. However, further analysis in EY2023 revealed that re-opening site solicitations would not be worth the costs. Even if program spots can be filled via wait-listed sites, PG&E staff expressed concerns that the increased costs identified below will continue to keep their cost per port threshold at $90,000, as opposed to the originally planned $70,000 per port:

- **Construction Labor Costs and Supply.** Staff noted that construction labor costs have increased as inflation has risen. In addition, like in EY2021, it has been difficult to secure a sufficient labor force since COVID-19.
- **Incorrect Assumptions.** PG&E staff noted in EY2021 that during the program design in 2018, they had underestimated assumptions about site needs, such as trench length or proximity to a PG&E power source. Similarly, permitting costs were higher than expected. These incorrect assumptions continue to burden the program throughout its implementation.
- **Material Costs.** Most materials were generally more expensive than originally anticipated in 2018 (when the program funding cap was decided).
- **Supply Chain Delays.** Staff confirmed that supply chain delays, which started as a result of COVID-19, continue to be a challenge.

To decrease the number of screened out sites and address issues of attrition and high costs, PG&E staff successfully implemented several practices:

- **Enhanced Phone Screening.** In EY2021, PG&E staff added an additional phone screen step to try to mitigate the attrition of applicants in later stages. In EY2022, PG&E staff began to take even further additional verification steps before investing more time and resources into a prospective site. For example, if something within a site's phone screen did not make sense or if program staff sensed hesitancy from the interested customer, they would ask specific follow-up questions of their site point-of-contact. This helped program staff verify interest before performing more costly activities such as the site visits.
- **Site Host Contributions.** In EY2022, after discussions with staff in the CPUC Energy Division, PG&E staff shifted the program design to allow partnering site hosts to contribute to project costs if the costs exceeded the program funding limits. Prompting hosts to contribute to the site cost also served as an indicator of site host commitment. In EY2022, this resulted in one additional project site being admitted into the program, and program staff anticipate this flexibility being an important aspect of success for enrolling additional sites in 2023.

Highlights

- The EV Fast Charge program struggled again in EY2022 with site hosts dropping out in the middle or late into the application and contracting process, depleting program funds without full commitment. Staff added screening questions to further verify site host commitment in hopes to mitigate dropouts in EY2023.

- Program staff worked with EVSPs to make sure EVSPs had a clear understanding of PG&E priorities when considering if a site should be considered for the program.
- PG&E shifted the program design to let site hosts contribute project funding, which increases the likelihood of a site meeting the cost threshold and being allowed into the program.

4.3.3. Lessons Learned

The Evaluation Team identified several lessons learned from EY2022. These lessons presented with key supporting findings and recommendations, may be applied to future program years and to other similar efforts.

Coordination and training with EVSPs who partner with the program is key to minimizing the number of sites that are screened out early in the application process.

PG&E designed the program so that all site hosts would have to apply through an approved EVSP, who would lead the complex application completion. At the beginning of the program, and prior to launching each site solicitation, PG&E provided training to help EVSPs become knowledgeable about the application. However, as the program was implemented, PG&E staff had to turn away many applications because of projected issues with cost-effectiveness. After conducting an exercise where PG&E staff and the participating EVSPs ranked submitted sites from most to least ideal, it was clear that EVSPs were misunderstanding PG&E's priorities in site selection or did not have the capabilities to assess site construction costs.

Though a lack of a formal commitment in advance of site walks resulted in PG&E continuing to invest in customers who were not able to commit, continually improving the intake process has helped PG&E to minimize the impact.

EV Fast Charge participants are not required to sign a formal participation agreement until the preliminary site design has been completed and agreed upon. Therefore, PG&E accepts a certain amount of risk when investing in planning a site. Although withdrawals early in the process are not significantly disruptive, PG&E staff experienced challenges when promising sites withdrew partway through the planning process; this was particularly straining on the program budget, as PG&E had invested considerably in the sites (such as conducting site walks). Despite adapting the intake process in EY2021, this challenge resulted in the EV Fast Charge program investing more resources in withdrawn applicants than anticipated. PG&E has continued to revise the intake process as needed to try to identify these issues earlier in the intake process to further mitigate sunk costs.

Market conditions and program requirements resulted in higher-than-expected site costs for the EV Fast Charge program. While these have limited participation so far, program design flexibility may be key to ensuring that PG&E can meet the program participation goals.

PG&E began the EV Fast Charge program just as the COVID-19 pandemic started. COVID-19 had unprecedented economic impacts across nearly every market, driving up costs for materials and labor and disrupting supply chains. These changes were so significant that the estimates PG&E had created for Decision 18-05-040 (which mandated the EV Fast Charge at determined funding levels) did not reflect the actual costs for implementing EV Fast Charge. Though PG&E staff conducted research ahead of program design, these expenses were then compounded by inadvertent inaccuracies in site design estimations. Because of this, and despite increasing its cost threshold, many sites must be turned away from the program for being cost-prohibitive. In EY2022, after discussions with staff in the CPUC Energy Division, PG&E staff shifted the program design to allow partnering site hosts to contribute to project costs if the costs exceeded the program funding limits, thus expanding the pool of eligible site hosts. Furthermore, staff added more phone screening steps to try to mitigate the attrition of site hosts during later stages in the application process.

PG&E's EV Fast Charge program is nominally influencing regional EV adoption.

While the EV Fast Charge program positively influenced EV adoption in households neighboring the infrastructure, both the EY2022 and program-to-date cumulative effects were small (2.5 EVs) relative to baseline registrations. This modest impact was likely a result of the location of the charging stations in nonresidential areas, in which impacts are limited for neighboring homes. While this was by design to locate them along highway corridors, it does not impact the adoption methodology.

The EV Fast Charge program sites are helping to displace petroleum, reduce GHG and local emissions, and achieve nominal health impacts overall and within DACs.

The EV Fast Charge sites accounted for an EY2022 annualized impact of over 20,000 gallons of petroleum (295,000 gallons over a 10-year period), with 7% of the impact within DACs. In addition, the program resulted in an 80% reduction of GHG, with 7% occurring within DACs. Overall, 20% of the health benefits are in DACs with the monetary health benefits from EY2021 and EY2022 PG&E EV Fast Charge sites ranging from $1,336 to $3,007.

5. SDG&E Transportation Electrification Programs

5.1. Power Your Drive for Fleets

5.1.1. Overview

This overview provides a detailed description of the SDG&E PYDFF program, as well as summaries of the program implementation process, performance metrics, program materials and budget summary, and a major milestone timeline. Following the overview, the Evaluation Team present the EY2022 findings, highlights, and lessons learned.

Program Description

Per Decision 18-05-040, SDG&E's PYDFF program provides infrastructure for fleet electrification at low or no cost to participants. Launched in November 2020, SDG&E designed PYDFF to accelerate the adoption of MDHD EVs by providing infrastructure for fleet electrification while working with fleets from the initial planning phases to design, construction, and ongoing site maintenance. PYDFF has an approved budget of $155 million and is designed to enroll and assist a minimum of 300 sites supporting the electrification of 3,000 MDHD on- and off-road vehicles.

PYDFF Target
Achieve minimum of 300 sites with 3,000 MDHD EVs supported.

Customers participating in the program can choose either Utility ownership or customer ownership of BTM infrastructure. With Utility ownership, SDG&E will pay for, construct, own, and maintain all infrastructure up to the charging station. The customer will then pay for, construct, own, and maintain the charging station. If the customer decides to own the BTM infrastructure, then SDG&E will pay for, construct, own, and maintain all TTM infrastructure and the customer will pay for, construct, own, and maintain all BTM infrastructure and receive an incentive payment for up to 80% of the resulting costs. Additional charger rebates of up to 50% of the cost are available for transit agencies, school districts, and fleets located in DACs that are not operated by Fortune 1000 companies.

Power Your Drive Program Design Goal
Accelerate the adoption of MDHD EVs by providing infrastructure for electrification while working with fleet operators from the initial planning phases to design, construction, and ongoing site maintenance.

The PYDFF program requires participating customers to purchase, lease, or convert at least two MDHD EVs. MDHD EVs are defined as Class 2 through Class 8 on-road and off-road vehicles, including MDHD trucks and vans, transit bus, commuter bus, school bus, transportation refrigeration units, airport ground support equipment (GSE), port equipment, forklifts, and other equipment. Additionally, fleets must own or lease the property, operate and maintain the infrastructure for 10 years, provide data related to EV usage, use approved vendors for the EVSE, and use qualified/state-licensed labor for all work, among other requirements. Specific terms and conditions listed in Appendix A and section 6.4 of Decision 19-08-026 require that a minimum of 30% of the infrastructure budget for PYDFF shall be allocated to deploy infrastructure in DACs, consistent with the California Environmental Protection Agency's CalEnviroScreen 3.0 tool (used to identify the top quartile of census tracts on a statewide basis). As allowed by the Decision, SDG&E submitted an advice letter in September 2023 requesting to expand the DAC definition to the service territory application, which the CPUC denied without prejudice. SDG&E is continuing to perform outreach to DAC customers to meet the 30% requirement. Additionally, at least 10% of the infrastructure expenditures must support the deployment of transit bus and school bus, and no more than 10% can support the deployment of electric forklifts.

In EY2021, SDG&E created an EV charging rate (EVHP) designed to make the transition to EVs easier and more cost-effective for fleets. The new rate eliminates demand charges, and instead uses a subscription fee model based on the amount of power fleets need to charge their vehicles, which provides consistent, straightforward monthly bills. The EVHP rate went into effect in January 2022.[100]

Implementation

Figure 129 shows the key steps in the PYDFF program implementation process.

Figure 129. SDG&E PYDFF Implementation Process

SUBMIT INTEREST

1. *Customer submits interest form*
2. *SDG&E representative works with fleets to ensure that the site is eligible and help fleets apply for the program*

PRELIMINARY DESIGN AND ENGINEERING

1. *SDG&E conducts physical inspection of project location*
2. *Customer returns executed customer package (participation agreement, 30% design, and easement)*
3. *SDG&E creates and finalizes infrastructure design package and obtains permits*

CONSTRUCT INFRASTRUCTURE

1. *SDG&E constructs make-ready EV charging infrastructure*
2. *Fleets have two options to construct and pay for charging infrastructure*

ACTIVATE SITE

1. *Customer commissions EV charging stations*
2. *SDG&E inspects and energizes equipment*

CLOSEOUT AND MAINTENANCE

1. *SDG&E conducts post-event job walk*
2. *SDG&E is responsible for ongoing maintenance of SDG&E-owned infrastructure*
3. *Customer is responsible for ongoing maintenance of customer-owned infrastructure and equipment*

---

[100] San Diego Gas & Electric. Effective January 1, 2022. "Schedule EV-HP: Electric Vehicle High Power Rate." https://tariff.sdge.com/tm2/pdf/tariffs/ELEC_ELEC-SCHEDS_EV-HP.pdf

Program Performance Metrics

The Evaluation Team reviewed the sites participating in the PYDFF program and analyzed them by program status. Table 75 provides the count of sites in the PYDFF program by completion status as of December 31, 2022[101].

Table 75. SDG&E PYDFF Program Complete Site Count by Status

Site Status	EY2021	EY2022
Utility Construction Complete	2	11
Activated	1	12
Operational	1	12
Closed Out	1	3

Note: The SDG&E 2021 SB 350 report included a second activated site based on start of activation date, but the evaluation reports are using end of activation date for count of activated sites.

In EY2022, SDG&E's PYDFF program received 23 additional customer applications, signed contracts with eight sites, and activated 12 sites supporting 246 vehicles across four market sectors. This raises the total number of applications received to date by SDG&E's PYDFF program to 57, and the total contracts executed to data to 22. As shown in Table 76, none of the MDHD activated sites are located within a DAC.

Table 76. SDG&E PYDFF Activated Site Summary by Market Sector

Market Sector	EY2022 Number of Activated Sites in DAC	EY2022 Number of Activated Sites in Non-DAC	Program-to-Date Number of Activated Sites in DAC	Program-to-Date Number of Activated Sites in Non-DAC
Airport Ground Support Equipment (GSE)	-	1	0	1
Medium-Duty Vehicles	-	1	0	2
School Bus	-	9	0	9
Truck-Stop Electrification (TSE)	-	1	0	1
Total	**0**	**12**	**0**	**13**

During 2022, SDG&E's PYDFF program had the greatest participation from school bus fleets, with 75% of EY2022 activated sites and 58% of supported vehicles (or 142 vehicles) being attributed to this market sector. Airport GSE comprised the second most commonly electrified MDHD market sector, representing

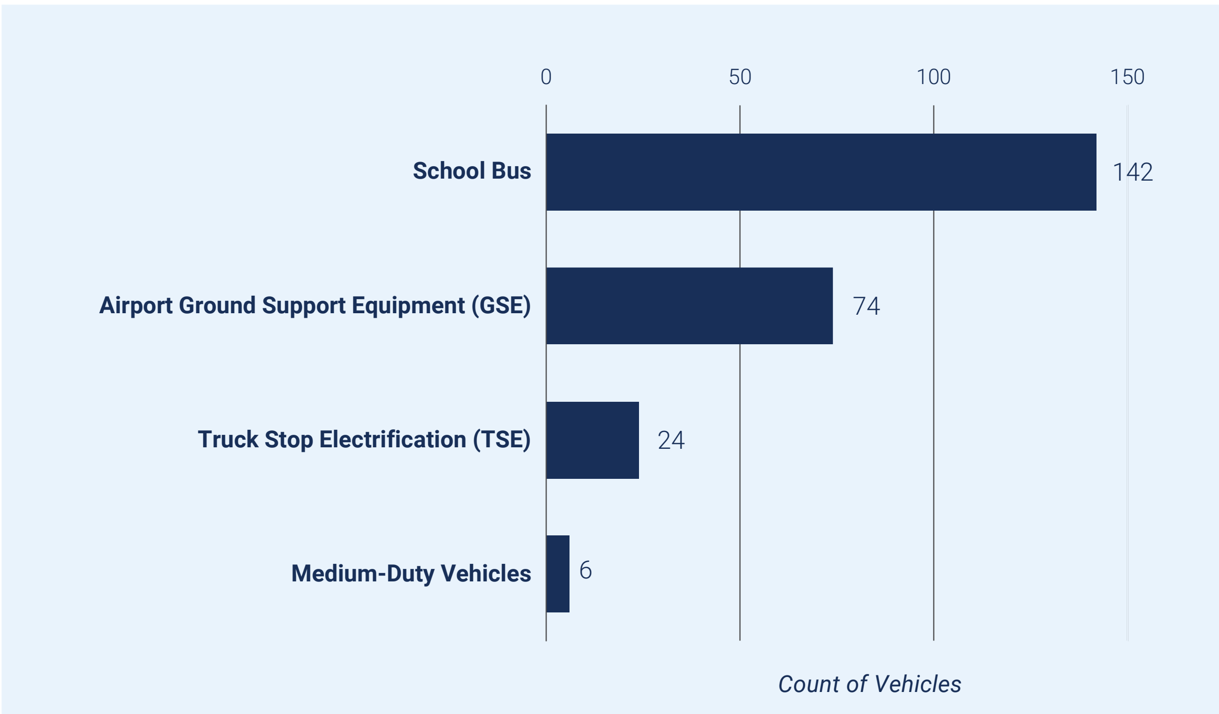
---

101 Note that these numbers are not additive and apply only for the evaluation year indicated; for example, in EY2022, 12 new sites in the PYDFF program were activated (all 12 constructed in EY2022), 12 new sites became operational (all 12 constructed and activated in EY2022), and 3 sites were financially closed out in EY2022 while one was closed out in EY2021.

30% of vehicles (or 74 vehicles), followed by TSE (10%, or 24 vehicles).[102] The medium-duty vehicle market sector records the fewest number of vehicles electrified in EY2022, with only 2%, or six medium-duty vehicles.

As illustrated in Figure 130, through PYDFF, SDG&E installed infrastructure to support 246 MDHD vehicles across four market sector, bringing the cumulative number of MDHD vehicles electrified in PYDFF to 248 EVs in the program to date.

Figure 130. SDG&E PYDFF Number of Vehicles Supported by Market Sector, EY2022 Sites



Note: The SDG&E PYDFF TSE site vehicle count was based on a methodology that was proposed as part of the Joint Utilities Advice Letter (PG&E AL 6546-E and SCE AL 4761-E) filed on April 1, 2022. However, in September 2023 CPUC Resolution E-5257 denied the modification request of the vehicle purchase requirements for MDHD public charging sites which included the TSE vehicle count methodology.

Table 77 displays the median durations per program phase (measured in calendar days). The column labeled EY2021 Sites refers to sites included in the 2021 Evaluation Report.[103] The column labeled EY2022 Sites refers to sites activated during Calendar Year 2022. Program-to-Date refers to all sites

---

102 Per SDG&E Q1 2022 Program Advisory Committee slide 17, dated April 15, 2022, SDG&E adopted a method to count six fleet vehicles per DCFC charging port above 20 kW within public charging sites (four vehicles for a L2 charging port between 10 kW and 20 kW and two vehicles for a L2 charging port with less than 10 kW). SDG&E's activated TSE site has four 62.5 kW DCFC charging ports. However, as part of CPUC Resolution E-5257 in September 2023 in response to the Joint Utilities Advice Letter (PG&E AL 6546-E and SCE AL 4761-E) filed on April 1, 2022, the methodology was not adopted.

103 https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/sb-350-te/sb-350-standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

activated since the initiation of the program to December 31, 2022. Values in Table 77 are used as a representative indicator of project phase length trends over time. Note, sites in each column did not necessarily pass through each phase in the same calendar year. For example, some sites in the EY2022 Sites column may have passed through Design and Permitting in 2021 while others passed through in 2022. For this reason, the columns capture different moments in the Utility program's lifecycle and may not be directly comparable.

Across all program phases, PYDFF applicants continue to take the shortest amount of time to complete the first (Application Reviewal) and final (Activation) program phases. The median duration for Design and Permitting is the longest phase for program to date sites, with a median of 313 calendar days and of 316 days for EY2022 sites. Note that the sum of calendar days in Table 77 does not equate to the total program duration as program phases overlap and applicants can concurrently work toward completing multiple phases.

Median durations vary by market sector. For instance, the TSE applications in the Contract Issuance phase took a median of 221 calendar days to complete, while it only took school bus applicants, the market sector with the next highest duration, a median of 63 days to complete the same phase. The customer applications in the medium-duty vehicle market sector had significantly greater times in the Activation phase, at a median of 49 calendar days, compared to the overall median duration of three calendar days.

Table 77. SDG&E PYDFF Median Calendar Days per Phase in EY2021, EY2022, and PTD

Program Phase	EY2021 Calendar Days (Median)	EY2022 Calendar Days (Median)	Program to Date (Median)
Application Reviewal	16	21	16
Site Assessment	165	144	146
Contract Issuance	29	104	63
Design and Permitting	159	316	313
Construction Complete	125	163	154
Activation	49	3	3
Number of Activated Sites [a]	**2**	**12**	**13**

[a] SDG&E 2021 SB 350 Report and the EY2021 Evaluation Report included two sites in EY2021 median duration calculations, despite having only one EY2021 activated site. The second site, activated in EY2022, was still in the Activation stage of the program as of December 31, 2021. Due to this discrepancy this site is included in both EY2021 and EY2022 columns.

By the end of 2022 the PYDFF program had 13 activated sites to support the electrification of 248 MDHD vehicles per customer's VAPs. The 22 contracts signed in the PYDFF program to date meets 7% of the program's *per se reasonableness* goal of 300 sites and support 554 MDHD vehicles meeting 18% of the program's *per se* reasonableness goal of electrifying 3,000 MDHD vehicles. The 57 applications received to date could satisfy 19% of the program's site goal.

The analysis of program phase durations is expanded upon in Figure 131, which displays the average number of calendar days per phase (denoted by X), as well as calendar day median (middle line inside of box), the 1st quartile (bottom of box), 3rd quartile (top of box), minimum (bottom tail), maximum (top tail), and outliers (dots). The distributions per program phase provide deeper insight into program phase completion, illustrating that the design and permitting, construction complete, and site assessment phases take the most calendar days to complete. Applicants experienced the highest degree of variation in completion time for the Design and Permitting phase, spanning from 111 to 422 calendar days. The phases in which customer applications experienced the shortest amount of time per phase, Application Reviewal and Activation, were also the phases with the least variation in completion times in EY2022.

Figure 131. SDG&E PYDFF Summary of Calendar Days per Phase for EY2022 Sites

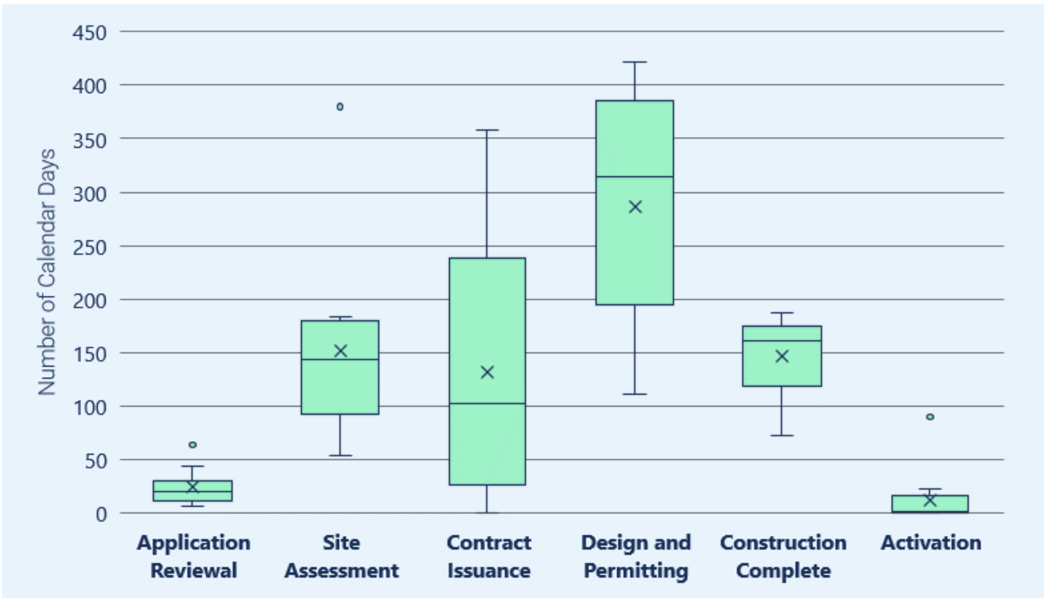


Table 78 displays the median quantity of calendar days that PYDFF program applicants took from program start to finish (Application Reviewal to Activation) for 12 activated sites across four market sector in EY2022. The 12 activated sites in EY2022 had an overall median start-to-activation duration of 654 calendar days. There was only one activated site in EY2021. There was variation between the longest and shortest median start-to-finish durations across market sectors, with the median program completion duration for school bus sites taking 702 days, or 225 calendar days longer than for the TSE market sector.

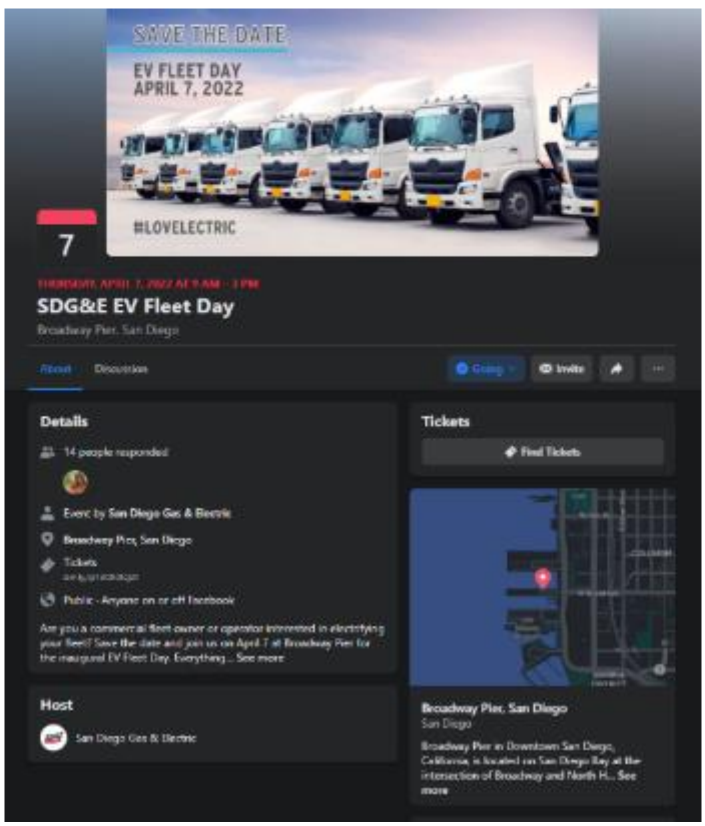
Table 78. SDG&E PYDFF Median Duration for Site Activation, by Market Sector

Market Sector	EY2022 Sites		Program-to-Date Sites	
	Median Start-to-Finish Activation (Calendar Days)	Number of Activated Sites	Median Start-to-Finish Activation (Calendar Days)	Number of Activated Sites
Truck-Stop Electrification	477	1	477	1
Medium-Duty Vehicles	629	1	468	2
Airport Ground Support Equipment	570	1	570	1
School Bus	702	9	702	9
All Market Sectors	**654**	**12**	**645**	**13**

Program Materials Summary

This section highlights findings from the review of program material and ME&O activities conducted by SDG&E in EY2022. SDG&E staff coordinated throughout EY2022 to increase program participation through internal communication regarding grant and funding guides and the language to use in sales conversations, hosting virtual events, and providing fleet electrification and market landscape trainings. SDG&E staff also provided trainings and coordinated events. Training included multiple webinars to enrich ME&O. Events hosted included SDG&E's inaugural fleet day, which had over 1,000 attendees. This event enabled customers to speak directly with fleet electrification experts such as charging providers, vehicle manufacturers, public agencies, and grant funding organizations. The EV Fleet Day event also included speaking panels, vehicle and equipment displays, and an exposition hall showcasing products from electrification vendors. These events attracted media coverage, including several local TV broadcasts and stories in trade publications and business journals about the event and the future of fleet electrification. In addition, SDG&E generated a robust social media coverage by media organizations, business, and attendees, with the hashtag #EVFleetDay trending on LinkedIn and over 100 posts related to the event. Figure 132 provides an example of social media coverage.

Figure 132. SDG&E PYDFF Facebook Event Page for SDG&E EV Fleet Day



As part of its ME&O, SDG&E staff also completed 13 paid advertising campaigns for the PYDFF program in EY2022. Each of these campaigns included aspects targeted at small businesses, and resulted in 1,907,736 impressions, 14,373 clicks, and 16,411 visitors to SDG&E's website. SDG&E staff also tracked earned media for its program, including several articles from the San Diego Union Tribune and pieces in

Cleantech San Diego, California’s HVIP, CBS, Fleet Management Weekly, CALSTART, and San Diego Community Power. Figure 133 presents an earned media opportunity from EY2022.

Figure 133. SDG&E PYDFF Promoting the Fleet Electrification Program

Source: SDG&E ME&O Data.

SDG&E staff increased their focus on reaching DACs in EY2022:

- **Targeted ME&O materials.** SDG&E staff developed a robust set of ME&O materials specially targeted to DACs. This includes a dedicated webpage, titled “Electrification for Fleets Operating in Disadvantaged Communities,”[104] which can be reached through the main PYDFF page located at SDGE.com. DAC-specific outreach materials also include several fact sheets, including a general fact sheet for fleets in DACs, a TCO fact sheet for fleets in DACs, a fact sheet on the benefits of SDG&E’s EV High Power pricing plan with DAC-specific information, a fact sheet on funding opportunities and incentives with DAC-specific information, and a fact sheet on the LCFS and how it can support fleets with earning revenue to offset electrification costs. Many of these fact sheets are available in digital and print form. SDG&E also hosted a series of webinars alongside SCE and PG&E, which included highlighting opportunities specific to fleets operating in DACs, and SDG&E included DAC-specific information at their inaugural EV Fleet Day event.

---

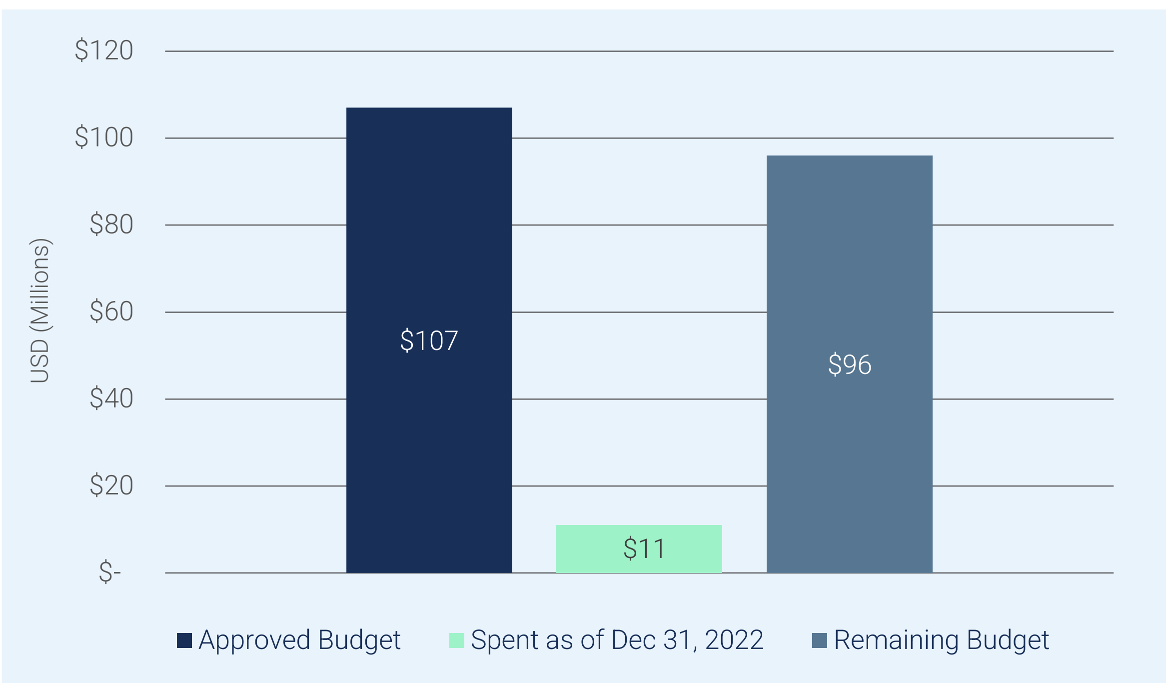
[104] https://www.sdge.com/business/electric-vehicles/power-your-drive-for-fleets

- **Dedicated email and advertising**. SDG&E staff included DAC-specific information in a dedicated email and advertising campaign and an ongoing paid advertising campaign highlighting funding opportunities and stackable incentives.
- **Customer surveys**. SDG&E staff provided surveys to SDG&E customers, including those in DACs, to gain insight into fleet readiness for EV adoption, and they conducted outreach to targeted outreach lists, which included fleets in DACs, through a third-party teleservice call center.
- **Fleet industry partner networking**. SDG&E staff created a fleet industry partner network that meets quarterly to provide expert information and facilitate discussions on electrification, including information specific to DACs.
- **Rebate calculator**. SDG&E offers additional support for charger rebates through dedicated information on SDG&E's rebate calculator for fleets operating in DACs.

Budget Summary

As shown in Figure 134, from program inception through the end of 2022, SDG&E spent $11.02 million of the approved $107 million (constant dollars). In EY2021 and EY2022, program spending was $4.5 million and $5.5 million, respectively. Figure 134 does not include spending on sites that were not fully closed out as of December 31, 2022.

Figure 134. SDG&E PYDFF Budget Remaining versus Spent through 2022

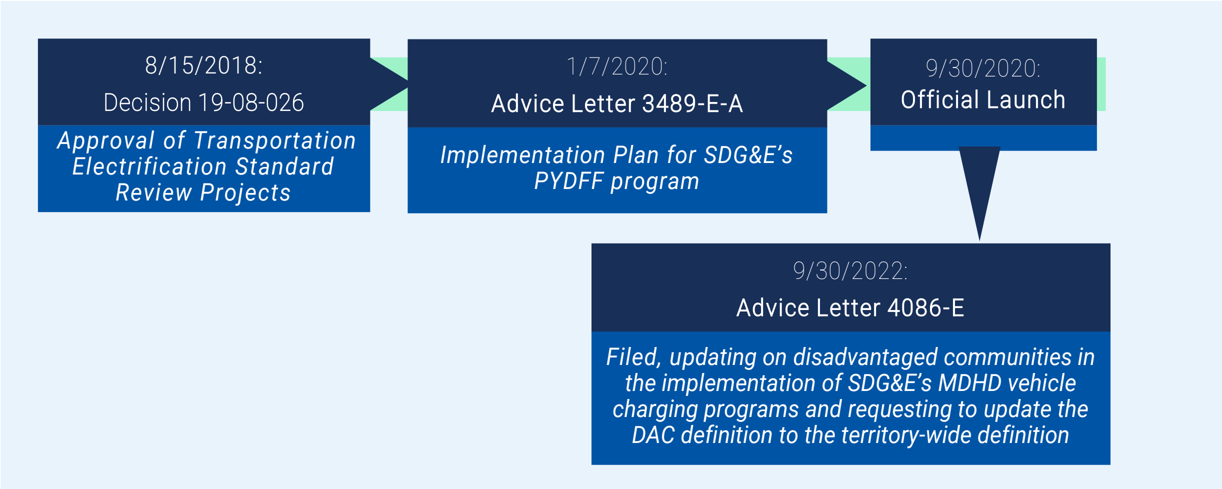


Timeline

As allowed by the Decision, SDG&E submitted Advice Letter 4086-E on September 30, 2022, requesting to expand the definition of DACs to the service territory application, matching the definition approved in

Advice Letter 2876-E.[105] The timeline in Figure 135 shows all major milestones since the beginning of the program.

Figure 135. SDG&E PYDFF Timeline of Power Your Drive for Fleets Milestones



5.1.2. Findings

The following sections provide findings from the Utility staff and vendor interviews and from the survey and site visits. In addition, the Evaluation Team provide insights from the co-benefits and co-cost analysis, as well as the deep dive analysis, TCO, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health impacts, and net impacts.

Table 79 summarizes key impact parameters for EY2022 as well as for the program to date. Annual estimates of impacts are provided for metrics calculated as part of the impact evaluation. Additionally, the table provides estimates of impacts across all sites included in the program population through the end of EY2022.[106]

Table 79. SDG&E PYDFF Impacts Summary in EY2022

Impact Parameter	EY2021 [a]	EY2022 [a]	EY2022 Percentage in DAC	Program-to-Date Actuals [d]	Program-to-Date Actuals Percentage in DAC
Population of Activated Sites (#)	1	12	0%	13	0%
Sites Included in Analysis (#)	1	12	0%	13	0%
Ports Installed in Analyzed Sites (#)	2	181	0%	183	0%
EVs Supported (#) [b]	2	246	0%	248	0%

[105] SDG&E submitted Advice Letter 2876-E to allow it to define DACs using the CalEnviroScreen service territory definition, rather than basing DACs on a statewide assessment.

[106] For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

Impact Parameter	EY2021 [a]	EY2022 [a]	EY2022 Percentage in DAC	Program-to-Date Actuals [d]	Program-to-Date Actuals Percentage in DAC
Electric Energy Consumption (MWh)			0%		0%
Petroleum Displacement (DGE)	N/A	109,285	0%	48,871	0%
GHG Emission Reduction (MT GHG) [c]	N/A	947	0%	410	0%
NO_x Reduction (kg)	N/A	1,274	0%	479	0%
PM_{10} Reduction (kg)	N/A	8.0	0%	2.9	0%
$PM_{2.5}$ Reduction (kg)	N/A	7.4	0%	2.7	0%
ROG Reduction (kg)	N/A	71.9	0%	25.7	0%
CO Reduction (kg)	N/A	2101	0%	802	0%

[a] Energy consumption, petroleum displacement, emission reductions, and health benefits are based on annualized data. Program-to-date results in the table are based on actual data (see the *Methodology* section for more details).

[b] The Evaluation Team derived the EVs supported value from applicants' VAPs. This value represents the maximum number of vehicles expected to be supported by the charging infrastructure.

[c] GHGs include CO_2, CH_4, and N_2O multiplied by their respective GWP as defined by IPCC AR5 (see the *Methodology* section for more details).

[d] Program to date column is less than EY2022 column across several impact parameters because EY2022 is annualized data (i.e., showing impacts over a 12-month period, even if sites had less than 12 months of data. See the *Methodology* section for more details on Annualization).

Note: values for electric energy consumption for population of fever than 15 sites are redacted

Utility Staff Insights

The Evaluation Team interviewed SDG&E PYDFF program staff in October 2022 to discuss program challenges and successes. Program staff identified several program challenges:

- **Site costs.** Equipment and construction material costs grew significantly over the past year, on everything from switchgear and its components to conduit and concrete. Labor costs have also increased.
- **Supply chain delays.** Equipment and material lead times have increased, from between eight and 12 weeks to 52 weeks or more on switchgear, and from 30 days to six months for EV chargers. This increase in lead times impacts SDG&E's carrying costs, as well as the alignment of construction and design processes.
- **Permitting delays.** Staffing shortages at local and state government agencies have also impacted timelines.
- **Limiting program design requirements.** The program requirement of a two-vehicle minimum has been challenging for small fleets, as these fleets may not be able to afford multiple vehicles or may not own a dedicated parking space.
- **DAC Requirement.** Staff were concerned about meeting existing DAC requirements given the limited number of DACs in their service area. In EY2022, they submitted Advice Letter 4086-E requesting to update the definition of DACs, but this request was denied in Q1 2023. SDG&E is continuing to perform outreach to DAC customers to meet the 30% requirement.

SDG&E staff also report a notable success in EY2022:

- **Expanded outreach.** SDG&E staff created a team to track progress and set up a project management office to assist customers throughout the entire electrification process. Staff reflected that this change appeared to help smooth the process for customers by providing planning support and access to industry resources, including trade associations and educational materials like free webinars. SDG&E staff are also assisting customers with identifying grant funding for EVs. In addition, staff conducted a second round of outreach for DAC participants (for example, conducting outreach via mailings and a partnership with the Port of San Diego). Finally, SDG&E staff noted that there is an opportunity to provide additional advisory services to make customers more aware of best practices, load management, and opportunities for integrating technologies such as solar, battery storage, and V2G capabilities.

Highlights

- Despite continued efforts to reach DACs, staff continued to be concerned about meeting program DAC goals.
- As site construction continued in EY2022, site costs and delays continued to be challenges.
- Program design requirements of a two-vehicle minimum may limit small business participation.
- To further serve interested customers, PYDFF staff expanded outreach efforts and created a project management office with industry resources and educational materials.

Vendor Interviews

The Evaluation Team interviewed representatives from four different charging providers, known as EV service providers (EVSPs), to explore their program experiences including Utility engagement; project installation; perceived insights from fleet owners, site hosts, and drivers; data collection and load management; barriers to electrification; overall market outlook; and suggestions for program improvement. Many of these findings are similar or identical to those reported for the SCE program (Chapter 2) and for the PG&E program (Chapter 3), as EVSPs tended to offer observations on the Utility programs as a whole, rarely mentioning specific programs for praise or criticism.

Utility Engagement

Generally, the four interviewed EVSPs were strongly complimentary toward and supportive of Utility engagement through the PYDFF program. One EVSP specifically highlighted SDG&E's strong communication, which helped the EVSP know what to expect and what was required for the program. In addition, three EVSPs reported that SDG&E staff involvement in the make-ready infrastructure process was a very important element in accelerating EVSE deployment. However, two of the four representatives said the Utilities (SCE, PG&E, and SDG&E) would benefit from additional staffing to expedite the analysis and accommodate the increased load attributable to EVSE.

Installation

EVSP representatives provided insights regarding installation challenges, interoperability, and installation cost differences.

Installation challenges. The EVSPs reported several challenges with EVSE installation: (1) long lead times for vehicle and equipment availability, (2) labor shortages among installation contractors, and (3) long timelines for permitting approval at the city or state levels. For example, one EVSP noted that the Service Level Agreements with Utilities can require product delivery within 21 days, which can be difficult under current market conditions; however, the EVSP did not specify which Utilities had such challenging and inflexible Service Level Agreements. Three EVSPs also noted that permitting had previously been a problem (not simply with the PYDFF program but with EVSE installation generally) but indicated that these challenges had largely been resolved (and attributed the remaining permitting challenges to staff shortages at the permitting entities). However, one EVSP reported that local permitting remained a barrier, with previously expected timelines of 12 months becoming 18 months. One EVSP also noted that EVSE installation at schools could be delayed by the need to secure approval from the Division of the State Architect.

EVSPs identified additional challenges, each mentioned by one respondent: inconsistent processes for setting up right-of-way agreements for Utility-owned infrastructure across the three different Utilities, lack of readily available grid capacity information, and inconsistent responses from Utility staff about the eligibility of V2G-capable chargers for rebates and installation incentives.

Interoperability. When asked about interoperability as a challenge, three EVSPs reported that interoperability issues between EVSE and specific vehicles are sporadic and often rapidly rectified through over-the-air software updates. As opposed to on-site software updates requiring a service call by a technician or engineer, over-the-air updates can be implemented remotely and therefore quickly.

One EVSP required significantly more effort to correct interoperability issues, noting that they have engineers working to better integrate their software with the software on board the vehicles and that a "plug and play" solution was about a year away.

Installation costs. All four EVSPs reported that cost differences in the installation of comparable EVSE at different sites arose primarily from the state of the existing infrastructure on each site. Examples include the available load on the transformer, capacity of the distribution panel, need for facility upgrades, need for trenching, type of surface material, distance from the meter to the EVSE, the quality of product installed (which materials and components are used), the quality and availability of software, and the desired EVSE functionality.

Fleet Owner, Site Host, and Driver Perspectives

All four EVSP representatives noted that there was extensive interest from customers in electrifying their fleets and good alignment between what Utilities can provide and what customers need.

EVSPs noted several key aspects of PYDFF for customers:

- **Capital funding.** All four EVSPs reported that program incentives for both the infrastructure and the vehicles was extremely important for accelerating customer EV adoption. In addition, the EVSPs agreed that there is sufficient demand from fleet owners to warrant expanding the PYDFF program with additional technical assistance and incentive funds. Furthermore, all four EVSPs indicated that the current Utility incentive levels per site are adequate, although one noted that there could be benefits to helping customers (especially schools) identify and access grant funding opportunities.

- **Identified products.** One EVSP noted that the qualified products list supports fleet owners by removing some of the guesswork involved in fleet electrification.[107]

From the EVSP perspective, challenges for fleet owners include the rapid pace of changes in the MDHD EV industry. For example, a customer's needs may have changed in the time since they developed their VAP or recommendations from the feasibility study may have lost some relevance by the time the fleet is ready to implement the plan. EVSPs expressed a desire for Utilities to offer greater flexibility to program participants in modifying their EVSE and vehicle plans, especially for schools.

EVSPs reported mixed perceptions from fleet drivers regarding EVs. One EVSP attributed uncertainty regarding EVs to a lack of knowledge about the vehicles, citing that some drivers worried about plugging in a vehicle to charge while it was raining, fearing the risk of electrocution.

Data Collection

The four EVSPs were generally supportive of the data collection needs required by PYDFF. However, one EVSP commented that the data collection process carries a cost, and that individual EVSPs can be at a disadvantage if they invest in providing a large volume of high-quality data while some of their competitors provide lower-quality data. This EVSP recommended clear standards and requirements for the quality of data collection.

Load Management

Load management capabilities can reduce EVSE installation costs by avoiding the need for infrastructure upgrades, or by reducing operational costs through shifting consumption away from periods of higher electricity prices. However, one EVSP noted that uptake of the load management capabilities could be constrained by a fleet's operational needs. For example, some fleets require charging during peak hours, and not all loads can be shifted. One EVSP noted that it did not yet have fully operational load management capabilities but was in the process of developing such features. Three EVSPs reported that the use of load management often requires customized support that factors in each customers' unique operations and charging needs. One EVSP also noted difficulty in calibrating load management systems to complicated Utility tariffs, especially when it was unclear which tariff would apply to a vehicle. An example of this is when a vehicle might have multiple locations where it can charge.

Barriers to Electrification

The most common barrier to fleet electrification reported by the EVSPs was component supply, specifically transformers and switchgear. One EVSP noted that custom switchgear can have a 48-month timeline to delivery yet recognized that Utilities had been receptive to recommendations from the EVSP on addressing supply chain issues.

---

[107] The Vetted Product List for PYDFF is hosted by EPRI at https://www.epri.com/vpl.

Market Outlook

Forthcoming technological advances that could accelerate fleet electrification include plug-and-charge capability, V2G or bidirectional charging, wireless charging, and billing management through the vehicle's system. Additionally, two EVSPs noted that extensive grid communication strategies are in development, and one plans to integrate with home energy management technologies.

All four EVSPs noted that the Utilities in general were good partners in deploying infrastructure, emphasizing that Utility engagement was vital and that the sector is not yet mature enough for a self-sustaining market if Utilities were to disengage. Compared to the light-duty market, the EVSP reflected that the MDHD market is at a much earlier stage of development. For example, one EVSP suggested that the transition in this segment may take another decade. This same EVSP noted that, while early adopters may have the financial means to make the shift today, there will be broader demand in five years, and those customers may also need Utility support. One EVSP said, "These are really great programs for everybody involved. They help the capital cost burden for early adopters. This is something that Utilities should continue to support going forward."

Suggestions for Improvement

The EVSPs had the following suggestions for improving the PYDFF program:

- Revise the timeline in the Service Level Agreements to reflect market realities and longer lead times for EVSE and associated equipment
- Communicate major program changes more promptly to key partners such as EVSPs
- Shorten the load analysis timeline
- Standardize and clarify the program data collection requirements

Highlights

- EVSPs agree that the PYDFF program is beneficial and well-implemented but said SDG&E could benefit from additional staffing to expedite the analysis and accommodate the increased load attributable to EVSE.
- Interoperability issues are relatively minor and are resolved quickly, generally through over-the-air software updates.
- Supply chain constraints continue to be a concern and impact installation timelines.
- Utilities are good partners in deploying infrastructure and EVSPs emphasized the need for Utilities to stay involved, as the MDHD sector is not yet mature enough for a self-sustaining market.

Survey Results

The Evaluation Team surveyed seven fleet managers who participated in SDG&E's PYDFF program about their motivations for and barriers to electrification, program satisfaction and awareness, experience with EVs and charging infrastructure, the impact of the program on fleet electrification, and their perspective on the industry.

Of these seven fleet managers, six were from the school bus sector and one was from the airport sector, as shown in Table 80.[108]

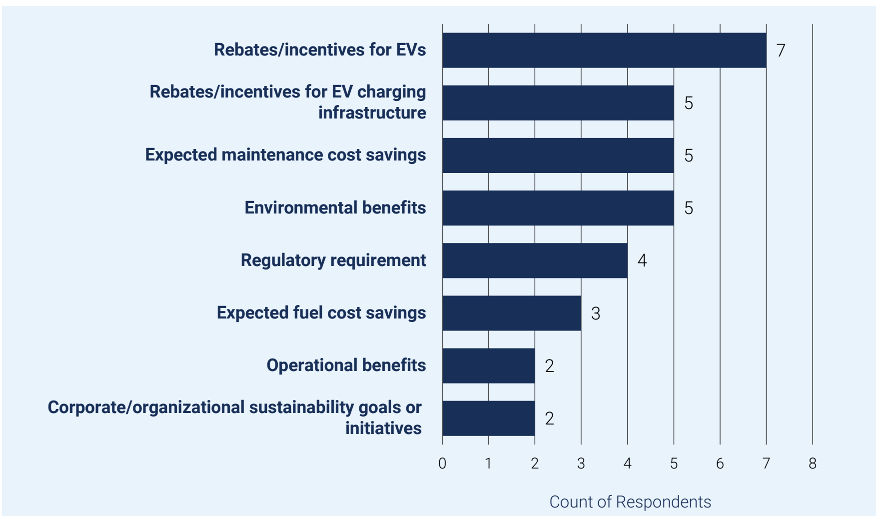
Table 80. SDG&E PYDFF Fleet Manager Survey Sample in EY2022

Survey Type	Sector	Number of Surveys Sent	Number of Partial Surveys	Number of Completed Surveys
Participants	Airport GSE	1	0	1
	Medium-Duty	2	0	0
	School Bus	8	0	6
Total Participants	--	**11**	**0**	**7**

Electrification Motivators and Barriers

The Evaluation Team asked SDG&E fleet managers about their motivations for transitioning to EVs. As shown in Figure 136, the top motivators were rebates/incentives for EVs (seven respondents), rebates/incentives for EV charging infrastructure (five respondents), expected maintenance cost savings (five respondents), and environmental benefits (five respondents).

Figure 136. SDG&E PYDFF Program Participant Motivators for Transitioning to EVs in EY2022



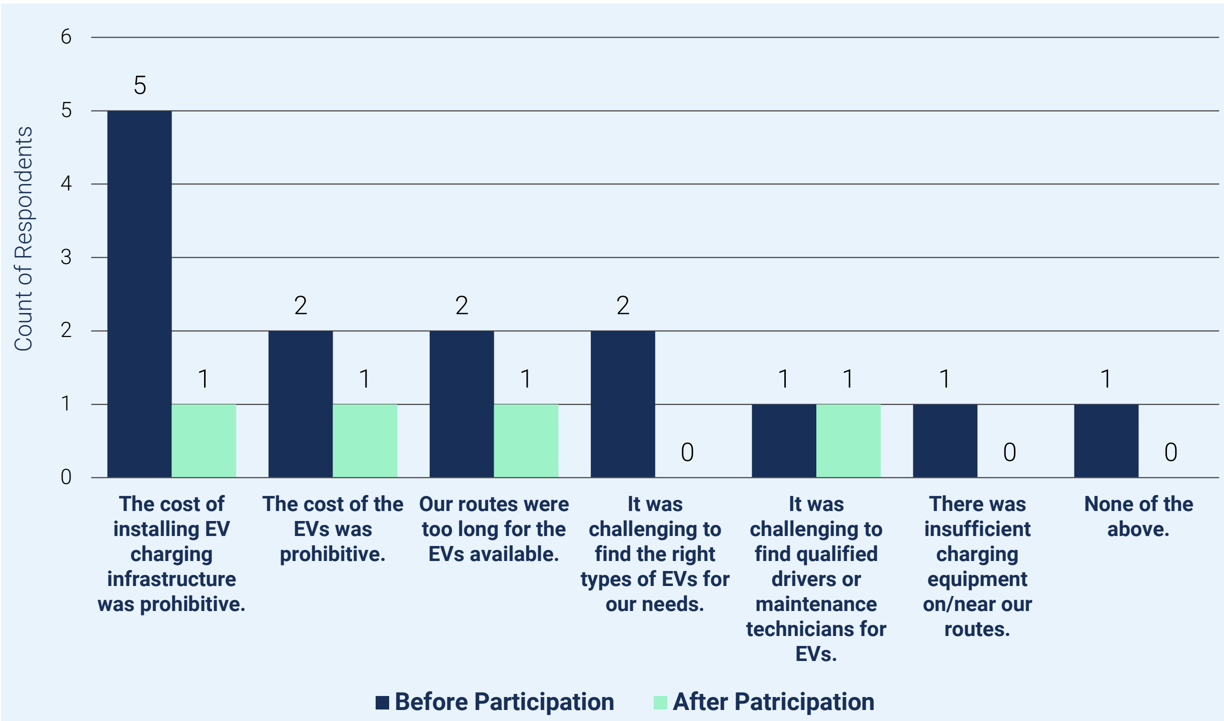
Source: Fleet Manager Survey Question C1. "Why did your fleet decide to transition to EVs? Select all that apply." (n=7; multiple responses allowed)

The Evaluation Team asked fleet managers which barriers to electrification their fleets faced before program participation and which barriers remained after participation (Figure 137). Five of seven fleet managers said the top barrier prior to electrification was the cost of installing EV charging infrastructure but only one fleet manager said this was a barrier after participation. After participating in the PYDFF program, the remaining barriers, stated by a single fleet manager each, were the cost of installing EV

108 In some cases, the number of responses to a question is greater or less than seven. This is due to the inclusion of partial participants (those who answered some questions but did not complete the survey) and cases where not all respondents answered a question. Despite the Evaluation Team's efforts to improve the response rate through multiple rounds of outreach and increased survey incentives, the fleet manager survey did not reach the target response number, which limits the insights that can be gleaned due to a smaller sample size.

charging infrastructure, the cost of EVs, their routes being too long for EVs, and finding qualified drivers or maintenance technicians. Insufficient charging equipment on or near routes (one respondent) and finding the right types of EVs (two respondents) were barriers before participation but were not mentioned as barriers following participation.

Figure 137. SDG&E PYDFF Barriers to Electrification before and after Program Participation in EY2022



Source: Fleet Manager Survey Questions F3 and F4. "Which of the following barriers to electrification did your fleet face before participating in the Power Your Drive for Fleets program?" (n=7) and "You mentioned that the following were barriers to electrification before participating in the Power Your Drive for Fleets program. Do any of these barriers still exist after you participated in the program?" (n=7)

Program Satisfaction

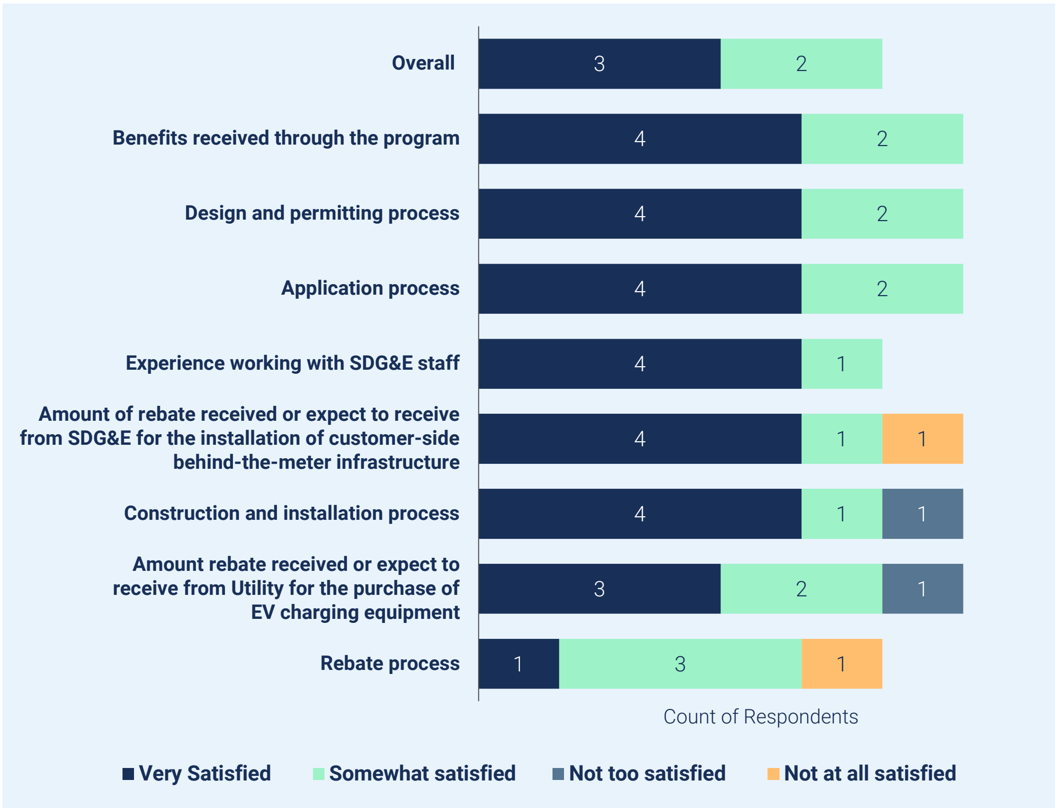
When asked to rank the likelihood of recommending the PYDFF program on a scale of 0 to 10, with 10 being the most likely to recommend, four of six fleet managers who answered the question had already recommended the program, while one fleet manager rated their likelihood as a 7 and one rated their likelihood as an 8. Together, these ratings led to a net promoter score of +100.[109]

Five fleet managers rated their satisfaction with their overall program experience as *very satisfied* or *somewhat satisfied*.

[109] The net promoter score is calculated by subtracting program detractors (those who rated their likelihood to recommend the program to others as a 0 through 6) from the program promoters (those who rated their likelihood to recommend the program as a 9 or 10). Those who gave a rating of 7 or 8 were labeled as passives and did not negatively or positively impact the score.

As shown in Figure 138, all responding fleet managers rated themselves as *very satisfied* or *somewhat satisfied* with benefits from received through the program (n=6), the design and permitting process (n=6), the application process (n=6), and their experience working with SDG&E staff (n=5). Two fleet managers were particularly satisfied with the SDG&E support teams, with one summing up their sentiment by stating, “we were satisfied with the project. [It] went well from start to finish.”

Figure 138. SDG&E PYDFF Satisfaction with SDG&E Program and Elements in EY2022



Source: Fleet Manager Survey Question B1. “Thinking about your experience with the Power Your Drive for Fleets program, how satisfied are you with the following?” (n=5 or 6). Not all fleet managers answered all questions, resulting in differing sample sizes per item.

As shown in Figure 138, one fleet manager was *not too satisfied* with the construction and installation process and one fleet manager was *not too satisfied* with the amount of the rebate received for the purchase of EV charging equipment (this respondent was also *not at all satisfied* with the amount of the rebate received for the installation of customer-side BTM and with the rebate process). Furthermore, three fleet managers provided comments about their dissatisfaction with the program. One said that although it is typical, air-side coordination is a challenge, one said the online rebate application had multiple glitches that delayed the rebate process, and one said it was difficult to receive the rebate for the chargers.

When asked, fleet managers shared what they would have done differently if going through the program again. One fleet manager would have accomplished better long-range planning, while another would have done more research to look at successes in other districts and taken a more future-looking approach. Two managers would have purchased different chargers, with one specifically noting issues with BTC Power chargers and the other saying they would have opted for alternative management systems. Another fleet manager would have waited for improvements and stability in V2G technology and L3 charging before beginning the implementation process. Yet another fleet manager wished they had better understood the importance of the relationship between chargers and third-party software.

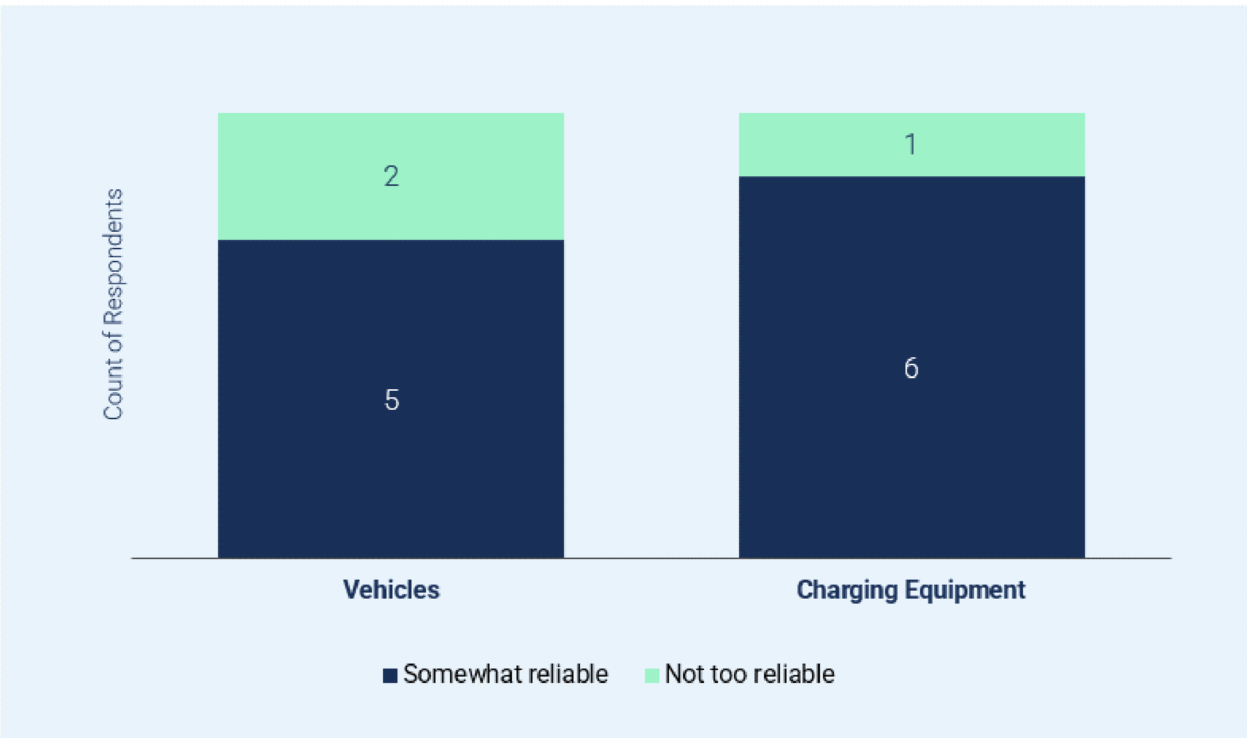
Program Awareness

The Evaluation Team asked fleet managers how they learned about the PYDFF program. Four of five fleet managers learned about the program directly from SDG&E and one learned about the program from an EV/EVSE manufacturer. Prior to joining the program five of six fleet managers knew they needed to upgrade the electrical infrastructure from the Utility grid to their meter to charge EVs at their site, while one fleet manager did not know what was needed.

Experience with EVs and Charging Infrastructure

The Evaluation Team asked fleet managers about the reliability and ease of using the EVs and charging equipment in their fleet: five of seven fleet managers gave positive responses about the reliability of EVs and two fleet managers rated EVs as *not too reliable* (Figure 139). Six fleet managers gave positive responses about the reliability of EV charging equipment and one rated it as *not too reliable*. One respondent who rated the charging equipment and EVs as *not too reliable* said the equipment was frequently not working.

Figure 139. Reliability of Vehicles and Charging Equipment in EY2022



Source: Fleet Manager Survey Questions C3 and C4. "How would you rate the reliability of the electric vehicles that are part of your fleet?" (n=7) and "How would you rate the reliability of the electric vehicle charging equipment?" (n=7)

Additionally, five out of seven fleet managers rated the ease of using EV charging equipment as *somewhat easy to use,* while one rated it as *very easy* to use and one rated it as *not too easy* to use.

Impact of Program on Fleet Electrification

The Evaluation Team asked fleet managers if they plan to accelerate their procurement of EVs and EV-related equipment because of their program experience. Three of seven fleet managers plan to accelerate their procurement of EVs. Two fleet managers will not make any change and two fleet managers plan to slow their procurement. Both of the fleet managers who plan to slow their procurement noted that range is a concern for EVs in their sector, while one of these fleet managers also mentioned issues with charging reliability.

The team asked the three fleet managers who plan to accelerate their procurement of EVs what aspects of the program impacted this decision. One fleet manager said they have charging infrastructure to support more EVs because of PYDFF. Another fleet manager plans to leverage program opportunities whenever possible.

The Evaluation Team asked fleet managers about the number of EVs they plan to acquire in the next 10 years. Four of six fleet managers with school buses in their fleet said they plan to electrify a combined total of 25 school bus, while the remaining two fleet managers do not plan to electrify additional school buses within the next 10 years.

One fleet manager who has transit vehicles plans to electrify one transit vehicle within the next 10 years, and the other does not plan to electrify any transit vehicles in that timeframe.

Three of four fleet managers with medium-duty vehicles said they will not electrify any medium-duty vehicles in the next 10 years. The remaining fleet manager plans to electrify two medium-duty vehicles in the next 10 years. One fleet manager plans to electrify their airport GSE.

The Evaluation Team asked fleet managers what other types of vehicles or equipment they plan to electrify in the next 10 years. Of the three fleet managers who responded, one plans to electrify their district maintenance fleet, while two plan to electrify passenger vans and white fleet passenger vehicles such as cargo vans, pick-up trucks, and district use vehicles.

The team asked fleet managers if they changed the number of EVs they acquired or plan to acquire based on program participation. Three of seven fleet managers said their program participation caused them to increase the number of EVs they acquired:

- “It encouraged [us] to electrify our bus fleet.”
- “Vehicle acquisition plans influenced conversations around potential transition of equipment. Specifically, around the electric shuttle bus conversions, the infrastructure being installed is enabling us to convert 30 existing natural gas transit bus to electric within the next five to 10 years, and to document that within the acquisition plan.”
- “With more chargers, we can now support more electric vehicles.”

Industry Perspective

The Evaluation Team asked fleet managers how well their industry or sector is positioned for electrification. As shown in Table 81, the five fleet managers in the school bus sector who answered this question had differing perspectives of their industry.

- The fleet manager who rated the sector as *somewhat well-positioned* said, "I think it's better than it was two years ago when we started."
- One of the fleet managers who was *neutral* about industry positioning said, "EV infrastructure is new to everyone. Vendors and end-users are both learning about the benefits and flaws."
- The other fleet manager who rated the industry as *neutral* said, "the EV school bus units are still evolving and need many more advancements and improvements to truly be the vehicle this industry needs them to be. I hesitate to convert my fleet to all EV due to the unreliability of the current version of these vehicles. In time, as range and reliability improve, I can envision a greater confidence in making the majority of our fleet electric. Until then, I need versatility with additional fuel sources."
- One fleet manager who rated the sector as *not too well-positioned* said the industry is moving too fast and more time is needed to make the change. The second fleet manager who rated the sector as *not too well-positioned* elaborated by noting that, "the funding is there; however, grants require vehicles to be 10 years or older, and that limits the equipment we can use for grant funding. The vehicles do not have the range to complete a route on one charge cycle, and charging is unreliable and not consistent enough to count on EVs for daily work."

The one airport fleet manager, who rated the sector as *neutral*, said, "airports are electrifying transportation at a fast pace, but the impacts to grid availability of power are significant and are presenting challenges to electrification. Many airports are now simultaneously carrying out power studies and EV charging studies, in addition to actually deploying EVSE."

Table 81. Industry Positioning for Electrification among Program Participants in EY2022

Market Sector	Extremely Well-Positioned	Somewhat Well-Positioned	Neutral	Not Too Well-Positioned	Not at All Well-Positioned
School Bus (n=5)	0	1	2	2	0
Airport GSE (n=1)	0	0	1	0	0

Source: Fleet Manager Survey Question F1. "How well-positioned do you think your industry/sector is for electrification?"
Note: No fleet managers provided a rating of *extremely well-positioned* or *not at all well-positioned.*

When asked about the availability of EV options in their sector, two of five fleet managers in the school bus sector rated themselves as *satisfied* with the EV options available.

The fleet managers identified two limiting factors to adoption:

- **Range.** Three school bus sector fleet managers said range is the limitation of EV options in their sector.
- **Procurement timelines and cost.** The fleet manager in the airport sector said the limitation in their sector is "procurement timelines (lead times) and costs."

The Evaluation Team asked fleet managers, given what they know or believe about requirements for fleets to purchase zero-emission MDHD trucks, whether they believe electric or diesel trucks seem like a riskier purchase in the next three years and in the next 10 years. Three of five fleet managers believe that diesel trucks are a riskier purchase than EVs in the next 10 years. In the next three years, two fleet managers (one airport and one school bus) said that diesel trucks are a riskier purchase while four fleet managers (all with school bus) said EVs are a riskier purchase.

Highlights

- Four of five responding fleet managers learned about the program directly from SDG&E.
- Fleet managers were primarily motivated to participate because of EV rebates and incentives, for EV charging infrastructure, expected maintenance cost savings, and environmental benefits as secondary motivators.
- All five responding fleet managers rated themselves as *very satisfied* or *somewhat satisfied* with their experience participating in the PYDFF program.
- Four of six fleet managers had already recommended the program.
- Five of seven fleet managers gave positive responses about the reliability of EVs, and six of seven gave positive responses about the reliability of charging equipment.
- The seven fleet managers were split on whether they plan to accelerate the procurement of EVs and EV-related equipment, with three saying they would accelerate, two saying they would make no changes, and two saying they would slow procurement.

Site Visit Findings

The Evaluation Team conducted a census and visited all 12 activated and operational sites in EY2022. These projects, described below, span four sectors: school bus, airport GSE, medium-duty vehicles, and TSE. The Evaluation Team's findings and observations varied widely. For example, one completed site had no charger usage because it was still awaiting its EVs. Another site was nearing completion of a second phase that is a separate PYDFF project. Two sites represented the only completed project in their respective market sector across the Utilities (an airport GSE project and a TSE project).

During each site visit the Evaluation Team collected both qualitative and quantitative information on fleet composition and operations. The purpose was to verify information such as the number of chargers installed, the EVSPs that were used, the types of vehicles on site or to be delivered, and the influence of project design on operations. The Evaluation Team additionally analyzed the load management capabilities of the chargers, the electrical infrastructure to support the station, future vehicle adoption and replacement plans, any public funding sources that were used, and the potential for on-site solar and/or storage.

These visits offered us valuable firsthand information on how program incentives were used at different types of sites. The Evaluation Team were able to converse with site operators about their experience with the program and factors that influenced their operations. Additionally, these visits offered us a chance to identify EVSPs to contact for the Evaluation Team's data collection, especially to gather vehicle charging session information needed for the evaluation.

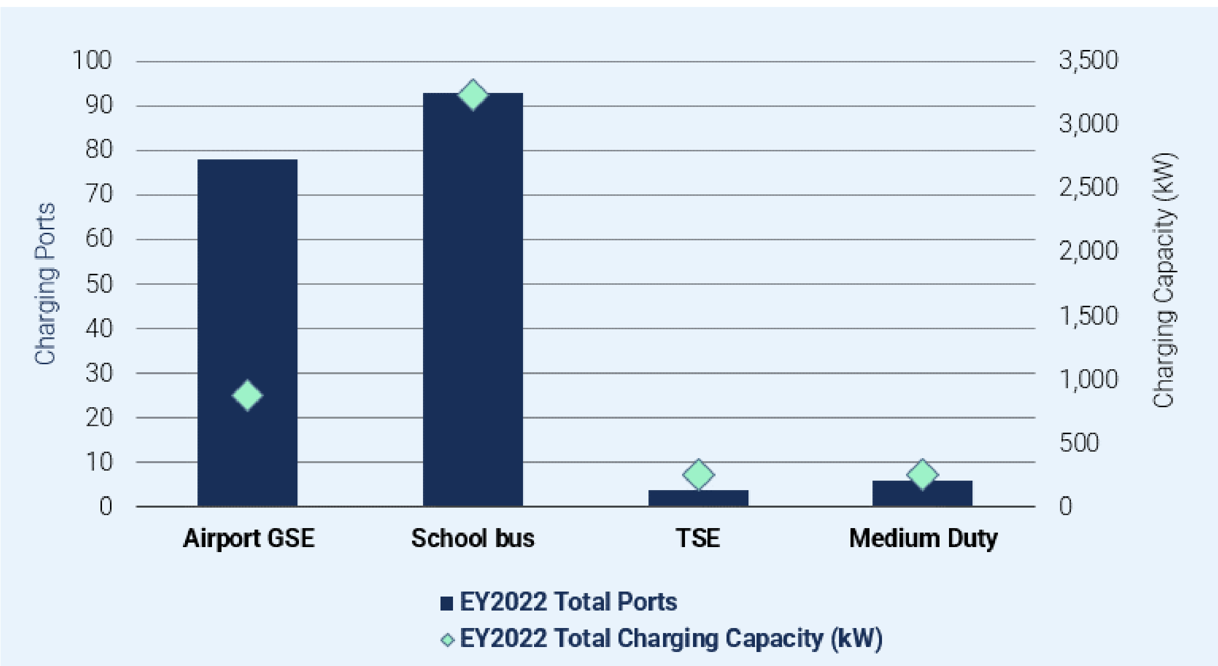
Table 82 provides a summary of charging site characteristics by market sector, with information on the number of sites visited, quantity of L2 and DCFC charging ports, and total charging capacity. Collectively, the Evaluation Team visited 12 sites with a total of 181 new charging ports and more than 4,600 kW of charging capacity.

Table 82. SDG&E PYDFF Program Site Summary, EY2022 Sites

Market Sector	Number of Sites	L2 Ports	DCFC Ports	Total Installed Charging Power Capacity (kW)
School Bus	9	31	62	3,232
Truck-Stop Electrification	1	-	4	250
Airport Ground Support Equipment	1	-	78	884
Medium Duty	1	-	6	250

Figure 140 summarizes site characteristics by market sector for EY2022 sites, including the total number of charging ports and installed charging capacity.

Figure 140. SDG&E PYDFF Summary of Site Characteristics by Market Sector, EY2022 Sites



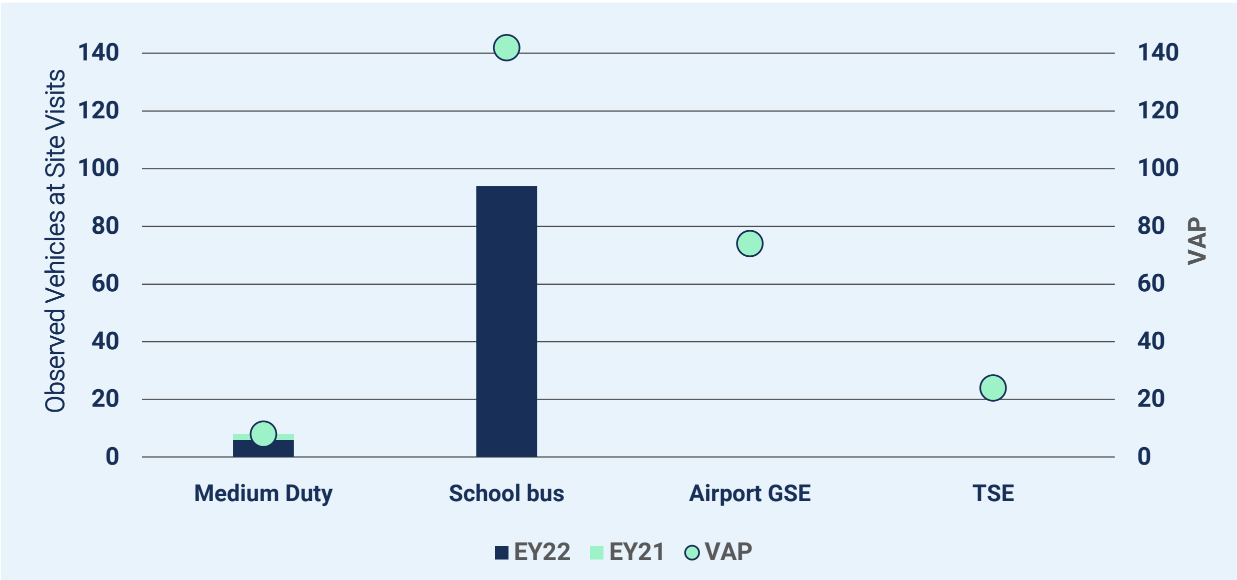
Note: Neither the airport GSE nor the TSE site had any new vehicles in operation, although both have acquisition plans.

Figure 141 shows a comparison of the number of vehicles observed during the Evaluation Team's site visits with the number of vehicles included in each site's long-term VAP. Of the total 246 vehicles in the VAPs, only 100 had been delivered by December 31, 2022. Among the remaining 146 vehicles, 94 are planned to operate at the nine school bus sites.

Neither the airport GSE nor the TSE site had any new vehicles in operation, although both have acquisition plans. The GSE site has letters of commitment for 74 vehicles over a three-year period. The TSE site intends to support their existing fleet customers and is open to the public, including for LDVs.

In the medium-duty vehicle segment, one project constructed in EY2021 that became operational in EY2022 accounted for six vehicles. The Evaluation Team visited this site for the EY2021 Evaluation Report.

Figure 141. Comparison of Long-Term VAP with Observed Site Visit Vehicles by Market Sector



Note: Neither the airport GSE nor the TSE site had any new vehicles in operation, although both have acquisition plans.

The following sections offer a summary of key observations and data from the Evaluation Team's site visits, organized by market sector.

School Bus

In EY2022, the Evaluation Team conducted site visits of nine school bus depots out of twelve total sites. These account for over 50% of total installed ports in the program.

Fleet operators at all nine of the sites the Evaluation Team visited described a similar schedule, with bus departing around 7 AM, returning around 9 AM, leaving again around 1 PM, and returning by 4 PM. One school district has a third route midday. Every bus spends about 15 hours at the depot when it can potentially charge, including overnight, at least three hours mid-morning, and on weekends.

School bus sites in the PYDFF program were more likely to install DCFC than

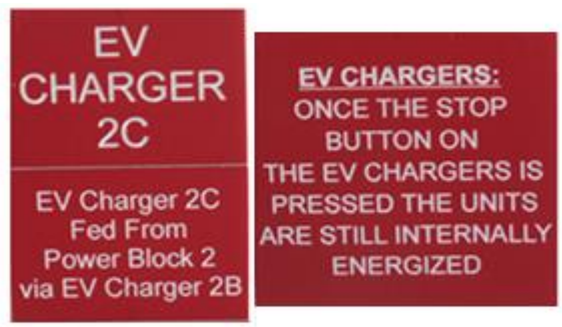
Figure 142. Centrally Placed EV Chargers that Maximize

comparable sites in the other Utility programs. Only one PYDFF site did not install DCFC. Four sites have DCFC and L2 charging, compared with only eight of 40 sites in the other Utility programs that have DCFC (five of which also had L2 charging).

Two school bus fleet operators said their school districts purchased DCFC hardware specifically to participate in vehicle-to-grid program services such as the Emergency Load Reduction program (ELRP). At the time of the Evaluation Team's site visits, no fleets had enabled load management to control charging schedules despite familiarity with applicable time-of-use rates.

One site operator made use of its DCFC system with sequential charging. The hardware and software application are relatively new, and it took several weeks for it to be tuned before the site operator was comfortable using it. This site operator specified that the vehicle's state of charge must be "complete" (vehicle fully charged) before a given power cabinet (60 kW capacity) can move on and initiate charging of the next vehicle in the sequence. The site operator learned that requiring a 100% state of charge increases the charging duration because the last 10% takes significantly longer. This delay could potentially cause a bus to be late for its next route.

Figure 143. Sequential EV Charger Labeling



Each 60 kW power cabinet supports three charging dispensers and is 35% more powerful than a typical 16.5 kW L2 EVSE. This site also installed dual-port DCFC chargers and is the second site the Evaluation Team visited to have installed make-ready infrastructure for future expansion. The site layout is shown in Figure 144.

Figure 144. School Bus Site with Sequential Charging and Make Ready Infrastructure

One school bus site installed among the lowest power L2 chargers, rated at 10 kW. Historical charging patterns at this site indicated a maximum usable 175 kWh, and 80% of charging sessions are half (or less) than this amount. The operator indicated that the slow speed of charging can be a hindrance and could limit their charging flexibility to avoid consuming power between 4 PM and 9 PM.

Truck-Stop Electrification

In EY2022 the team visited the single completed TSE project site, with four 62.5 kW DCFCs, each with a CHAdeMO and CCS port (only one is powered at a given time). The site host mentioned that each pair of chargers will have kits installed to support up to 125 kW per port.

The TSE site is near the Otay Mesa border crossing with Mexico, which is one of the busiest border crossings in the U.S. Access to these chargers is public and sized for semi-trucks with trailers, as shown in Figure 145. While there are four stalls, charger accessibility is limited by a charging cable length of 14 feet (compared to a maximum of 25 feet for other DCFC). Several trucking fleets serving the Los Angeles and San Diego ports, which are required to acquire ZEVs, currently fuel their conventional vehicles at this location.

Figure 145. Truck-Stop Charging Adjacent to U.S.–Mexico Border Crossing for Commercial Vehicles

Airport GSE

In EY2022 the team visited the first and single completed GSE project site as part of MDHD Standard Review Programs. While five GSE operators have committed to acquiring 74 vehicles over three years (with 41 baggage tractors, 21 belt loaders, and eight push back tractors) the airport could not confirm that any new vehicles were using the 78 installed charging ports. Electric GSE has been operating at this location for over two decades and the electric fleet continues to expand.

The installed ports represent just over 800 kW of capacity. Chargers were installed across approximately 30 gates to support the continued use and transition to EVs for airlines operating GSE. Notably, this project made use of chargers that can provide a wide range of voltage and charging needs (accommodating a variety of GSE types) and allow the fleet operators to better track energy consumption trends for the equipment (Figure 146).

Figure 146. Example of Enclosure Cabinet for Load Research Meters

This project is unique in that the size of the facility did not allow for Utility's traditional separate metering of the EV charging infrastructure. SDG&E did install load research meters (same units as for billing) to capture the consumption from each batch of chargers (usually grouped around one of the terminal gates). A site representative mentioned that a typical conduit run from an existing electrical room to a bank of chargers is between 200 and 300 feet but that no electrical capacity upgrades were required (Figure 147).

The Evaluation Team learned during the site visit that this was a significant project for the airport, as well as for the operators who want to pursue Federal Aviation Administration Voluntary Airport Low Emission (VALE) program funding. According to the site host, VALE funding contributed 75% of the total project cost while SDG&E funded about 10% of the total cost (including design review and charger rebates). Subject to VALE funding, these EVs will remain at this airport for their lifetime. This was the first BTM installation that a customer designed and built, and the SDG&E PYDFF program was limited to charger and construction rebates. Figure 147 and Figure 148 exemplify some of the vehicles expected to use these chargers.

Figure 147. Conduit Runs to Electrical Rooms and GSE Charging (push back tractor and belt loader)

Figure 148. Complex Airport GSE Charging Installation (baggage tractor and push back tractor)

Common Site Visit Findings

Many of the PYDFF sites visited in EY2022 are examples of large lots that required significant trenching and repair of existng pavement. However, one site appeared to have charging infrastructure installed entirely in softscape, which can reduce construction costs significantly. An example of this can be seen in Figure 149, whereas Figure 150 shows an example of a significantly more labor-intensive installation.

Figure 149. Example of Charging Infrastructure Installed Exclusively in Softscape

Figure 150. Mid-Parking Lot Installation of Dual Port DCFC Requiring Cement Work and Repair

At this site, fuel economy, fuel cost, and charging demand data are only available at the aggregate site level and not at the individual vehicle or route level.

During site visits, two fleet operators discussed their interest in distributed generation, including solar and energy storage. Operators also expressed interest in offsetting Utility billing costs and/or enhancing resiliency in the event of wildfires or other emergencies. These operators found that the current SB 350 Utility funding mechanisms impinged on their ability to include these elements in transportation planning. Specifically, one site reported that they are unable to tie into the Utility-owned BTM infrastructure to install a solar and storage project, which would have been privately financed. None of the operators were aware of their fuel costs or how they compared to their conventional vehicles.

Highlights

- Seven of the nine PYDFF school bus sites installed DCFC (two of which are the same location for a single district). Three of the school bus sites installed V2G capable chargers and another deployed sequential charging capability.
- While all of the visited sites exhibited operational profiles that seem to allow for load management, only one site is actively applying load management via a setting by the EVSP. This is an area of opportunity for SDG&E to provide additional customer education and assistance.
- The PYDFF program had the first TSE and GSE projects across all Standard Review Projects (SRP) Utility programs.
- The TSE project site has accessibility concerns due to short cable lengths, making charging potentially difficult depending on the vehicle charging port location.

Deep Dives

The Evaluation Team did not perform any deep dives for the PYDFF program in EY2022. The team selected sites for deep dives from EY2021, when only one PYDFF site was activated. Due to the low quantity of vehicles, the site did not meet the Evaluation Team's criteria for a deep dive (see the *Methodology* section).

Co-Benefits and Co-Costs

Through fleet manager surveys and site visits, the Evaluation Team identified several co-benefits and co-costs associated with the PYDFF program's vehicle electrification sites.

Fleet Manager Surveys

The Evaluation Team sent fleet managers surveys, which included questions asking about co-benefits and co-costs. These surveys included both aided (asking fleet managers if they have noticed a specific co-benefit or co-cost) and unaided (via an open-ended) questions.[110]

Table 83 shows that fleet managers expected to realize significant benefits for their community or fleet because of electrifying. Fleet managers had the highest expectations about reduced noise pollution and improved air quality and health. Six of seven fleet managers expecting *some benefits* or *significant benefits* in reduced noise pollution and improved air quality. Five of seven fleet managers expected *some benefits* or *significant benefits* in improved driver comfort and convenience and encouraging others to convert to EVs. Finally, fleet manager expectations about fleet flexibility were split. Three of seven expected either *some benefits* or *significant benefits* in this area and three expected *no benefits*. Additionally, one fleet manager said students' excitement to ride in electric bus was a benefit.

Table 83. Benefits Expected from Electrification in EY2022

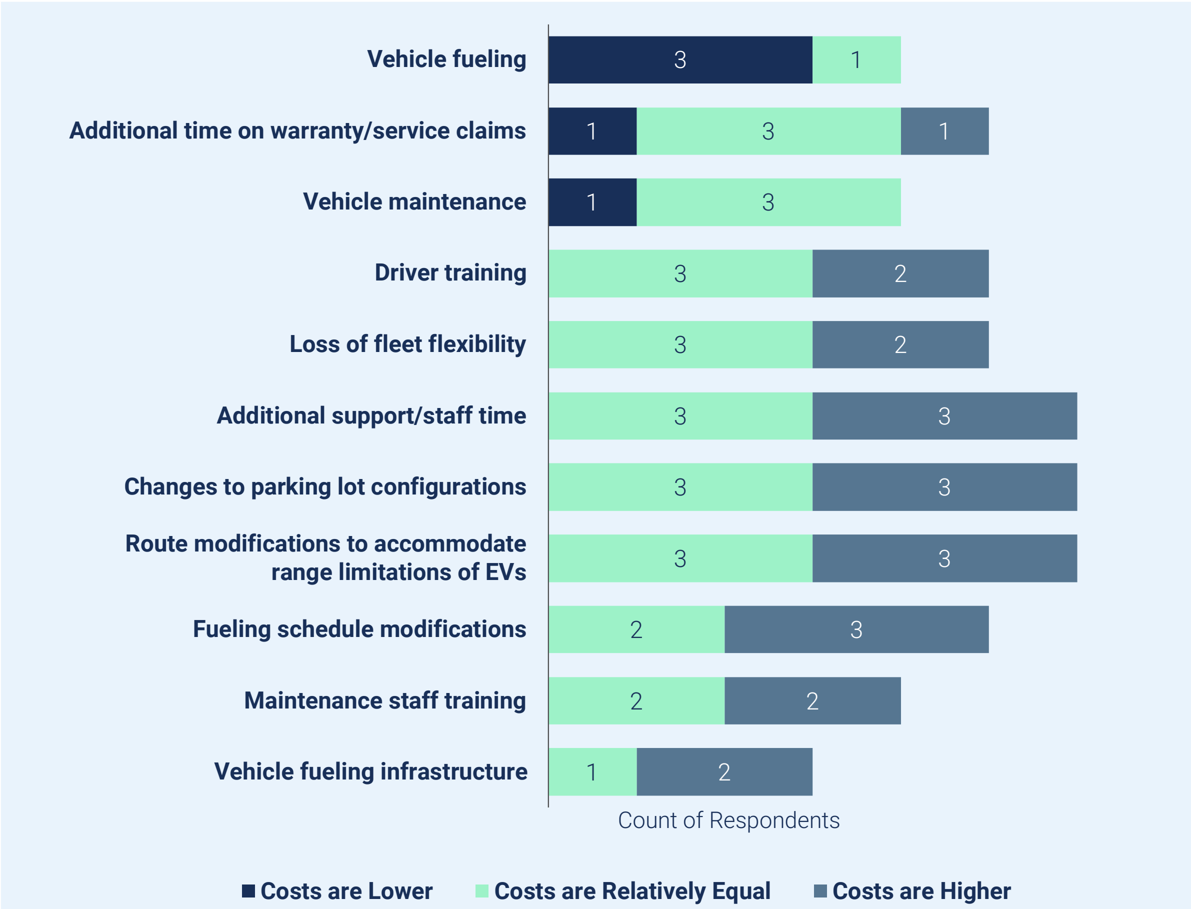
Benefit	Significant Benefits	Some Benefits	No Benefits	Not Sure
Reduction in noise pollution	5	1	-	1
Improved air quality/health	4	2	-	1
Improved driver comfort/convenience	3	2	1	1
Encourages other individuals/fleets to convert to EVs	2	3	-	2
Increased fleet flexibility	2	1	3	1

Source: Fleet Manager Survey Question D1. "What ancillary benefits do you think will be realized for your community/fleet as a result of electrifying?" (n=7)

Figure 151 shows surveyed managers responses to questions on the observed cost changes associated with operating and maintaining EV fleets. Three of four fleet managers said that vehicle fueling was *lower* since electrification. Four managers noted that costs were either *lower* or *relatively equal* for additional time on warranty and service claims (n=5) and vehicle maintenance (n=4). For the remaining cost categories, fleet managers reported that costs were either *relatively equal* or *higher* since electrifying their fleets. Three of five managers indicated *higher* costs for fueling schedule modifications and two of three fleet managers said vehicle fueling infrastructure costs were higher.

[110] The team received responses from seven SDG&E fleet managers, but the sample size (n) denoted in the tables differs because fleet managers could skip questions and response options. Despite the Evaluation Team's efforts to improve the response rate through multiple rounds of outreach and increased survey incentives, the fleet manager survey did not reach the target response number, which limits the insights that can be gleaned due to a smaller sample size.

Figure 151. Observed Cost Changes Since Electrification in EY2022

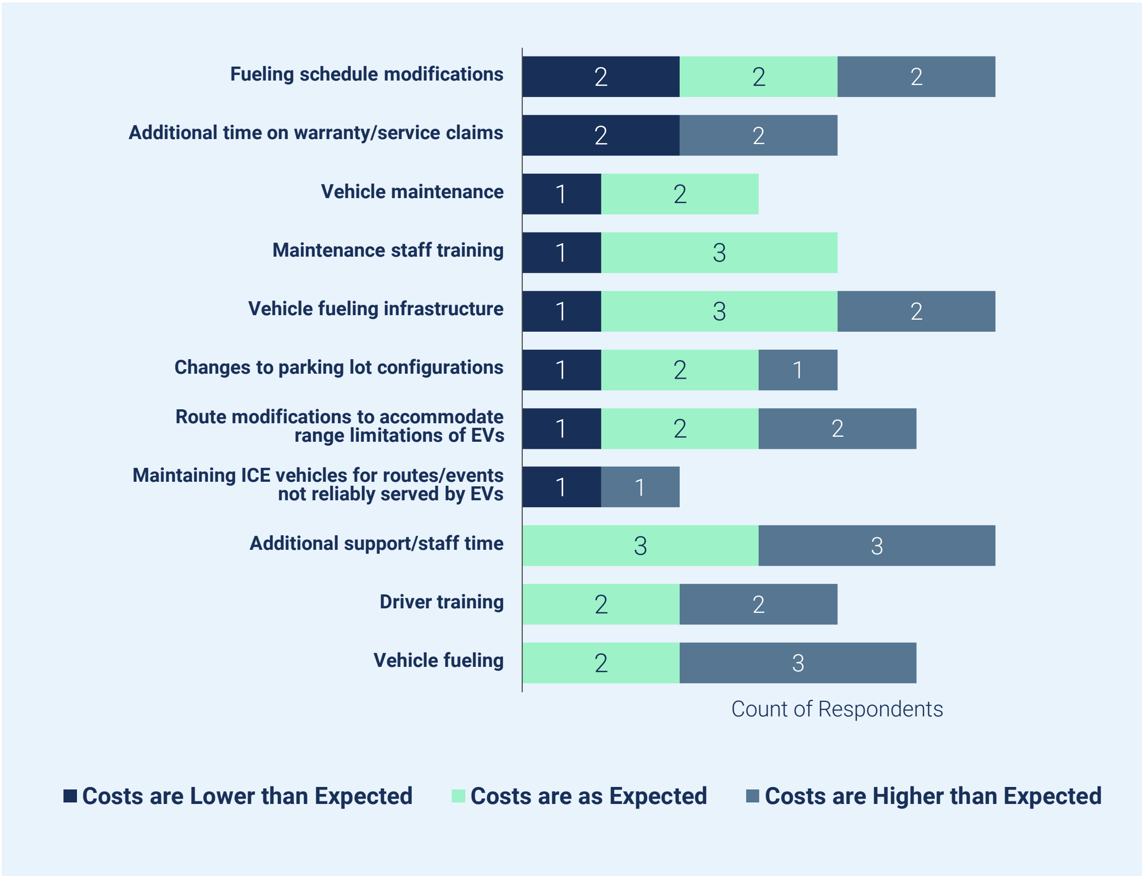


Source: Fleet Manager Survey Question E1. "Please think about all the costs associated with operating and maintaining your fleet. For each cost type shown below, please estimate how much the cost has changed since transitioning your fleet to EVs." (n=3 to 6)

The Evaluation Team also asked fleet managers about electrification cost expectations, or to what extent operational and maintenance cost changes aligned with their expectations prior to electrifying their fleet. As shown in Figure 152, two fleet managers said costs were *lower than expected* for fuel schedule modifications (n=6) and time spent on warranty and service claims (n=4).

Fleet managers indicated that cost changes were *as expected* for vehicle maintenance (two of three respondents) and maintenance staff training (three of four respondents). For certain cost categories, such as driver training (n=4) and additional support/staff time (n=6), fleet managers were split, with half reporting that cost changes were *as expected* and half reporting that costs were *higher than expected*. Three of five managers said vehicle fueling costs were *higher than expected*. One fleet manager noted that "there have been a few unexpected maintenance issues related to new [electric] bus, and until the full project build-out there is increased cost and complexity to maintaining battery states of charge, but I believe overall the O&M [operational and maintenance] costs have decreased." They went on to state that new EVSE infrastructure is the biggest component of electrifying, and that the Utility incentive programs has been critical to bridge that gap.

Figure 152. Differences in Electrification Cost Expectations in EY2022



Source: Fleet Manager Survey Question E2. "Have these operational and maintenance costs been what you expected?" (n's=3 to 6)

Additional Insights from Site Visits

The Evaluation Team incorporated qualitative insights from 11 EY2022 site visits to inform the co-costs and co-benefits findings. At the time site visits were conducted, all these fleets were only recently electrified and none of the site contacts were able to determine co-benefits at the time.

Regarding co-costs, one site contact each reported increased costs due to training for drivers and maintenance staff, loss of parking spaces, and route modifications to accommodate the range limitations of EVs. The remaining site contacts reported being unable to determine co-costs.

Figure 153 shows the costs identified during site visits. Two site contacts reported additional time on warranty or service claims and two reported costs due to additional support staff and time spent on duties such as plugging in vehicles or reporting. Two site contacts also reported *other* costs, with one specifying higher-than-anticipated electricity costs due to an inability to conduct load management and the other reporting issues with vehicle software updates and overall fit-and-finish quality issues with doors, mirrors, and parking brakes. These issues were reported as rendering the vehicle unfit for regular school bus service and less viable for V2G service. One site contact each reported increased costs due to training for drivers and maintenance staff, loss of parking spaces, and route modifications to accommodate the range limitations of EVs. The remaining site contacts reported being unable to determine co-costs.

Figure 153. Costs Identified during Site Visits

Highlights

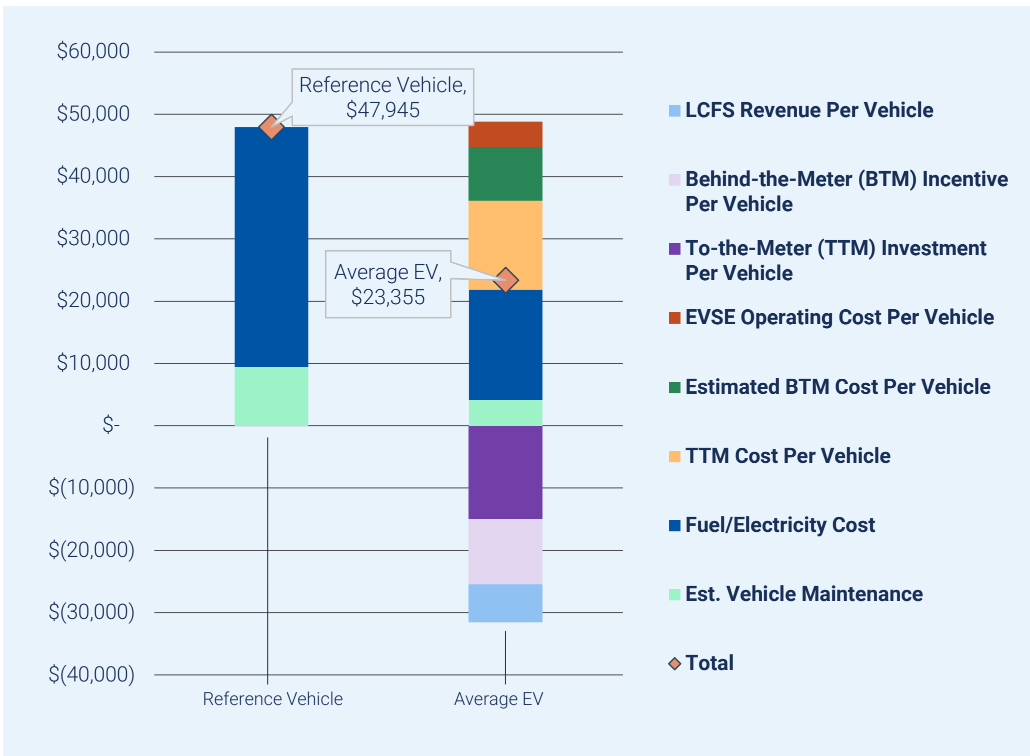
- All seven fleet managers cited benefits including reduced noise pollution and improved air quality, followed by improved driver comfort and convenience and encouraging others to convert to EVs.
- Fleet managers said costs were either relatively equal or higher since electrifying their fleets except in the case of vehicle fueling, for which three of four fleet managers reported lower costs.
- Reports of higher costs were most prevalent in areas that needed additional support time, changes to parking lot configurations, route modifications, and fueling schedule modifications. Site visits confirmed varied responses to cost with site contacts indicting higher-than-expected costs in areas such as additional time requirements (two respondents) and the need for additional support staff (two respondents).
- Fleet managers reported a range of responses regarding whether EVs met their expectations; for example, managers were evenly split on whether fueling schedule costs decreased, remained the same, or increased.

Total Cost of Ownership

The Evaluation Team conducted a TCO analysis for the PYDFF projects. Four projects were closed out and reported cost data. Although the team did not have information on the specific vehicles acquired and their purchase prices, we could rely on estimated prices. EV costs and rebates dominate the TCO analysis; specific vehicle rebates that a PYDFF customer may have received include the California HVIP incentive, the Commercial Clean Vehicle Tax Credit, and Air Quality Management District funding, in addition to SDG&E incentives. The precise level of vehicle incentives received by each fleet customer was unknown.

Figure 154 shows the TCO for the average vehicle in the PYDFF program *excluding* the vehicle price and any vehicle incentives received. Vehicle price and incentives are the largest and most uncertain cost components and removing them allows for greater clarity on the impact of the PYDFF program itself. The analysis does include estimated charging costs (based on reported EVSE electricity consumption) and operating costs (based on inferred annual mileage), as well as infrastructure costs and incentives.

Figure 154. Total Cost of Ownership Per Vehicle, Excluding Vehicle Price and Incentives, for PYDFF



All four sites reporting cost data had medium-duty trucks. Site EVSE data shows an average of 7,692 kWh per year for each vehicle. Assuming that the vehicles achieve 0.94 miles per kilowatt-hour (the actual efficiency of EVs varies by use case), this would correspond to about 7,257 miles per year. This low utilization results in relatively low operational cost savings, as shown in Figure 154. The 10-year NPV of the operating cost for the EV option is about $24,600 less than that for the conventional (ICE) medium-duty truck when considering the infrastructure cost. If the vehicles operated at 12,435 miles per year (the national average for delivery trucks, a common class of medium-duty vehicle), then the operational cost savings over conventional trucks would be about $62,000 per vehicle.

SDG&E provides an incentive approximately equal to 80% of the BTM cost; while the structure of the incentive may result in some differences from this value, the team used 80% to model site host BTM cost (the Evaluation Team divided the incentive by 0.8 to determine the gross BTM cost). Costs borne by the site host include approximately 20% of the BTM cost, as well as the cost of electricity to charge the vehicles, vehicle maintenance, and EVSE operating costs (such as charger maintenance and network fees).

Without incentives or utility investment, the total infrastructure and operating cost would be approximately $32,267 per site. The BTM incentive and TTM investment reduce this cost by $21,222, or about 66%. Of these, the TTM investment was larger for the average PYDFF customer, at $14,336 per vehicle, while the BTM incentive averaged $6,885 per vehicle.

With only four sites reporting in this segment, it is not possible to provide a distribution of costs without compromising individual site information. Utility spending resulted in an average spend of $195,420 per project site and $18,179 per vehicle for 4 financially closed out sites.

Highlights

- BTM incentives and TTM investments reduce the infrastructure and operating cost for medium-duty vehicles by 66% for the four projects assessed.
- The value of the TTM incentive by itself is greater than the 10-year NPV of electricity costs, vehicle maintenance costs, and EVSE operating costs combined.
- Vehicle purchase price and purchase incentives (including non-SDG&E incentives and tax credits) are by far the largest components of a TCO analysis but are not clearly known.
- VMT of assessed medium duty trucks is low, resulting in only modest operational cost savings compared to conventional trucks.

Grid Impacts

The team evaluated grid impacts for the PYDFF program based on the analysis of energy consumed by operational charging stations installed through the program in EY2022, combined with charging session data provided by the EVSPs. Table 84 presents a summary of estimated PYDFF grid impacts.

Table 84. SDG&E PYDFF Grid Impacts Summary

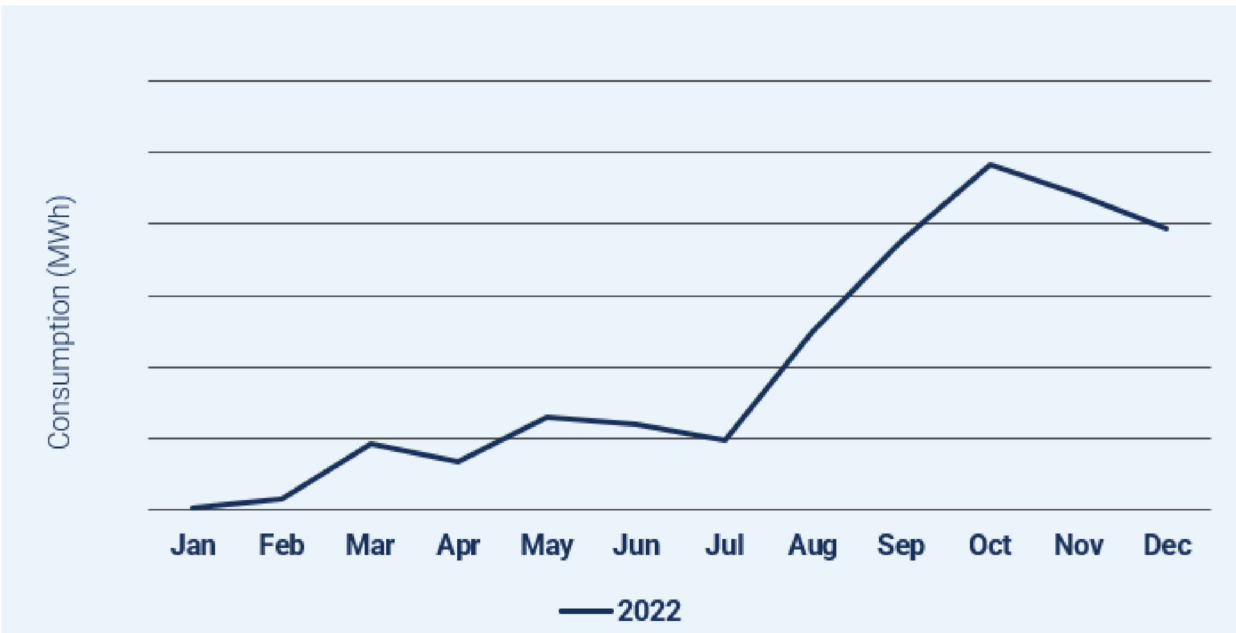
Impact Parameter	CY2022		Program to Date (n=13)	
	Actual EY2021 + EY2022 (n=13)	Annualized EY2022 (n=12)	Actual PTD	10-Year Projection PTD
Operational Sites				
Electric Energy Consumption, MWh				
On-Peak MWh (4 PM to 9 PM) (and % of total)				
Maximum Demand, kW (with date and time)				
Maximum On-Peak Demand, kW (with date and time)				

Note: values for population of less than 15 sites are redacted

The remainder of this section offers detailed findings on actual monthly consumption for EY2022 and maximum demand load curves.

Figure 155 shows total monthly electricity consumption in 2022 for all operational sites. There was a steep increase in energy consumption from summer to fall, which coincides with school bus projects becoming operational and schools coming back into session. Given the steepness of the line, more projects were becoming operational when the holiday season began, then showing a drop in November and December. As explained in the *Site Visit Findings* section above, some sites had not yet received all expected vehicles or had not yet put them into operation. Energy consumption is expected to further increase in 2023 when more of these vehicles enter fleet service.

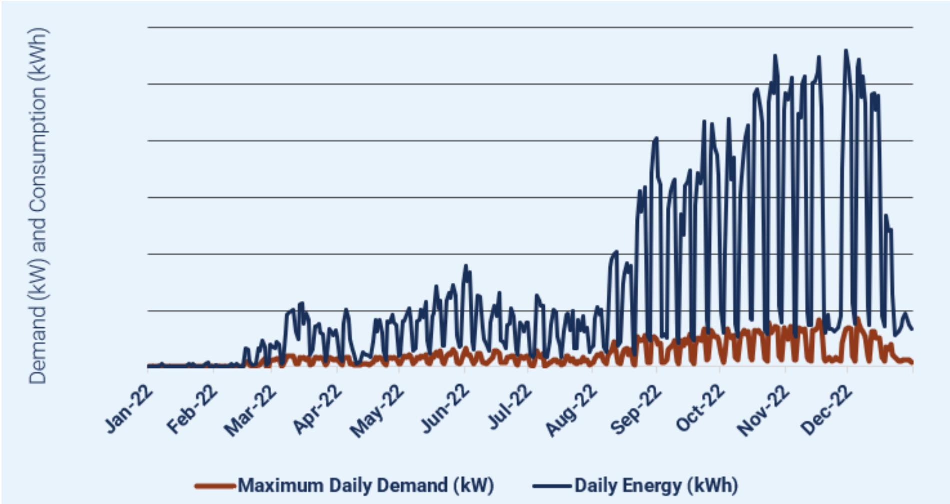
Figure 155. SDG&E PYDFF Program Monthly Electricity Consumption, Program-to-Date Sites



Note: Y-axis labels are hidden due to fewer than 15 sites

Figure 156 shows charging load and consumption in 2022, as projects came online and matured in operations. The Evaluation Team calculated load based on average demand within each 15-minute interval of Utility meter data. The low marks typically represent reduced weekend operation. Thirteen sites were operational in 2022. The maximum daily demand in 2022 was about 20% of the nearly 4,500 kW of installed capacity based on data collected from site visits. Notably, the low points that mark weekends in 2022 are several times larger than the low points for most days in 2021.

Figure 156. SDG&E PYDFF Program Maximum Daily Demand and Consumption, Program-to-Date Sites



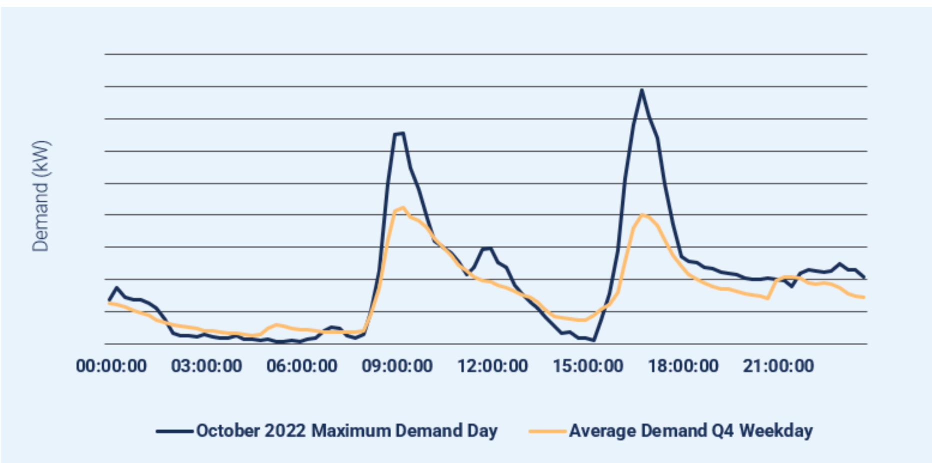
Note: Y-axis labels are hidden due to fewer than 15 sites

There are a few considerations (also discussed in the *Site Visit Findings* section above):

- Not all vehicles have been delivered
- Among delivered vehicles, not all operated reliably
- Many sites are still conservatively operating vehicles so as not run out of range
- Some sites installed charging capacity for anticipated vehicles they have not yet ordered

Figure 157 shows average weekday demand for Q4 2022 and daily peak demand on the highest day in the same time period, which is primarily attributed to school bus charging. As shown, the highest average demand occurs in the morning beginning at 8 AM, often coincident with lowest cost and lowest emissions electricity. However, there is substantial and nearly equal demand taking place between 4 PM and 9 PM, when energy is most costly.

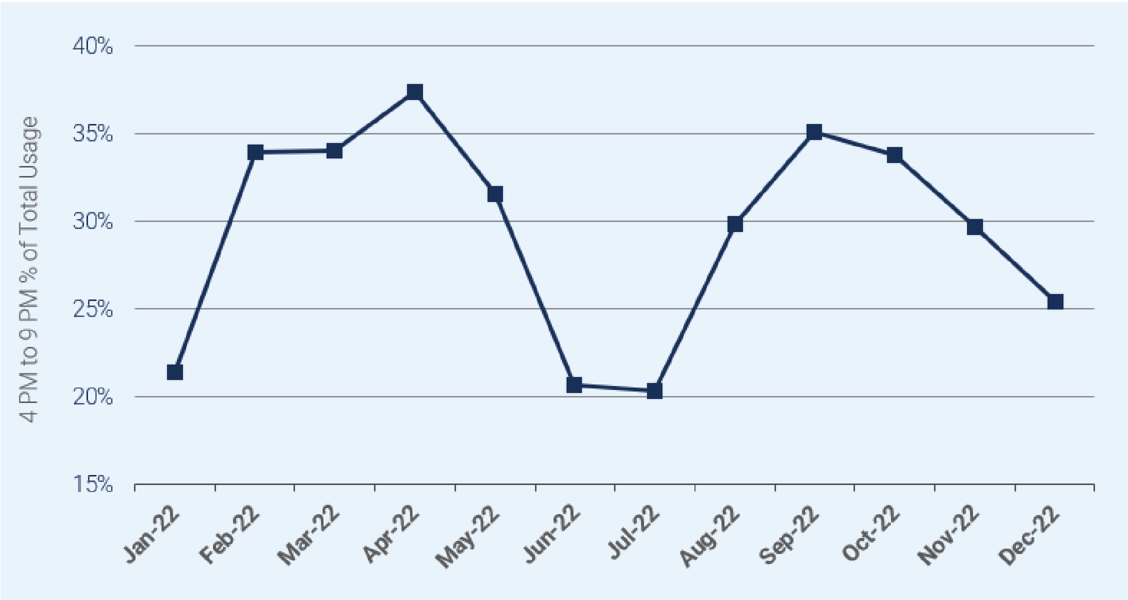
Figure 157. SDG&E PYDFF Program Demand on Highest Day and Average Fourth Quarter Weekday, Program-to-Date Sites



Note: Y-axis labels are hidden due to fewer than 15 sites

Figure 158 shows that overall consumption from 4 PM to 9 PM hovers around 35% of total energy consumed across all PYDFF program sites. This means that several fleets have high usage at times when power is expensive, contributing to grid congestion. The figure also shows that this percentage is lower during the summer when most school buses are not operating, which heavily influences the overall fleet load shape.

Figure 158. SDG&E PYDFF Program Monthly Proportion of Energy Use 4 PM to 9 PM, Program-to-Date Sites



School bus operations across the state shared many characteristics. These include similarities in duty cycles, EV battery capacities, and parking dwell times at charging location. This has resulted in similar load curves across sites. A closer look at school bus charging reveals certain trends and opportunities to shift usage to off peak.

School bus duty cycles are evident in analysis of charging session data. Figure 157 above shows that, on average, school bus charging reaches high demand in the morning, often coincident with lowest cost and lowest emissions electricity. There is a substantial and nearly equal level of demand taking place in the high-cost time period between 4 PM and 9 PM. This load shape indicates some amount of unnecessary energy costs that will adversely impact the TCO for school districts.

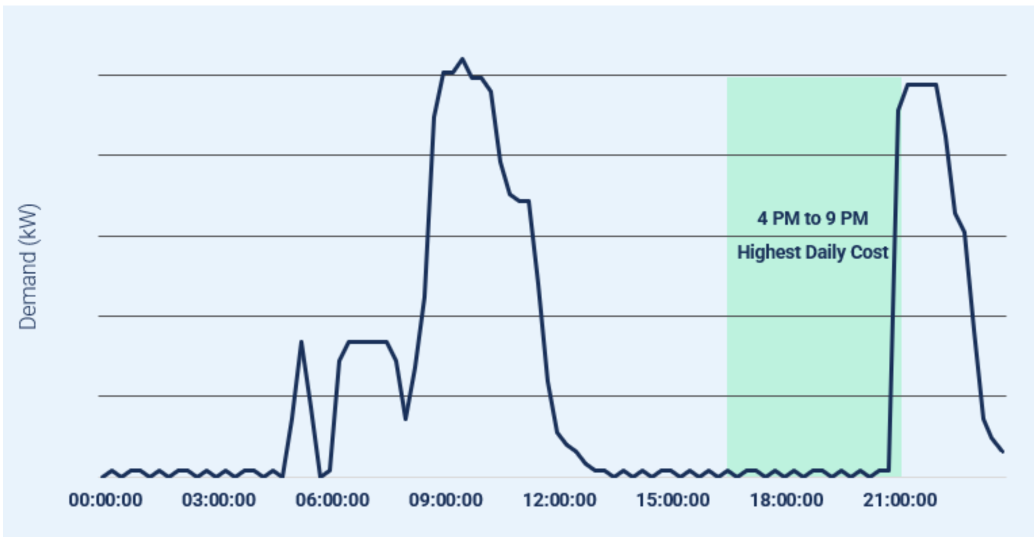
The Evaluation Team periodically reviews data on a site-by-site basis throughout the year to identify load management at project sites. The Evaluation Team's site visits offered an opportunity to meet in person with fleet managers who could offer additional context about operations and load management intentions. Of the 13 observed PYDFF sites, two sites clearly exhibited the use of load management. This was evident in two ways:

- Load spiking quickly around 9 PM, when the high-cost peak period ends

- Low monthly proportion of energy between 4 PM and 9 PM, often below 10%, during the highest cost period

In EY2021, a single site was using load management. That project was able to consume just 10% of the total electricity used during the 4 PM to 9 PM period. In 2022, a second site began using load management several months after beginning operations. After communicating with their EVSP to confirm the capability, they were able to schedule charging to avoid the highest cost time period each day. Figure 159 offers an example from this site's operation. Load ramps up quickly between 8 AM and 10 AM, then drops precipitously for the period from noon until 9 PM, and then rapidly ramps up to a similar load exhibited during the morning peak.

Figure 159. SDG&E PYDFF Program Example of Customer Using Load Management on Single Day

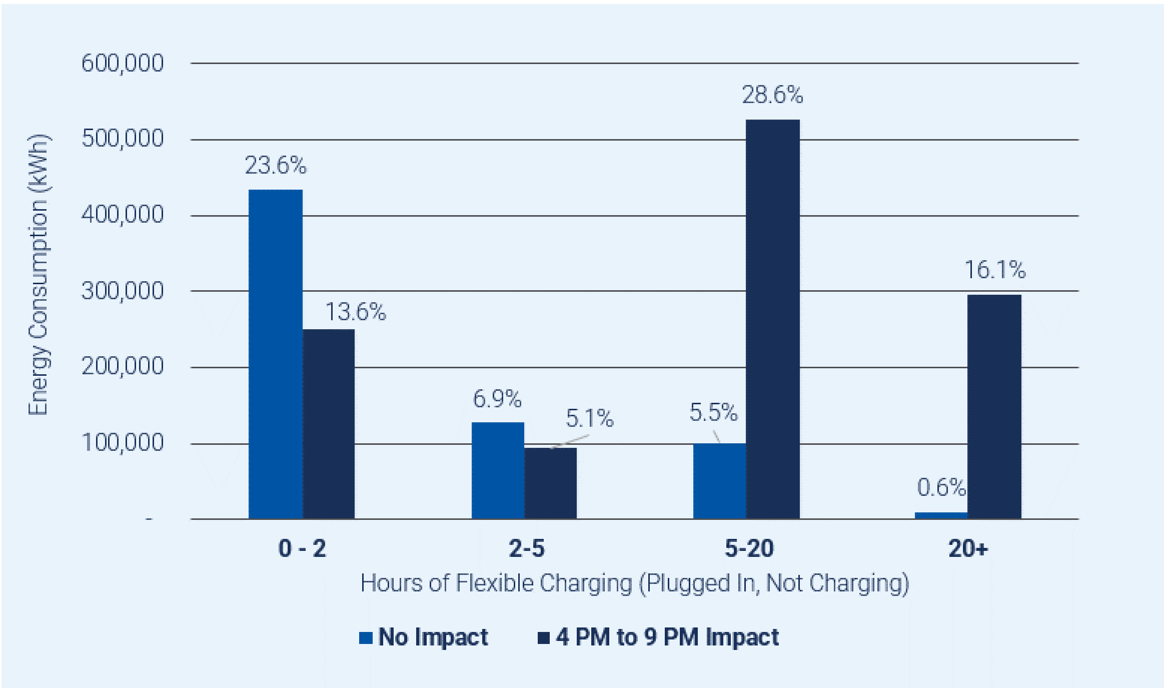


SDG&E's EV tariffs account for both time-of-use and demand-oriented pricing. This means that in addition to avoiding the 4 PM to 9 PM period, reducing demand can reduce the site Utility bills. Both of the load curves above (Figure 157 and Figure 159) show rather steep drops in demand after reaching the maximum. This could mean that vehicles complete their charge and then stay connected to the charging port for a significant amount of time.

The team used charging session summaries from EVSPs to assess potential flexibility for when charging sessions consumed energy. Flexibility is currently defined as how much time a vehicle was connected to a charging port in excess of electricity consumption. In the Evaluation Team's initial analysis of sessions, we scanned for realistic durations of connection or charging and potential faults ending sessions prematurely.

Figure 160 shows results of the charging flexibility analysis conducted by the Evaluation Team of school buses across all Utility programs. This analysis reveals that nearly 50% of charging energy and nearly 40% of school bus charging sessions (not pictured) overlapped with the high-cost peak demand period from 4 PM to 9 PM and appears to have sufficient flexibility (outside of 0-2 hour connection beyond charging consumption ending) to avoid consuming energy during this period. This indicates that most school bus charging can be optimized. It is apparent that load management strategies could allow operators to shift much of this consumption to other lower cost and lower emissions time periods. To a similar extent (not pictured), non-school bus charging appears to show that around 30% of charging sessions during the 4 PM to 9 PM peak-rate period have enough charging flexibility to avoid this time period through load management.

Figure 160. SDG&E, SCE, and PG&E MDHD Programs School Bus Charging Flexibility, Program-to-Date Sites



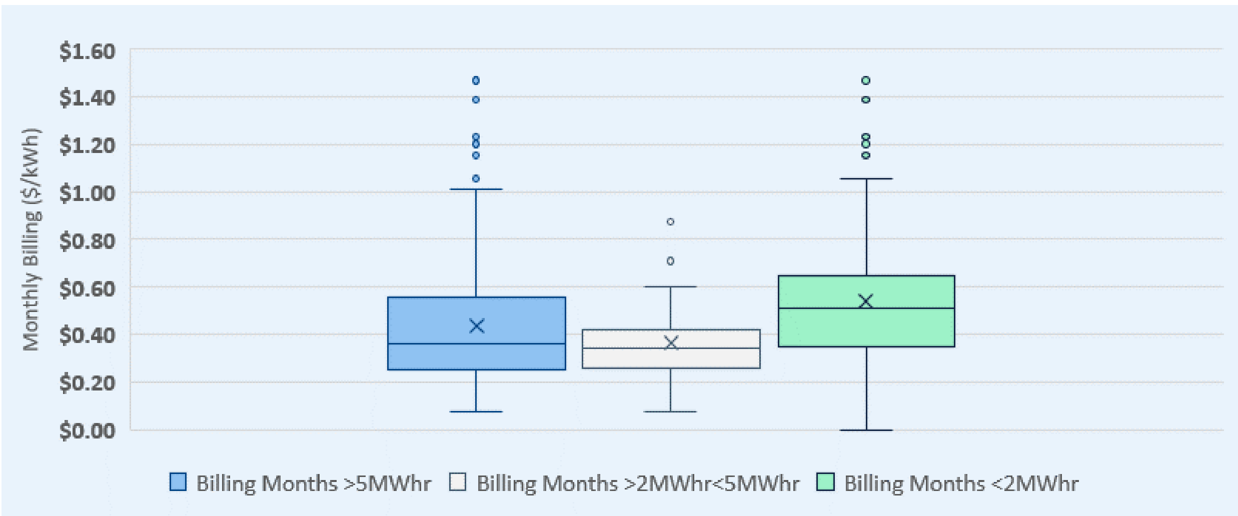
As part of the review process, the Evaluation Team frequently communicated with EVSPs, typically to collect data and verify site activity when charging session data should be flowing. During these conversations the Evaluation Team has often been able to discuss load management capabilities and usage trends.

Nearly every EVSP involved in the program provides reliable data. However, not all EVSPs offered load management throughout 2022. Of the EVSPs that did provide load management, there is a mix of those that provided all-inclusive load management, versus using a tiered or subscription basis. Interoperability between hardware, software, and vehicles has presented an additional challenge that could make load management impractical or difficult to achieve. As the EVSPs are pursuing a variety of business models, there is variability in both communication from the EVSP to a fleet operator, as well as ability to participate in load management.

While most EVSPs do provide a reporting function to fleet operators, many fleet operators are unaware of their consumption trends and the resultant costs. Often a finance office receives Utility bills but does not share this information with fleet operators, who could compare this data against other fuel types in their fleet. The Evaluation Team uses energy trends as discussion points during site visits if operations have started. Many fleets had not seen their data presented prior to evaluation site visits.

In terms of cost, larger and higher consuming fleets (above 5 MWh per month) generally have an average monthly utility billing costs below $0.40 per kilowatt-hour, as shown in Figure 161. These sites may be benefiting from higher consumption to spread out fixed fees and demand-related costs compared to sites with smaller consumption.

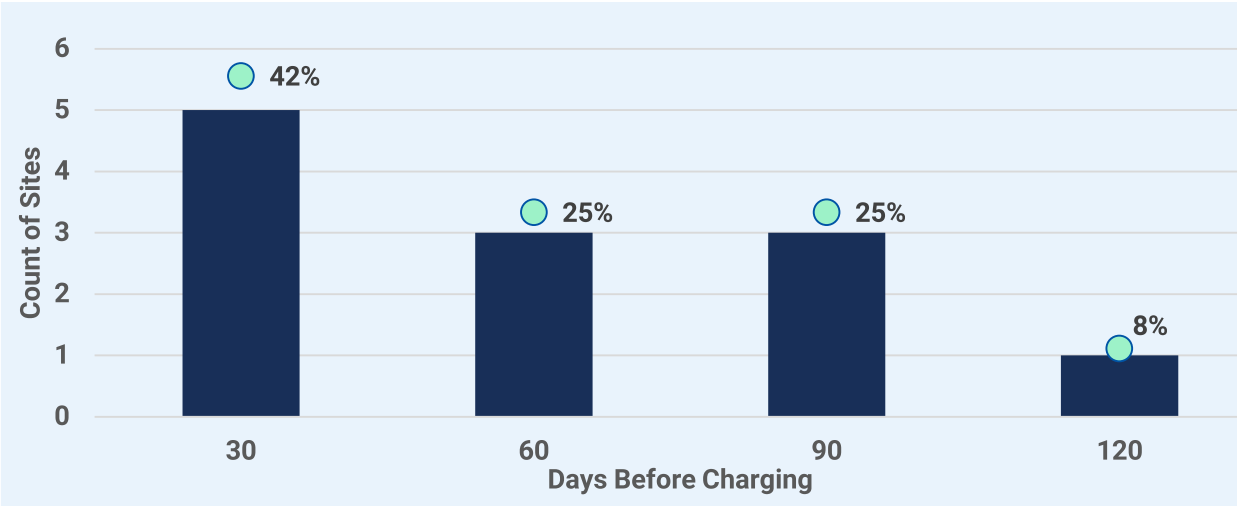
Figure 161. SDG&E PYDFF Monthly Utility Billing Costs for Sites, by Monthly Use, Program-to-Date Sites



Smaller energy consuming sites (that use below 2 MWh monthly) have an average monthly utility billing costs above $0.50 per kilowatt-hour and appear to have costs inverse to usage; less usage results in higher average cost with less consumption over which to spread fixed fees.

AMI data has shown that sites in general take substantial time to begin operations and then to stabilize or mature their new EV operations. Figure 162 summarizes the duration between power being available for sites and when charging first began. While approximately 45% of sites exhibit regular charging operation within the first 30 days, others can take significantly longer than that, typically due to supply chain issues (discussed in the *Site Visit Findings* section). This is important to note, as the sites brought online in EY2022 are likely to stabilize in consumption trends in 2023 compared to what was recorded in 2022. Some sites in EY2022 were not yet charging any vehicles or did not operate nearly as many vehicles as were listed in their long-term VAP.

Figure 162. SDG&E Program Frequency of Days between Site Energization and Start of Charging, Program-to-Date Sites



Highlights

- Charging data indicates that there is significant opportunity for most fleets to shift their charging energy use to lower cost time-periods.
- Interoperability between hardware, software, and vehicles presents as significant a challenge to load management as education and awareness.
- Nearly 40% of school bus charging sessions overlapped the 4 PM through 9 PM peak-rate period but have enough flexibility to delay charging to a lower cost time-periods with effective load management.

Petroleum Displacement

The Evaluation Team estimated petroleum displacement that is attributable to the vehicle electrification enabled by SDG&E's PYDFF program. DGE is used for reporting purposes. Transit bus primarily use CNG fuel, which required converting natural gas consumption into DGE units based on the energy content of the fuel.

Table 85 summarizes petroleum displacement impacts for PYDFF through 2022, including estimated annualized impacts for EY2022 sites, actual impacts for program-to-date sites, and the 10-year forecast for program-to-date sites. For EY2022 sites, the charging usage is estimated to displace more than 100,000 DGE on an annualized basis. The results below are reported for the four market sectors represented in the program, the majority of which were school bus. If there are fewer than 15 customers for any market sector, the results are shown as totals across all market sectors only.

Table 85. SDG&E PYDFF Petroleum Displacement Summary

Market Sectors	Usage		Petroleum Displacement (DGE)		
	EY2022 Sites Annualized kWh (n=12)	EY2022 Sites Annualized (miles, hours) (n=12)	EY2022 Sites Annualized (n=12)	PTD Sites Actuals (n=13)	PTD 10-Year Projection (n=13)
Airport GSE					
Medium-Duty Vehicles					
School Bus					
TSE					
Total		**734,052 miles**	**109,285**	**48,871**	**1,010,836**

Note: values for population of less than 15 sites are redacted

Based on the Evaluation Team's analysis of EY2022 operational sites, the program is on target to displace over a million DGE over a 10-year period. The actual displacement will be higher as more EVs are added at existing sites. In addition to greater use at existing sites, SDG&E will build out additional sites through the program, resulting in higher total program impacts in the months and years ahead.

Highlights

- The 12 operational EY2022 sites resulted in an annualized impact of more than 100,000 gallons of displaced petroleum.
- Over a 10-year period, all sites in the program to date can be expected to displace more than 1,000,000 gallons of petroleum.

Greenhouse Gas and Criteria Pollutant Impact

The Evaluation Team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service because of PYDFF. First, we developed ICE counterfactual equivalents for each market sector, then calculated the emissions associated with these vehicles under conditions that otherwise matched the EVs, to provide a baseline. Although EVs have no tailpipe emissions, the mix of generation sources from the electric grid used for vehicle charging includes renewable as well as fossil fuel power to supply electricity to the charging stations, with the latter primarily responsible for emitting GHGs and criteria pollutants into the atmosphere.

Table 18 summarizes GHG impacts from PYDFF for three time periods: (1) estimated annualized reductions that reflect what the program would have saved in 2022 if all EY2022 activated sites had been fully operational for all 12 months, (2) actual program to date reductions from EY2021 and EY2022 activated sites, and (3) a 10-year projection based on annualized data from EY2021 and EY2022 activated sites.

Table 86. SDG&E PYDFF GHG Reductions Summary

Market Sector	Usage		GHG Reduction (MT)		
	EY2022 Sites Annualized kWh (n=12)	EY2022 Sites Annualized Use (n=12)	EY2022 Sites Annualized (n=12)	PTD Sites Actuals (n=13)	PTD 10-Year Projection (n=13)
Airport GSE					
Medium-Duty Vehicles					
School Bus					
TSE					
Total		**733,752 miles**	**946.70**	**409.7**	**9,032.5**

Note: values for population of less than 15 sites are redacted

Table 19 shows the estimated reductions in local emissions from the tailpipes of ICE vehicles that were displaced through this program. The estimates of local emissions reductions are still relatively small in the first two years of the program, with most of the reductions occurring from the airport GSE. GSE have a particularly poor emission profile as they are considered off-road vehicles and therefore have historically adhered to less stringent emission regulations compared to on-road vehicles.

Table 87. SDG&E PYDFF Local Emissions Reductions, Actual Program-to-Date Sites

Market Sector	PTD Sites Actuals (n=13)				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Airport GSE					
Medium-Duty Vehicles					
School Bus					
TSE					
Total	**17.7**	**2.9**	**2.7**	**25.7**	**802.2**

Note: values for population of less than 15 sites are redacted

Table 20 shows the same information as above but on an annualized basis for EY2022 sites. These are the localized emissions reductions would have been if the sites were fully operational for the entire year. This annual estimate is necessary to calculate a 10-year reduction projection based on the program to date results.

Table 88. SDG&E PYDFF Local Emissions Reductions, Annualized EY2022 Sites

Market Sector	EY2022 Sites Annualized (n=12 sites)				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Airport GSE					
Medium-Duty Vehicles					
School Bus					
TSE					
Total	**53.4**	**8.0**	**7.4**	**71.9**	**2,100.7**

Note: values for population of less than 15 sites are redacted

Table 21 provides an estimate of savings over the 10-year period. These are the annualized reductions from all projects to date extended over a decade.

Table 89. SDG&E PYDFF Local Emissions Reductions – 10-Year Projection Program-to-Date Sites

Market Sector	PTD Sites 10-Year Projected Impact (n=13 sites)				
	HC (kg)	PM_{10} (kg)	$PM_{2.5}$ (kg)	ROG (kg)	CO (kg)
Airport GSE					
Medium-Duty Vehicles					
School Bus					
TSE					
Total	**1,401.2**	**183.0**	**169.3**	**1,858.7**	**42,394.8**

Note: values for population of less than 15 sites are redacted

Table 22 shows counterfactual vehicle GHG emissions, emissions from the electricity used to charge the EVs, and GHG emissions reductions and percentage change. Table 23 shows the net reductions of NO_x emissions from using EVs based on the counterfactual and Utility emissions. The Evaluation Team estimated a total GHG reduction of 84% and a reduction in NO_X of 88% from the use of EVs compared to counterfactual vehicles for EY2022. In balance, the sites reduce local (tailpipe) emissions. Looking at the program to date, there is an estimated 82% reduction in GHG emissions and 84% reduction in NO_x emissions.

Table 90. SDG&E PYDFF Counterfactual GHG Reductions

Market Sector	EY2022 Sites Annualized GHG (MT) (n=12)				PTD Sites GHG (MT) (n=13)			
	Counter factual	Utility	Reduction	% GHG Reduction	Counter factual	Utility	Reduction	% GHG Reduction
Airport GSE								
Medium-Duty Vehicles								
School Bus								
TSE								
Total	**1,128.19**	**181.49**	**946.70**	**84%**	**500.5**	**90.9**	**409.7**	**82%**

Note: values for population of less than 15 sites are redacted

Table 91. SDG&E PYDFF Counterfactual NO_x Reductions

Market Sector	EY2022 Sites Annualized NO_x (kg) (n=12)				PTD Sites NO_x (kg) (n=13)			
	Counter factual	Utility	Reduction	% NO_x Reduction	Counter factual	Utility	Reduction	% NO_x Reduction
Airport GSE								
Medium-Duty Vehicles								
School Bus								
TSE								
Total	**1,451.33**	**177.63**	**1,273.70**	**88%**	**567.0**	**88.2**	**478.8**	**84%**

Note: values for population of less than 15 sites are redacted

Figure 163 shows the annual program net electricity generation mix matching the hours when the EVs were charging. The CAISO grid mix continually changes depending on factors such as the level of total demand for power on the grid and the availability of fossil generation as opposed to variable renewables resources such as solar. At this early stage of the program, it appears that the vehicles were not charging predominantly during the peak hours of solar output. Over 17% of the grid mix is comprised of electricity imports, which do not vary by time of day for analysis purposes, but match the resource mixed purchased for the California grid.[111]

Based on the real-time grid conditions when the charging occurred, the overall energy mix was about 48% zero-emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 35% natural gas. Emissions reductions from these sites over 10 years are expected to increase as the grid becomes cleaner. Additionally, the increased adoption of managed charging, where possible, would reduce emissions as EVs charging is shifted off peak and grid power is provided by greater amounts of renewable generation. Finally, emissions will further decrease as more charging sites and EVs are added in the future evaluation years.

Figure 163. SDG&E PYDFF Program Net Electricity Mix, Annualized EY2022 Sites

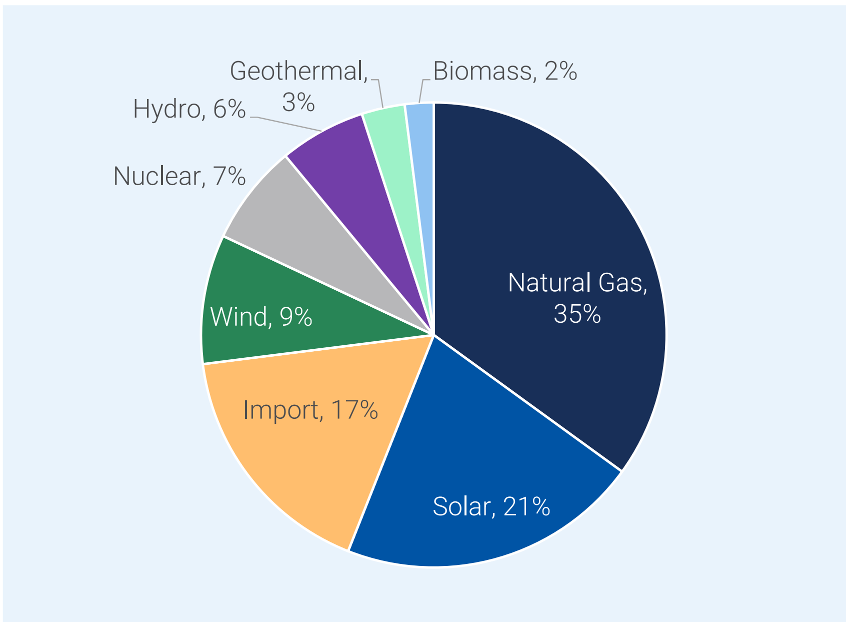
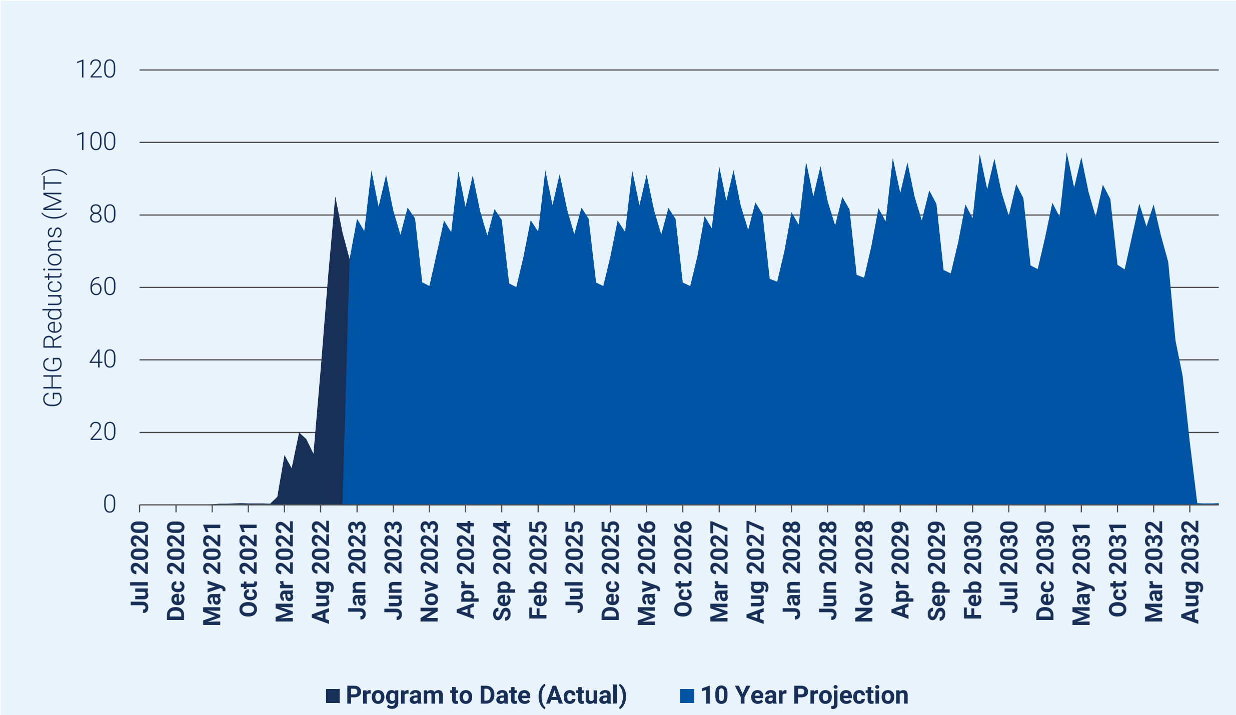


Figure 164 shows how program GHG reductions have increased to date and are expected to grow over time for EY2021 and EY2022 activated sites. The analysis period ranges from the date that the first site in the program was activated through the end of 2022. The analysis incorporates the net reduction (counterfactual emissions minus utility emissions) for each fleet within the SDG&E PYDFF program. Program to date emission reductions are shown in dark navy while anticipated benefits based on annualization are presented in royal blue. As each site has its own starting date of operation, the 10-year sunset for each site is observed as a gradual tapering off of program benefits between 2031 and 2032. While each year's operations appear similar, there are several key factors driving the variations such as seasonality of utility generation sources (high utility emissions will appear as a dip on the

111 The power associated with imports comes from a mixture of renewables, hydro, nuclear, and natural gas power plants located outside of California (https://www.energy.ca.gov/data-reports/energy-almanac/california-electricity-data/2021-total-system-electric-generation).

curves), holidays occurring on weekends versus weekdays, and sites that became operational late in 2022 having predicted operations year-round in future years.

Figure 164. SDG&E PYDFF Program GHG Reductions, Historical and Forecasted, Program-to-Date Sites



Highlights

- For EY2022 sites, analysis of annualized data estimated an 84% reduction of GHGs and an 88% reduction in NO_x emissions.
- The local emissions analysis for these sites estimated that the highest impact was the reduction of CO (annualized reduction of 2,100 kg and a projected 10-year reduction of 42,395 kg).
- Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 48% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 35% natural gas.

Health Impacts

The Evaluation Team calculated public health impacts (benefits and costs) of reductions in criteria pollutants from vehicle electrification. Pollutants included in the analysis are primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, including NO_x, SO_2, NH_3, and VOCs. This analysis only considers tailpipe emission reductions, rather than the full lifecycle emissions (power plant emissions). The Evaluation Team used the U.S. EPA's COBRA to evaluate the health benefits associated with the emission reductions. COBRA estimates the benefits at the county level for the county in which emissions are reduced. It also estimates the effect on all counties in the United States due to the transport of emissions. This analysis includes only the effects of the emissions reductions in California. The

Evaluation Team disaggregated the county-level effects to estimate the potential health benefits of projects for DACs and non-DACs.

Economic value depends on the health effects associated with the emissions, that is, whether they are associated with illnesses or death. The monetary value of the morbidity reductions associated with the emission reductions include avoided lost wages, avoided medical costs, and the amount people are willing to pay to avoid a negative illness like respiratory diseases. The value of the reduced mortality associated with the emission reduction is measured by the value of a statistical life, which uses value-of-life studies to determine a monetary value of preventing premature mortality. COBRA reports both a low and high impact, representing the uncertainties in the estimates.

The total value of the health benefits associated with the emission reductions is between $29,345 and $66,090. Table 92 shows the cumulative health benefits for counties in California associated with the emission reductions realized by the electrification of EY2021 and EY2022 SDG&E PYDFF sites.

Table 92. California Health Benefits for SDG&E PYDFF EY2021 and EY2022 Sites

Health Endpoint	Change in Incidence (Annual Cases)		Monetary Value (Annual, 2023 Dollars)	
	Low	High	Low	High
Mortality	0.002	0.005	$28,752	$65,075
Nonfatal Heart Attacks	0.000	0.002	$51	$473
Infant Mortality	< 0.000	< 0.000	$160	$160
Hospital Admits, All Respiratory	0.001	0.001	$27	$27
Hospital Admits, Cardiovascular	0.001	0.001	$39	$39
Acute Bronchitis	0.004	0.004	$3	$3
Upper Respiratory Symptoms	0.065	0.065	$3	$3
Lower Respiratory Symptoms	0.046	0.046	$2	$2
Emergency Room Visits, Asthma	0.001	0.001	$1	$1
Asthma Exacerbation	0.068	0.068	$6	$6
Minor Restricted Activity Days	2.008	2.008	$217	$217
Work Loss Days	0.342	0.342	$84	$84
Total Health Effects	**-**	**-**	**$29,345**	**$66,090**

The school bus sector has the highest health benefits overall, followed by the airport GSE, medium-duty vehicle, and transportation refrigeration unit segments. On a per-site basis, the single airport GSE site provided the most health benefits. The market sector results reflect health impacts from sites constructed in 2022, and these trends may change as more projects are completed.

As part of this analysis, the Evaluation Team also examined the health benefits within DACs. The COBRA tool estimates effects at the county level, so the team disaggregated the monetary health benefits by census tract using the relative population of each tract from the most recent American Community Survey. For example, a census tract with 10% of the county's population was allocated 10% of the value of the health benefits. The team then estimated the total benefits allocated to DACs and non-DACs. This approach implicitly assumes that the benefits of emission reductions are distributed evenly throughout the county. If the sites are located in DACs, and the emission reductions are greater in the tracts near the sites, this approach would understate the potential benefit to DACs. Additional information about emission dispersion within counties is needed to provide more precise estimates of the health benefits to DACs and non-DACs.

Most of the health benefits were in San Diego County, which had 65% of the total benefits, followed by Los Angeles County (12%), Riverside County (11%), Orange County (5%), and San Bernardino County (3%). Overall, 14% of the benefits are in DACs. San Diego County has the highest health benefit allocation due to sites being located in the SDG&E territory, however counties outside of the SDG&E territory also accrue health benefits due to the accounting of air dispersion and transport of emissions.

Highlights

- Cumulative monetary health benefit for counties in California realized by EY2021 and EY2022 PYDFF sites range from $29,345 for the low and $66,090 for the high estimate.
- Sites in the school bus sector have the highest health benefits overall while the airport GSE site provided the most benefits on a per-site basis.
- Most of the health benefits were in San Diego County, which had 65% of the total benefits, followed by Los Angeles County (12%), Riverside County (11%), Orange County (5%), and San Bernardino County (3%).
- Overall, 14% of the benefits are in DACs.

Net Impacts

As part of the net impacts analysis, the Evaluation Team estimated program effects on participants to exclude impacts from actions that participants would have taken without the program (freeridership) and to include any program-attributable indirect impacts on participants (participant spillover) and nonparticipants (market effects). The team conducted three separate analyses to assess net impacts from the MDHD programs.

Enhanced Self-Report

The Evaluation Team based the Evaluation Team's approach for the MDHD programs' enhanced self-report NTG analysis on information obtained as part of in-depth surveys with participating fleet managers. The team conducted the survey via an online survey platform, Qualtrics, and delivered the survey using email contact information provided by SDG&E. The Evaluation Team used the CPUC nonresidential customer self-report NTG framework as the base to develop the MDHD fleet manager NTG methodology approach.[112] The *Methodology* section details the MDHD fleet manager self-report NTG methodology. The Evaluation Team estimated the core component of the CPUC NTG methodology through three separate program attribution index (PAI) project scores. The team used three separate sets of questions to assess three components of the core NTG ratio, with each PAI score on a 0.0 to 1.0

[112] California Public Utilities Commission, Energy Division. February 20, 2015. *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Nonresidential Customers.*

scale representing a different way of characterizing the SDG&E PYDFF program influence. The analysis included fleet manager responses from seven of the 11 participating sites that were sent the survey.[113]

The Evaluation Team calculated the resulting self-report NTG for each project, prior to accounting for participant spillover, as the average of the PAI-1A, PAI-2, and PAI-3 score values. One minus the final core NTG ratio of 0.63 equals the 0.37 freeridership ratio for the PYDFF program. For participant spillover, one responding participating fleet manager reported purchasing 10 additional electric school buses since they started participating in the SDG&E PYDFF program for which they did not receive funding from the SDG&E program and where they rated their SDG&E program participation as *extremely important* in their purchasing decision. The fleet manager reported that this additional fleet electrification activity received funding from two separate organizations; therefore, the Evaluation Team did not quantify spillover for the program. The final program level NTG ratio of 0.63 equals one minus the freeridership ratio plus the participant spillover ratio. These score values are presented in Table 93, along with the average final core NTG for the surveyed SDG&E PYDFF program sites.

Table 93. EY2022 MDHD Fleet Manager NTG Analysis Results

Fleet Manager Survey Completes (n)	Average of PAI-1A Score NTG	Average of PAI-2 Score NTG	Average of PAI-3 Score NTG	Average of Final Core NTG	Freeridership Ratio	Participant Spillover Ratio	Final NTG Ratio
7	0.70	0.49	0.71	0.63	0.37	0.00	0.63

Highlight

- The EY2022 program-level freeridership ratio is 0.37 and the participant spillover ratio is 0.00, resulting in a program-level NTG ratio of 0.63.

Truck Choice Model

The Evaluation Team assessed the impacts of the Utility MDHD programs using a modified version of the Truck Choice Model, developed at the University of California-Davis.[114] The model mimics new vehicle purchase decisions made by MDHD fleet operators when accounting for lifecycle vehicle and operating costs and human preferences. Notable barriers to electric MDHD vehicle adoption—such as vehicle availability for specific market sectors—is not captured in the model. The Evaluation Team calculated new MDHD vehicle adoption for four market sectors—transit bus, school bus, medium-duty delivery trucks, and heavy-duty delivery trucks (short-haul)—for 2025, 2030, and 2035. The team developed three scenarios that vary who pays for the TTM and BTM infrastructure for electric MDHD vehicles,

[113] Five school bus sites, one distribution site, and one airport site completed the survey.

[114] University of California–Davis Institute of Transportation Studies (Miller, Marshall, Qian Wang, and Lewis Fulton). 2017. *NCST Research Report: Truck Choice Modeling: Understanding California's Transition to Zero-Emission Vehicle Trucks Taking into Account Truck Technologies, Costs, and Fleet Decision Behavior*." Research Report UCD-ITS-RR-17-36.

thereby isolating the impact of the TTM and BTM expenses on the vehicle purchase decision, all else equal:

- **Scenario 1: No Utility Support.** No Utility support for TTM or BTM. The fleet operator pays for the BTM costs, including EVSE installation and EVSE capital expenses.
- **Scenario 2: TTM Support.** Utility provides support for TTM infrastructure as required by AB 841 but the fleet operator pays for the BTM costs, including EVSE installation and EVSE capital expenses.
- **Scenario 3: TTM + BTM Support.** Utility provides support for both TTM and BTM infrastructure, including partial rebates for EVSE installation and capital expenses.

Table 26 shows new MDHD vehicle adoption for the three scenarios and four market sectors. The difference between scenarios within a market sector is the impact of Utility-sponsored TTM or TTM+BTM infrastructure. For example, for school buses in 2025, the difference between the No Utility Support and TTM+BTM Support scenario is 26% (29% - 3%), which—under the assumptions in the model—implies that Utility support for TTM and BTM infrastructure will increase electric school bus adoption by 26 percentage points.

Table 94. BEV Sales Shares for Each Segment as a Function of the Three Trajectories

Market Sector	2025	2030	2035
School Bus			
No Utility Support	3%	21%	40%
TTM Support	11%	45%	74%
TTM + BTM Support	29%	69%	92%
Transit Bus			
No Utility Support	1%	41%	84%
TTM Support	41%	80%	100%
TTM + BTM Support	44%	99%	100%
Medium-Duty Delivery			
No Utility Support	0%	0%	0%
TTM Support	2%	5%	7%
TTM + BTM Support	33%	63%	65%
Short-Haul			
No Utility Support	0%	0%	0%
TTM Support	1%	5%	9%
TTM + BTM Support	9%	30%	43%

The results illustrate that new electric MDHD vehicle adoption increases substantially across market sectors when TTM and TTM+BTM support is provided. Results also demonstrate the importance of the HVIP program, California's vehicle incentive program. For market sectors with high HVIP incentives relative to the new vehicle cost, like transit bus, adoption rates are higher than for other market sectors that have lower relative incentives compared to new vehicle cost, like short haul.

There are several reasons for caution when interpreting these results. For example, HVIP and LCFS funding levels vary year to year based on decisions in the state government or market fluctuations in the

LCFS credit market. Additionally, the Evaluation Team have intentionally ignored California's ACT and ACF regulations, which mandate the sale and purchase of zero-emission MDHD vehicles. This allows the Evaluation Team to isolate the impact of only the TTM and BTM costs. Finally, as noted above, results do not reflect certain known barriers to electric MDHD vehicle adoption, like vehicle availability, which would dampen the trajectories.

Highlights

- In scenarios in which fleet operators have no financial responsibility for TTM or BTM infrastructure expenses (TTM+BTM Support Scenario) and have no external constraints or requirements on vehicle purchases (such as vehicle availability and ACF purchase requirements), results of the Truck Choice Model suggest that Utility TTM and BTM programs are critical to changing the adoption trajectory of MDHD vehicles.
- Factors that are not easily captured in the model (such as ACF regulation, switchgear wait times, and vehicle availability) could change the trajectories.

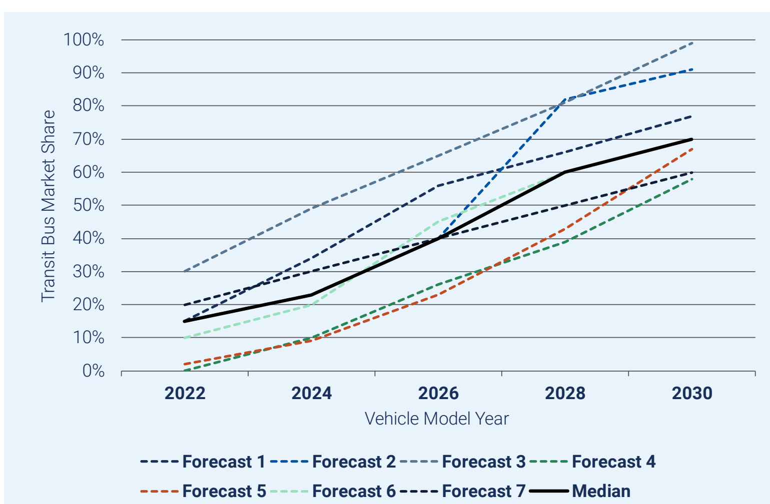
Market Effects

For the market effects analysis, the Evaluation Team assessed structural long-term changes in the TE market by comparing market activity to what would have happened in the absence of the programs.

Transit Bus Electrification Market Share Baseline

The Evaluation Team developed a baseline market share forecast of electric transit bus in California through vehicle model year 2030 based on two rounds of input from the Delphi process. This baseline represents electrification in the transit bus market in California in the absence of Utility incentives. Figure 165 shows the individual curves from the first round of input (Round 1), along with the median curve. Note that the horizontal axis indicates vehicle model year and only applies to *new vehicles*, not to the entire statewide vehicle stock.

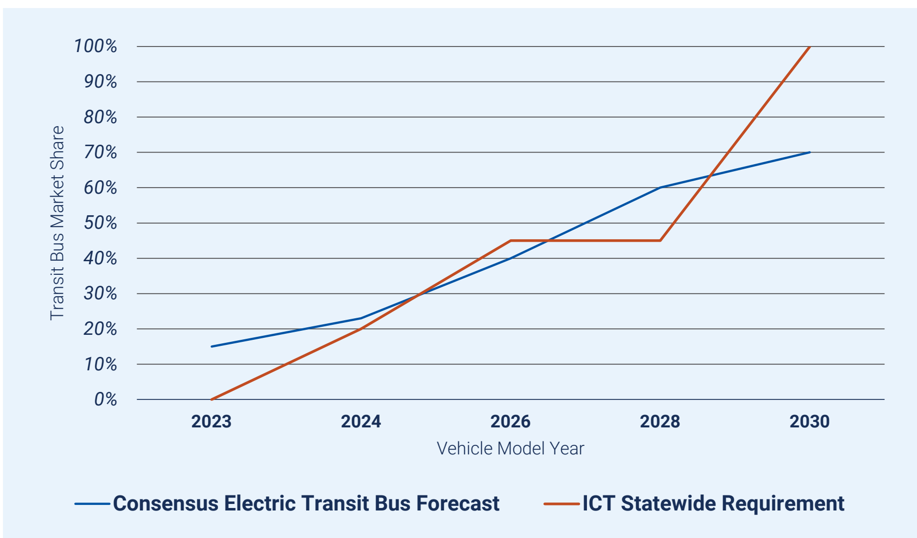
Figure 165. Delphi Panel's Round 1 Baseline Electric Transit Bus Adoption Forecasts



Despite the range in Round 1 forecasts, there was general agreement within the Delphi panel that the electric transit bus market will experience relatively linear growth over the next several years and will reflect most of the overall transit bus market by 2030. In Round 2, five of seven panelists agreed with the median or consensus forecast, while two panelists submitted new forecasts and rationales. As described in the *Methodology* section, the forecasting rounds continue until a majority consensus is reached. Since over half the panelists were in agreement after Round 2, the median forecast is considered the final consensus result. Figure 166 shows the final consensus estimate compared to the zero-emission transit bus sales schedule from the ICT regulation. The ICT regulation specifies calendar year purchase requirements (where a certain percentage of all new vehicle purchases must be zero-emission) for California public transit agencies.[115]

The consensus trajectory generally aligns with the ICT requirement for 2024 and 2026. It stays above the ICT required level for 2028 but falls short of the 100% requirement for 2030, possibly because the ICT regulation allows for flexibility in how transit agencies meet purchase requirements. Hydrogen fuel cell bus are also considered zero emission under ICT.

Figure 166. Delphi Panel's Electric Transit Bus Baseline Market Share Forecast



Of the two experts who did not agree with the median, one said the market share will grow faster than the median forecast starting in the mid-2020s due to headwinds against the fossil fuel industry, increased public support for electrification, and compliance with the ICT requirements. The other dissenting expert said the median forecast is too aggressive and that the electric transit bus market share will grow at a slower rate due to supply chain constraints (specifically that there are many competing demands for these batteries, such as for use in LDVs).

115 The ICT regulation specifies different sales requirements for small (<100 bus) and large (>100 bus) transit agencies. The Evaluation Team used the statewide requirement in the Evaluation Team's analysis, which assumes similar turnover at large and small transit agencies.

While deriving the majority consensus forecast achieved the main goal of the Delphi panel, panelists' supporting rationales also contain valuable qualitative information. Aggregating the supporting comments revealed deeper insights into factors that panelists predict will accelerate or impede transit bus electrification in California.

One panelist specifically cited the $1.3 billion in annual Federal Transit Administration grants for low- and zero-emission bus and infrastructure that is expected over the next five years. Another panelist projected that starting in the 2026 to 2028 timeframe, the TCO for many transit bus will achieve cost parity, which will drive up market penetration. Another noted that EV penetration will likely continue to increase with technology improvements, cost reductions, and competition in the transit EV market.

One panelist noted that without continued funding support at the federal and state levels, such as CARB's HVIP program, transit agencies may struggle to electrify larger proportions of their fleets. It will be particularly challenging to finance new bus if existing bus are still mid-lifecycle and not up for replacement. Buses are typically retired on a 12-year cycle; however, transit agencies may be down-sizing their bus fleets due to increased micro-transit and demand response service, which could alter vehicle replacement timing and subsequently slow the speed of adoption. Rationales for forecasts with lower and slower market growth included the possible lack of manufacturer compliance and the persistence of late adopters due to technology concerns.

Although this study only considered battery electric transit bus market share, two panelists also mentioned hydrogen fuel cell technology. Fuel cell bus could potentially allow the ICT requirement to still be met without achieving 100% battery electric bus market share in the transit bus segment by 2030. Fuel cell bus may become an attractive option if battery supply remains constrained. One expert noted that the advancements in and adoption of hydrogen will aid battery electric technology, specifically using hydrogen as an energy storage technology to support high-powered EVSE.

The fact that the consensus forecast falls short of ICT requirements in 2030 shows that experts believe it will be challenging for transit agencies to scale all-electric fleets to the ICT regulation levels without additional support. The consensus forecast represents the market share of electric transit bus in the *absence* of California Utility incentives. In conclusion, panelists agreed that transit agencies may struggle to scale up charging infrastructure and electrify larger proportions of their fleets to meet the later ICT requirements without either financial incentives and support from various sources, including Utilities, or the help of other ZEV technologies such as fuel cell bus.

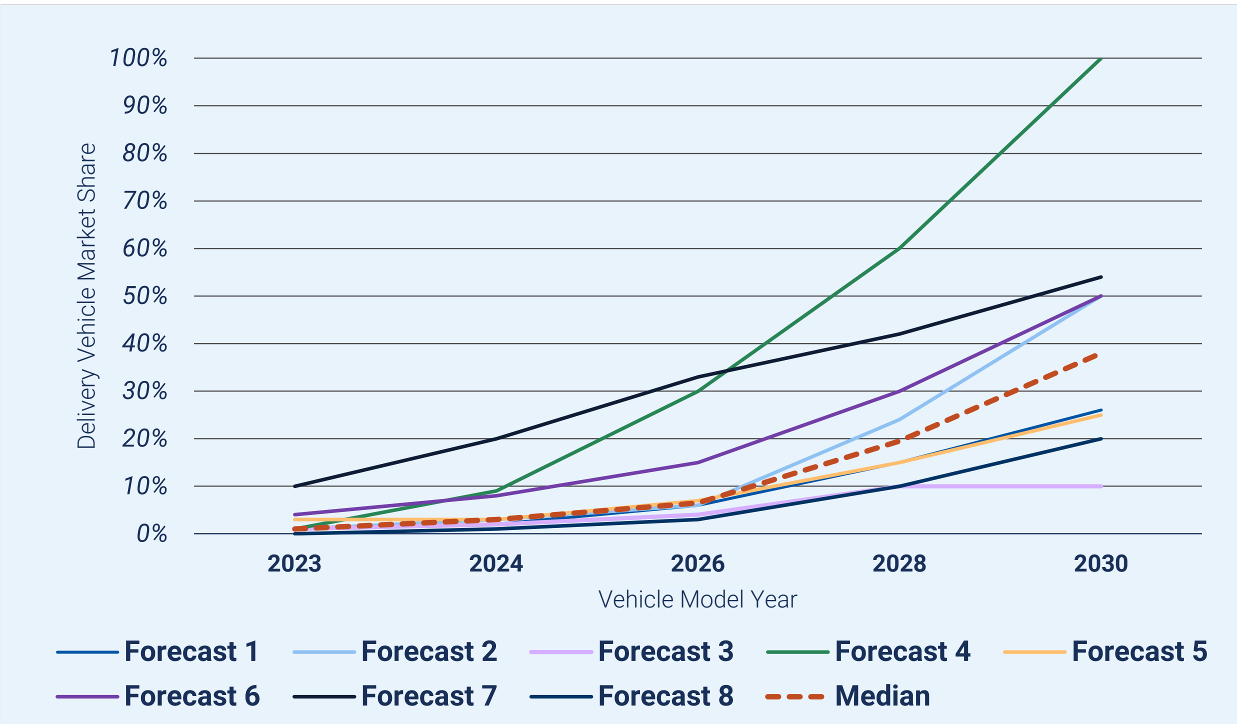
Highlights

- The consensus forecast for electric transit bus market share in California generally aligns with the ICT regulation requirements for 2024 and 2026 but falls short of the 100% level for 2030.
- Increased availability of funding is the primary factor in transit agencies meeting the initial purchase requirements of the ICT regulation, while economics will drive adoption starting in the mid- to late-2020s due to battery technology improvements, cost parity with diesel bus, and technological advances in charging infrastructure.

Delivery Vehicle Electrification Market Share Baseline

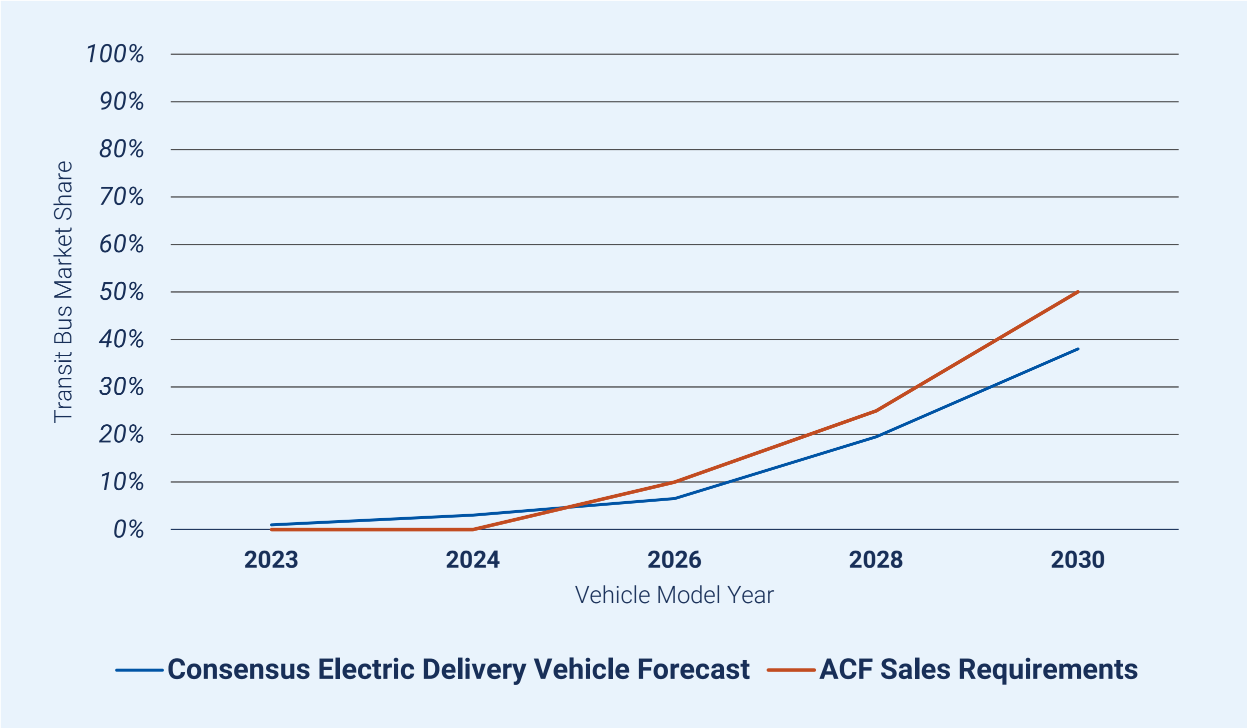
The Evaluation Team forecasted the baseline market share of electric delivery vehicles in California through vehicle model year 2030 following two rounds of input from the Delphi process. For this study the delivery vehicle market sector is defined as cargo vans, step vans, and box or straight trucks operating last-mile parcel delivery. Figure 167 shows the individual curves from the first round of input (Round 1), along with the median curve. Note that the horizontal axis indicates vehicle model year and only applies to *new vehicles*, not to the entire statewide vehicle stock.

Figure 167. Delphi Panel's Round 1 Baseline Electric Delivery Vehicle Adoption Forecasts



The Round 1 forecasts contain a few outliers, but in general panelists agreed that the electric delivery vehicle market will increase slowly until a tipping point in the mid-2020s when growth accelerates. In Round 2, five of eight panelists agreed with the median or consensus forecast, while three panelists submitted new forecasts and rationales. As described in the *Methodology* section, the rounds continue until a majority consensus is reached. Since over half the panelists were in agreement after Round 2, the median forecast is considered the final consensus result. Figure 168 shows the final consensus estimate compared to the zero-emission sales schedule for last-mile delivery vehicles from the ACF regulation. The ACF regulation imposes targets beyond those of the ACT regulation for fleets, businesses, and public entities that own or operate MDHD vehicles in California. The ACF regulation specifies calendar year purchase requirements (that a certain percentage of all new vehicle purchases must be zero-emission) for certain fleet segments that are well-suited for electrification, including parcel delivery vehicles.[116]

Figure 168. Delphi Panel's Electric Delivery Vehicle Baseline Market Share Forecast



Of the three experts who did not agree with the median, two decreased their projections while one increased their projection. The rationales for decreased projections warn of supply constraints on the battery market and the high costs of installing charging infrastructure. Battery supply will be in competition for use in LDVs, and the necessary grid improvements for high penetration rates will take significantly more time than accounted for in high adoption predictions, as permitting alone can take years. Delivery depots that house dozens to hundreds of vehicles will need massive electrical upgrades, and the costs of installing charging infrastructure will not be covered by EV energy savings alone, especially because charging will likely occur during peak periods. The panelist who increased their forecast argued that Class 2b trucks and vans will increasingly dominate the parcel delivery segment and are well-suited for electrification given their lower power requirements.

While deriving the consensus forecast achieved the main goal of the Delphi panel, panelists' supporting rationales also contain valuable qualitative information. Aggregating the supporting comments revealed deeper insights into factors that panelists predict will accelerate or impede delivery vehicle electrification in California.

---

[116] Parcel delivery vehicles are included in the ACF sales requirements for Milestone Group 1, which is composed of box trucks, vans, bus with two axles, yard tractors, and light-duty package delivery vehicles.

The median trajectory shows the electric delivery vehicle market falling short of the ACF sales requirements, which start in 2025. Panelists noted several reasons this segment could struggle to meet the ACF targets:

- Three panelists mentioned infrastructure costs in particular as a major concern.
- One panelist mentioned the potential of grid congestion and questioned whether California Utilities can build out new grid capacity before existing distribution grid capacity is too constrained.
- From the fleet operator perspective, another panelist noted that high infrastructure costs will absorb all the financial benefits of fleet electrification and fleet operators will not see any return on investments.

Other rationales included a slow ramp-up of production, the lack of market-ready options, and the fact that electric delivery trucks have yet to definitively demonstrate being reliable and durable for demanding work requirements. Two panelists also mentioned market contractions and the potential of a global recession, which could have a negative impact on the uptake of EVs across all applications.

Three individual forecasts were more optimistic and showed the ACF requirements either being met or exceeded. These panelists cited the increasing availability of models from national OEMs and incentive programs like the CARB's HVIP program that help to make delivery vehicles cost-competitive with their ICE counterparts. They noted that this segment is well-positioned for electrification by having predictable routes along relatively shorter distances in urbanized environments and the ability to charge overnight at depots (similar to transit bus).

After submitting their forecasts, the Evaluation Team asked the panelists about the impacts of the ACF and ACT requirements and Utility incentive programs on the electric delivery vehicle market share through 2030. Two panelists said that both the CARB regulations and Utility programs are accelerating the market. According to one expert, it is because of California's suite of ZEV-supportive policies that roughly half of all zero-emission trucks and bus sold in the U.S. and Canada are sold in the state of California. Without the CARB regulations, this panelist would have reduced their forecast by 50%.

Panelists also agreed that Utility programs are having a positive impact on electric delivery vehicle sales. Experts noted several benefits of the Utility programs, including the investments and partnerships to deploy truck-specific public charging and fast-tracking the installation of depot charging. Given that the consensus forecast represents the market share of electric delivery vehicles in the *absence* of Utility incentives, a potential 10 percentage point bump from these programs could be the difference in delivery fleets meeting or missing ACF requirements.

Highlights

- The baseline forecast for the electric delivery vehicle market share falls short of ACF sales requirements, which start in 2025. This shortfall is due to high infrastructure costs, competition with the light-duty market for battery supply, grid congestion, a slow ramp-up in the production of market-ready options, and the impacts of market contractions.
- The ACF and ACT requirements and Utility incentive programs are helping to accelerate the electric delivery vehicle market.
- Panelists agree that Utility programs have a positive impact on electric delivery vehicle sales.

5.1.3. Lessons Learned

EY2022 was the first year of operation for almost all PYDFF program sites and included a diversity of market sectors, however the number of contracted sites remains low.

In EY2022, 12 sites with new charging ports were activated supporting 246 vehicles based on customer VAPs for activated sites, up from a single EY2021 site. Notably, the PYDFF program had the first airport GSE and TSE projects across all investor-owned utility (IOU) programs in the SRP. As of the end of 2022, 13 sites have been activated with 183 charging ports to support 248 additional vehicles electrified.

The 22 contracts signed in the PYDFF program to date support 554 MDHD vehicles, meeting 7% of the program's *per se reasonableness* goal of 300 sites and support 18% of the program's *per se reasonableness* goal of 3,000 additional vehicles electrified. The total of 57 customer applications to date could satisfy approximately 19% of the program's site goal.

Overall program spending is ramping up slowly, however DAC requirements are a significant challenge.

SDG&E has spent a total of $11.02 million of the $107 million approved budget for the PYDFF program, or approximately 10% of available funding. SDG&E has a requirement to spend 30% of the infrastructure budget in DACs. SDG&E has a requirement that 30% of the infrastructure budget is spent on sites in DACs. However, none of the contracted sites are in a DAC.

SDG&E staff also noted that the program requirement of a two-vehicle minimum has been challenging for small fleets, noting that these fleets may not be able to afford multiple vehicles or may not own a dedicated parking space for charging.

The PYDFF program is having a measurable impact on petroleum displacement, GHG emissions reductions, criteria pollutant emissions reduction, and health benefits.

The 12 sites activated in EY2022 achieved an annualized impact of over 100,000 gallons of petroleum displaced. These 12 sites resulted in an 84% reduction in GHG emissions relative to counterfactual vehicles or 947 MT on an annualized basis.

The 13 programs to date sites have achieved an 82% reduction in GHG emissions relative to counterfactual vehicles and are expected to reduce GHG emissions by 9,032 MT over a 10-year period.

The total value of the health benefits associated with the emission reductions in the program to date is between $29,345 and $66,090, with most benefits occurring within San Diego County. The overall energy mix contained about 48% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear). Emissions impacts could be greater using greater load management, specifically by enabling vehicles to avoid charging during peak rate periods while taking advantage of periods with a higher mix of renewable generation.

SDG&E improved customer education and outreach efforts with a focus on DACs.

SDG&E staff have continued efforts to improve DAC participation. ME&O materials included a dedicated webpage titled “Electrification for Fleets Operating in Disadvantaged Communities,” a general fact sheet for fleets in DACs, a TCO fact sheet for fleets in DACs, a fact sheet on the benefits of SDG&E’s EV High Power pricing plan with DAC-specific information, and a fact sheet on funding opportunities and incentives with DAC-specific information.

As the PYDFF program continues to evolve, surveyed program participants and EVSPs report high satisfaction with the program and with SDG&E.

Four out of five surveyed fleet managers reported hearing about the program directly from SDG&E, and all five fleet managers rated themselves as *very satisfied or somewhat satisfied* with their experience working with SDG&E staff. Four out of six fleet managers have already recommended the program (i.e., prior to responding to the survey). Rebates and incentives for EVs was the strongest motivator for program participation (seven of seven respondents), followed by rebates and incentives for EV charging infrastructure, expected maintenance cost savings, and environmental benefits (five of seven respondents). Three of seven responding fleet managers plan to accelerate their adoption of EVs because of their program participation.

EVSPs also agreed that there is sufficient demand from fleet owners to warrant expanding the PYDFF program with additional technical assistance and incentive funds. All four EVSPs noted that the Utilities in general were good partners in deploying infrastructure and that the PYDFF program is beneficial and well-implemented.

Program timelines are longer than expected and site costs and supply chain delays are a challenge.

The median time to complete all six phases of the program in EY2022 was 654 days, far greater than the original program estimate of 11 to 16 months. The Design and Permitting phase contributed the largest share of this timeline, taking an average of 316 days, which was the longest period for any phase across all Utilities. However, this was often driven by customer design schedule, rather than Utility action. Despite the longer implementation timeline, the PYDFF program had the lowest median number of days to completion across all Utility programs.

PYDFF program staff stated that equipment and material lead times have increased, from 12 weeks to 52 weeks or more on switchgear, and from 30 days to six months for EV chargers. SDG&E staff also indicated that staffing shortages at local government agencies have impacted timelines. EVSPs noted that while SDG&E has been a strong project partner, additional staffing could expedite the site analysis process. Fleet operators reported that delays were also driven by vehicle availability and said several sites had not yet received some or all of expected vehicles at the time of site visits.

Significant new charging capacity was installed in EY2022 but is underutilized. The majority of fleet operators are not actively employing load management, and many are not tracking their charging costs.

EY2022 sites had 4,500 kW of new charging capacity. Peak daily demand reached almost 20% of available capacity across the 13 activated sites. Many fleet operators reported not yet having received some or all of their vehicles, leading to chargers being underutilized. There may be an opportunity to increase the number of vehicles per charging port in future years to maximize program impacts and reduce vehicle TCO, though chargers will have higher usage as vehicles are received and integrated into fleet operations at higher rates.

Two of the 13 program sites to date exhibited the use of load management, shown by sharp increases in load beginning after 9 PM, when peak demand charges diminish. During EY2022, approximately 35% of all fleet charging occurred between 4 PM and 9 PM on a monthly basis, resulting in higher operational costs and grid impacts. Thirty percent of non–school bus fleet charging sessions have enough flexibility to avoid charging during the peak period, which will improve TCO for fleet operations, reduce grid impacts, and reduce emissions from vehicle charging.

Not all EVSPs offer load management programs, and Utility bills may not be made available to fleet operators to understand the cost impacts of time of use. During site visits, many fleet operators reported it being the first time they had seen their own usage information, and almost every operator had a disconnect between what they expected the electricity to cost versus actual historical costs. However, most fleet operators are aware of time-of-use pricing, regardless of not being aware of their own usage trends and costs. Based on site visits, successful load management occurred when the EVSP was financially responsible for its application.

> **Recommendation: SDG&E should review current processes around communicating load management to ensure customers are maximizing monetary and emissions savings.**
>
> The Evaluation Team identified several challenges to the implementation of load management in this report related to awareness, operational constraints, knowledge of rate structure, and organizational capacity. Following site energization, SDG&E should review customer usage data over six to 12 months of operations and follow up with sites that exhibit opportunities for better load management. The Evaluation Team's interactive dashboard (an SDG&E-facing tool not publicly accessible) provides key metrics on customer load management performance that can be leveraged to highlight site-level charging behavior and opportunities for monetary and emissions savings.

There was general consensus among market experts that the EV market share for transit bus and delivery vehicles will increase over time, and that Utility programs are critical to meet deployment targets.

The market forecast for electric transit bus market share in California aligns with ICT requirements through 2025 but falls short of 100% by 2030. The increased availability of funding is expected to be the primary driver for transportation agencies to meet purchase requirements. Experts forecasted the electric delivery vehicle market share to fall short of ACF sales requirements in 2025, driven by high infrastructure costs, battery market competition, and limited product availability. EVSPs and fleet operators both identified Utility incentives as a key mechanism to reduce the barrier to electrification presented by high EV costs and the high cost of installing EV charging infrastructure.

5.2. Schools and Parks Pilots

5.2.1. Overview

This overview provides a detailed description of the SDG&E Schools and Parks Pilots and summaries of the Pilots' implementation processes, performance metrics, program materials, budget summary, and major milestone timelines. Following the overview, the Evaluation Team present the EY2022 findings and lessons learned.

Pilot Description

Schools Pilot: Through its Schools Pilot, SDG&E has offered the direct installation of and incentives for installing 184 L2 charging and 12 DCFCs at 30 schools and educational institutions. SDG&E is aiming for the Pilot to have 40% of installations within DACs.[117] The Pilot has a turnkey ownership model, where SDG&E offers to install, own, operate, and maintain the charging stations. The charging stations are required to use TOU rate pricing. Site hosts can opt to own the chargers and are then eligible for a rebate equivalent to the cost that SDG&E would pay to install EVSE under the SDG&E turnkey model. For both types of participants, SDG&E offers an EV curriculum to provide EV education for students.

Schools Pilot Targets

- 184 L2 and 12 DCFC charging stations
- 30 schools
- 40% in DAC locations

Schools Pilot Design Goal

Empower schools to offer public charging to staff, students, parents, and the greater community.

Parks Pilot: Through its Parks Pilot, SDG&E has installed 74 light-duty public chargers in 12 state parks and beaches within its service territory and 66 light-duty public chargers at 10 city and county park sites. SDG&E will build, own, operate, and maintain the charging stations, which will use a TOU rate. SDG&E developed an awareness campaign to inform the public of the availability of these chargers.

Parks Pilot Targets

- 74 charging stations at 12 state parks and beaches
- 66 charging stations at 10 city and county parks
- 50% overall in DAC locations (all city and county sites must be in DACs)

Parks Pilot Design Goal

Encourage parks and beaches to charge their own fleets and offer charging to staff and patrons.

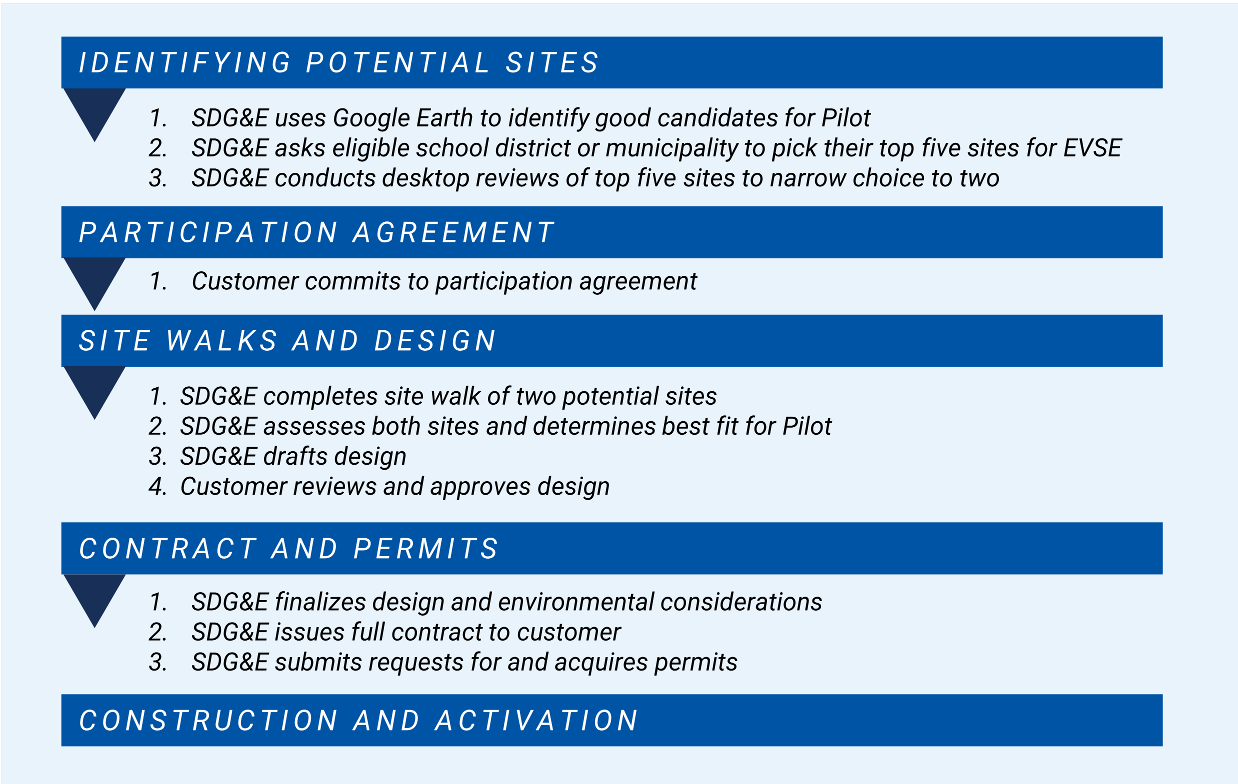
Implementation

As interested customers become aware of either Pilot—through SDG&E marketing efforts, word-of-mouth, or directly from an SDG&E account manager—they can choose to submit an application as the first step in the implementation process (Parks may not submit an application as the first step of their program participation). In EY2022 SDG&E staff were focused on implementing the Pilots. Figure 169

[117] As per Advice Letter 2876-E, SDG&E found that only 27 census tracts in its territory were considered DACs (using the top quartile in CalEnviroScreen statewide definition). However, the service territory definition produces a broader definition and leads to a calculated 180 DAC census tracts in SDG&E service territory.

shows the implementation process for the Schools and Parks Pilots. Note that the customer agreement step is slightly different for state parks compared to the process for municipal parks and for the Schools Pilot, since the DPR expects to approve a master participation agreement that will apply to all state parks in SDG&E service territory participating in the Parks Pilot. Each individual site will have site addendums to the master agreement based on specific site needs and designs.

Figure 169. Schools Pilot and Parks Pilot Implementation Process



Program Performance Metrics

The EY2022 data included the number of sites by Pilot, location of sites, DAC status of sites, and days by application phase. Table 95 and Table 96 provide the count of construction complete sites in SDG&E's Schools Pilot and Parks Pilot, respectively, by completion status in EY2022 and program to date.

Table 95. EY2022 SDG&E Schools Pilot Complete Site Count by Status

Site Status	EY2022	Program to Date
Utility Construction Complete	8	9
Activated	6	7
Operational	6	7
Closed Out	1	1

Note: For different site status categories site counts reported for EY2022 may include sites from EY2021. For example, a site activated in EY2022 could have been reported as construction completed in the EY2021 Evaluation Report.

Table 96. EY2022 SDG&E Parks Pilot Complete Site Count by Status

Site Status	EY2022	Program to Date
Utility Construction Complete	3	8
Activated	4	8
Operational	4	8
Closed Out	5	5

Note: For different site status categories site counts reported for EY2022 may include sites from EY2021. For example, a site activated in EY2022 could have been reported as construction completed in the EY2021 Evaluation Report. The SDG&E 2021 SB 350 and EY2021 Evaluation reports included a fifth activated site based on start of activation date, but EY2022 reports are using end of activation date for count of activated sites. Therefore, the fifth activated site from 2021 reports is also included as an EY2022 site.

As shown above, all of SDG&E's Schools and Parks Pilot sites that were activated at the end of EY2022 are operational. Figure 170 shows the site locations and DAC status.

Figure 170. SDG&E Schools Pilot (Left) and Parks Pilot (Right) Activated Charging Site Locations

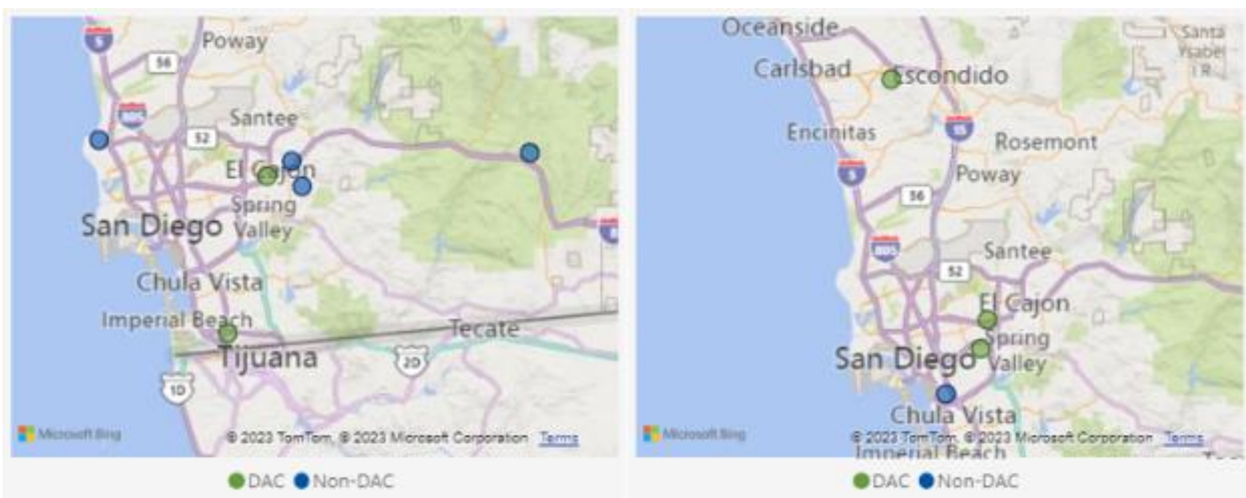


Table 97 presents site-level data by Pilot, showing DAC activation status and number of chargers for the 10 activated sites in EY2022 and program to date. For EY2022, five sites were inside DACs and five sites were outside DACs.

Table 97. SDG&E Schools Pilot and Parks Pilot Activated Site Data

Pilot	EY2022			Program to Date		
	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports	Number of Activated Sites inside DAC	Number of Activated Sites outside DAC	Total Number of Charging Ports
Schools	2	4	60	3	4	68
Parks	3	1	29	7	1	51
Total	**5**	**5**	**89**	**10**	**5**	**119**

The median number of days by phase for the Schools Pilot ranged from 13 days for Activation to 312 days for Design and Permitting (Table 98).[118] The Application Reviewal phase was reduced to 19 days in EY2022 compared to 269 days in EY2021; however, the Design and Permitting phase in EY2022 took a median of 312 days compared to 142 days in EY2021.

Similarly, the median number of days by phase for the Parks Pilot ranged from 10 days for Activation to 222 days for Design and Permitting, with the medium number of days for each phase being comparable between EY2021 and EY2022.

Table 98. Schools Pilot and Parks Pilot Median Number of Days by Phase

Phase Status	Schools Pilot			Parks Pilot		
	EY2021 Median Number of Days	EY2022 Median Number of Days	Program-to-Date Number of Days	EY2021 Median Number of Days	EY2022 Median Number of Days	Program-to-Date Number of Days
Application Reviewal	269	24	29	30	29	29
Site Assessment	189	186	188	164	184	182
Contract Issuance	22	29	26	23	28	23
Design and Permitting	142	326	313	174	223	206
Construction Complete	52	64	58	50	90	73
Activation	1	24	14	8	11	9

Program Materials Summary

In EY2022, SDG&E completed ME&O for both the Schools and Parks Pilots.

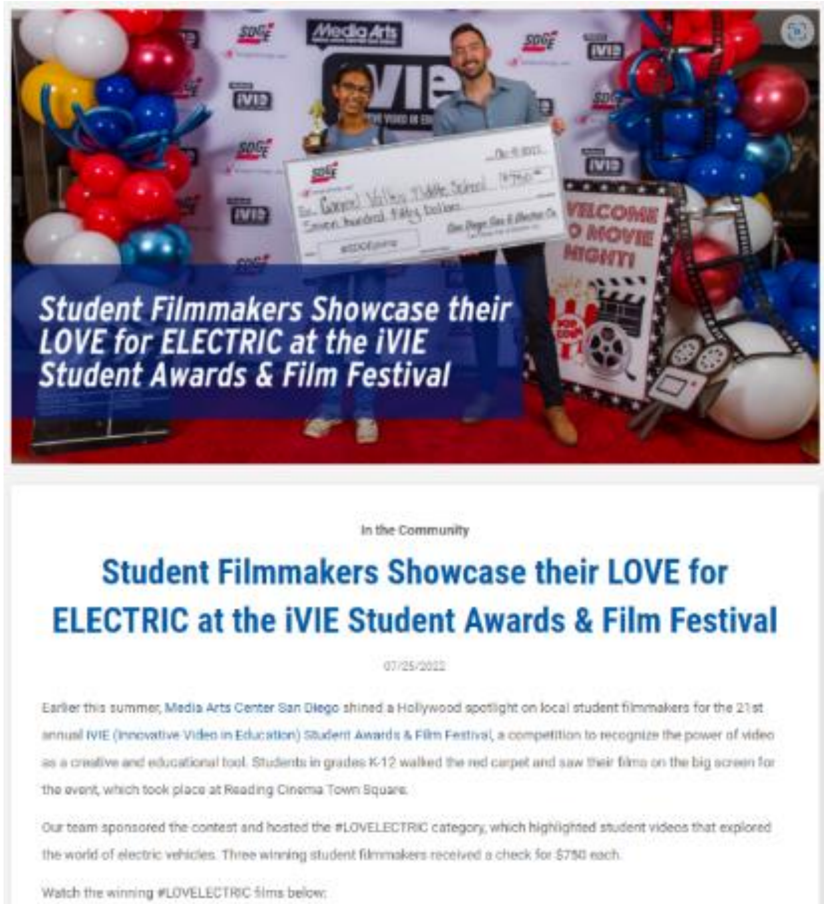
Schools Pilot

In EY2022, SDG&E published a story related to the Schools Pilot. SDG&E hosted #LOVELECTRIC to highlight student videos about EVs (see Figure 171). The blog post[119] highlighted the student filmmaking competition and the annual iVIE (Innovative Video in Education) Student Awards & Film Festival (see Figure 171).

[118] The full phase cycle of days may not sum to the total median number of days by phase due to potential overlapping days of phase durations.

[119] San Diego Gas & Electric. July 25. 2022. "Student Filmmakers Showcase their LOVE for ELECTRIC at the iVIE Student Awards & Film Festival." https://www.sdgenews.com/article/student-filmmakers-showcase-their-love-electric-ivie-student-awards-film-festival

Figure 171. Screenshot of Schools Pilot Blog Post



Source: SDG&E ME&O Data.

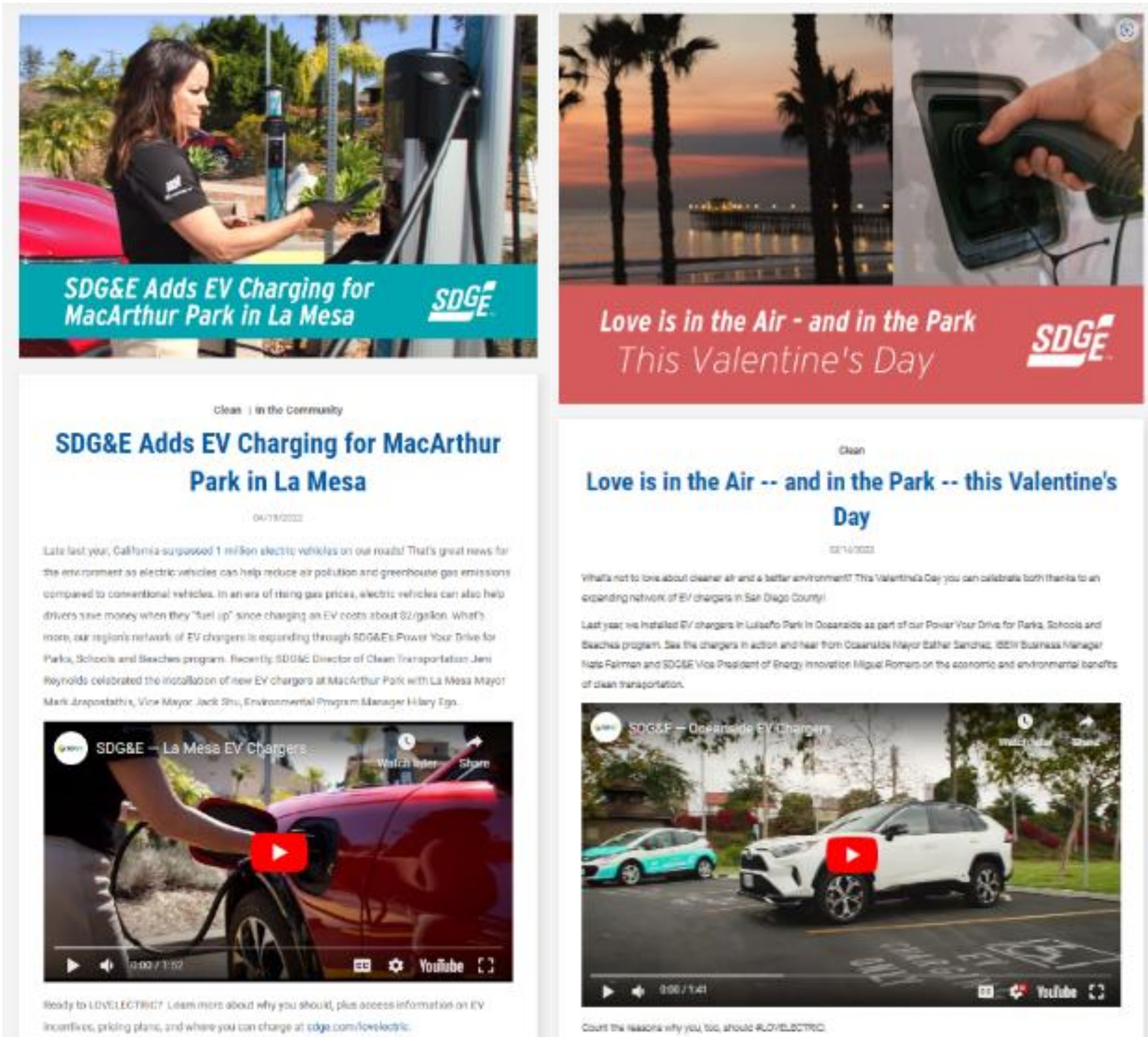
Parks Pilot

In EY2022 SDG&E published three stories to highlight Parks Pilot charging sites in MacArthur Park, Sunset Park, and Luiseño Park (see Figure 172).[120] All three stories were published to SDG&E's blog in EY2022, even though some of the mentioned sites were installed in EY2021. Each story also contained a promotional video and encouraged customers to use charging in the park. SDG&E leveraged the timing of Clean Air Month and Valentine's Day to promote these sites to customers during times when they may be more likely to pay attention to transportation electrification (Clean Air Month) or want to go to their local park (Valentine's Day).

---

[120] San Diego Gas & Electric. April 19, 2022. "SDG&E Adds EV Charging for MacArthur Park in La Mesa." https://www.sdgenews.com/article/sdge-adds-ev-charging-macarthur-park-la-mesa
San Diego Gas & Electric. May 24, 2022. "Take your EV to the Park in Celebration of Clean Air Month!" https://www.sdgenews.com/article/take-your-ev-park-celebration-clean-air-month
San Diego Gas & Electric. February 14, 2022. "Love is in the Air -- and in the Park -- this Valentine's Day." https://www.sdgenews.com/article/love-air-and-park-valentines-day

Figure 172. Screenshots of Parks Pilot Blog Posts

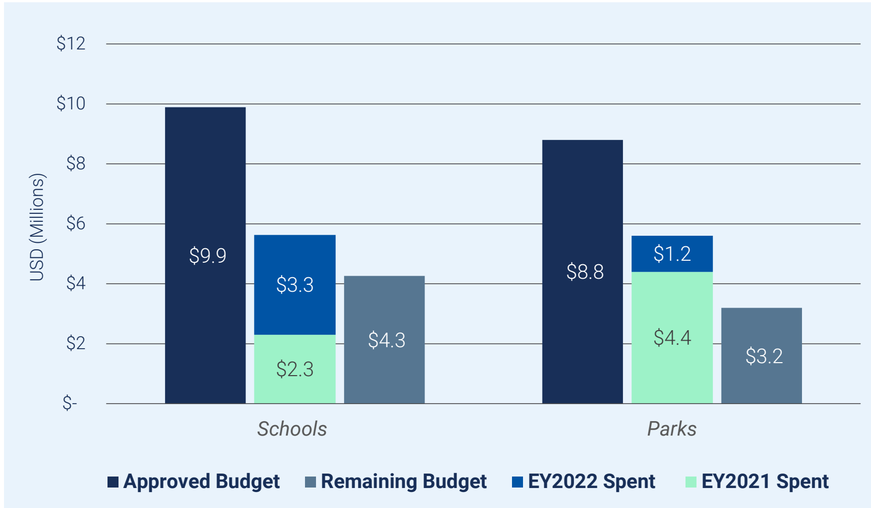


Source: SDG&E ME&O Data.

Budget Summary

As shown in Figure 173, from program inception through the end of 2022, SDG&E spent $5.6 million of the $9.9 million approved budget for the Schools Pilot and $5.6 million of the $8.8 million approved budget for the Parks Pilot. SDG&E spent more on the Schools Pilot in EY2022 than in EY2021 as the Utility ramped up construction activities, and it spent much less on the Parks Pilot in EY2022 due to limited municipal park construction and because of continued state park contract negotiations.

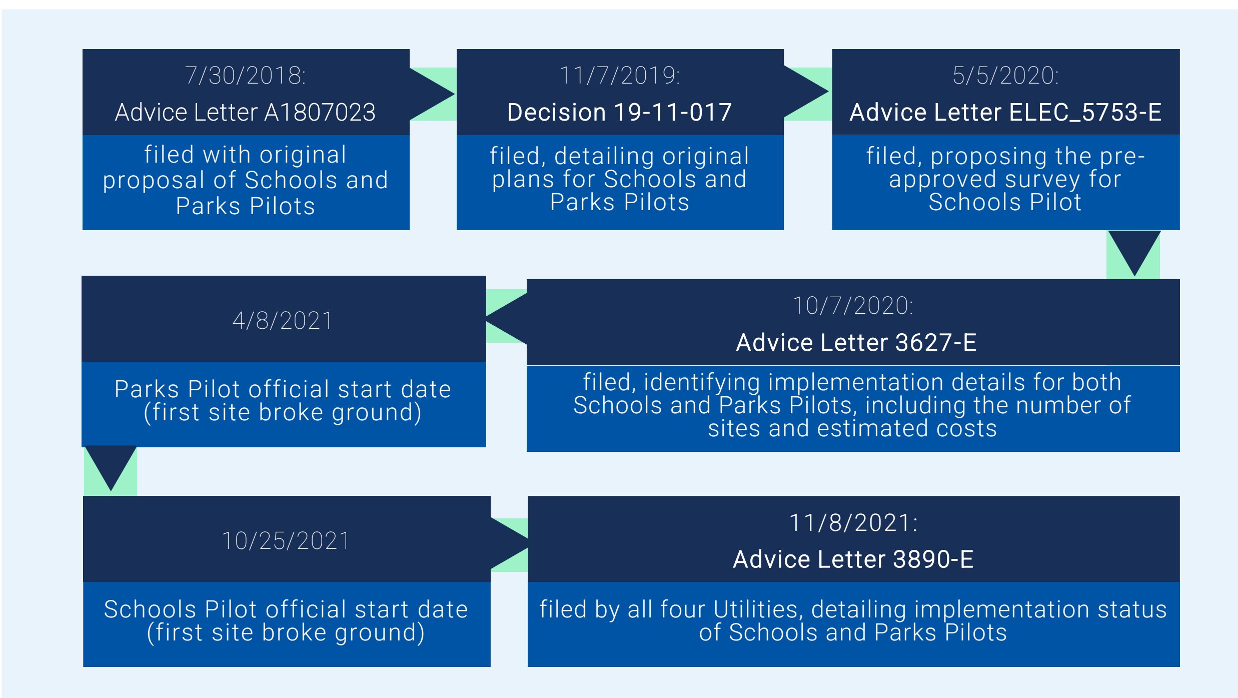
Figure 173. Budget Remaining versus Spent through EY2022



Timeline

In EY2022 SDG&E did not have any major milestones or filings and was focused on recruiting site hosts and constructing sites. Figure 174 shows the milestones of the Schools and Parks Pilots since their inception.

Figure 174. Timeline of Key Schools Pilot and Parks Pilot Milestones



5.2.2. Findings

The following sections provide findings from analyses of incremental EV adoptions, site visits, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health impacts, and TCO, as well as insight from Utility staff interviews.

Table 99 summarizes key impact parameters for EY2022 as well as for the program to date. Annual estimates of impacts are provided for metrics calculated as part of the impact evaluation. Additionally, the table provides estimates of impacts across all sites included in the program population through the end of EY2022.[121]

Table 99. SDG&E EY2022 Schools Pilot and Parks Pilot Summary Impacts

Impact Parameter	Annualized EY2021 [a]	Annualized EY2022 [a]	Annualized EY2022 Percentage in DAC	Program-to-Date Actuals	Program-to-Date Actuals Percentage in DAC
Population of Activated Sites	5	10	50%	15	67%
Sites included in analysis (#)	3	10	50%	15	67%
Charging Ports Installed (#)	16	89	51%	119	63%
Electric Energy Consumption (MWh)	30	147	68%	137	87%
Petroleum Displacement (GGE)	2,643	12,167	67%	11,767	87%
GHG Emission Reduction (MT GHG) [b]	18	94	67%	86	87%
PM_{10} Reduction (kg)	0.10	0.48	67%	0.44	87%
$PM_{2.5}$ Reduction (kg)	0.09	0.44	68%	0.40	87%
ROG Reduction (kg)	1.69	8	63%	7.60	87%
CO Reduction (kg)	54	253	67%	248	87%

[a] Energy consumption, petroleum displacement, emission reductions, and health benefits are based on annualized data. Program-to-date results in the table are based on actual data (see the *Methodology* section for more details).

[b] GHGs include CO_2, CH_4, and N_2O multiplied by their respective GWP as defined by IPCC AR5 (see the *Methodology* section for more details).

[121] For EY2021 impacts, please see: Cadmus, Energetics, et al. June 30, 2022. *Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021 (Year 1).* https://www.cpuc.ca.gov/documents/standard-review-programs-annual-transportation-electrification-evaluation-2021.pdf

Incremental EVs Adoption

The team estimated the effect of the public charging stations on EV adoption for neighboring populations[122] with a two-stage analysis: (1) historical analysis of public EV charging impacts on vehicle ownership and (2) analysis of ownership attributable to SDG&E Schools and Parks Pilots' investments. See the *Methodology* section for the details of Stage 1 analysis.

Using the impact estimates from the Stage 1 analysis, the Evaluation Team estimated the impact of SDG&E investments in public charging on EV ownership. By the end of EY2022, seven charging stations in SDG&E's Schools Pilot and eight charging stations in its Parks Pilot were activated and operational. The Evaluation Team estimated the impact of these stations based on annual EV registrations in EY2022 as well as program-to-date cumulative EV registrations.

SDG&E Schools Pilot

Based on the composite measure of public charging access, the Evaluation Team calculated the change in access to public charging due to SDG&E's Schools Pilot investment for each census block group (CBG) where access was affected by the investments. As shown in Table 100, the program-to-date average change in access per affected CBG was 14.4, and the average change in the number of chargers (ports) was 6.3 per affected CBG. For reference, the average change in access across all CBGs in California was 0.57 between 2015 and 2020. The average normalized EV annual registration per 1,000 households was 16.2 in the affected CBGs in 2020.

---

[122] There are two main channels through which the availability of public charging networks may affect EV purchases. The first is a network effect, through which EV owners gain increased access to the public charging stations because of the stations' placement at destinations such as workplaces, commercial establishments, schools, and parks. The availability of EV charging equipment at convenient locations (for midday charging away from home) is expected to increase the convenience of owning an EV (such as lessening range anxiety) and to increase the probability of EV ownership. The second channel is a neighborhood effect on the driving population living in areas neighboring the public EV charging stations. The availability of nearby charging infrastructure is expected to lower the cost of EV ownership by providing alternatives to home charging. It is expected that public EV charging will have the biggest impact on residents of multifamily buildings, many of whom will have limited access to EV charging equipment, or on low-income households, who may be unable to afford home EV charging equipment. The public charging access may lift EV ownership through both channels and there may be positive interactive effects between the channels that lift the overall impact of public charging networks. The Evaluation Team focused on analyzing the second channel and will analyze the impacts for the first channel separately when data become available.

Table 100. Summary Statistics for CBGs Affected by the Schools Pilot Utility EV Charging Stations

Pilot	CBG Mean (Standard Deviation)			
	Change in Composite Measure of Access	Change in Number of Chargers	Normalized Annual EV Registrations	Number of Households
SDG&E Schools Pilot	14.41	6.28	16.22	538.80
	(28.84)	(4.45)	(17.71)	(267.32)
CBGs (N)	10	10	10	10

Notes: The values in this table are averages for the CBGs where access to public charging was affected by SDG&E's investments. The changes are measured between 2020 and 2022. The normalized EV registration are average annual values in the affected CBGs in 2020. The number of households are based on the 2015 through 2019 American Community Surveys. Sample standard deviations are in parentheses.

The Evaluation Team combined the OLS and IV-2SLS regression estimates of the impact of public charging access on EV registrations from Stage 1, with the estimates of the CBG changes in public charging access and household counts, to calculate the impact of the Schools Pilot Utility charging investments on neighboring EV ownership.[123] The impacts of the SDG&E investments on EV registrations will depend on how much the investments increased access in the affected CBGs and the number of households in the CBGs.

Table 101 shows estimates of the annual and program-to-date EV registrations attributable to the Utility Schools Pilot charging investments.[124] Based on the OLS long differences model, SDG&E School Pilot investments in charging facilities increased EY2022 annual EV registrations by 4.1 vehicles. As the Schools Pilot charging facilities were not fully operational in EY2021, the program-to-date impact was the same as the EY2022 annual impact. Based on the IV-2SLS long differences model, the School Pilot investments increased annual EV registrations by 19.22 vehicles. The Evaluation Team prefers the IV-2SLS-based estimates because they account for the potential endogenous siting decisions of public charging (that public charging infrastructure may have been built in locations with expected lower- or higher-than-average rates of EV adoption). These estimates are based on the seven activated Schools Pilot facilities operating for a whole year.

[123] In Stage 1 the Evaluation Team estimated the impact of public EV charging access on EV ownership. For Stage 2 we built on the Stage 1 analysis and conducted an attribution analysis of Utility-specific investments. A notable benefit of this approach is that it can also be applied to evaluations of other programs that lead to increased EV charging access, which ensures methodological consistency.

[124] The long differences model estimates indicate the impact of public charging on EV registration over five years. The team divided these estimates by five to annualize them.

Table 101. EV Registrations Attributable to SDG&E Schools Pilot Public Charging Stations

Pilot	EY2022 Annual Increase of EV Registrations Driven by the Utility Program		Program-to-Date Cumulative Increase of EV Registrations Driven by the Utility Program	
	OLS	IV-2SLS	OLS	IV-2SLS
SDG&E Schools Pilot	4.13	19.22	4.13	19.22
	(1.71)	(8.48)	(1.71)	(8.48)

Note: The table shows the EV registrations attributable to the utility investments in public charging infrastructure. The left panel shows the impacts of utility investments since 2020 on registrations in EY2022. The right panel shows the cumulative impacts of utility investments since 2020 on EV registrations in EY2021 and EY2022. The Evaluation Team based these estimates on the OLS and IV-2SLS long differences models. The team estimated the OLS long differences model using data for all CBGs in the analysis sample. We estimated the IV-2SLS long differences model only for CBGs in the 20 largest California cities. The long differences estimates are five-year estimates, which the team divided by five to annualize. For each affected CBG, the Evaluation Team calculated the increase in annual registrations as the product of the regression-based access coefficient divided by five, multiplied by the change in composite public charging access from utility investments (between baseline 2020 and EY2022), multiplied by the number of CBG households (in thousands). Robust standard errors clustered at the block group level are in parentheses.

The SDG&E Schools Pilot investments in public charging had economically meaningful impacts on EV ownership in EY2022. Across all 10 affected CBGs, the total number of EV registrations is about 162 (10 * 16.22), so the program-to-date cumulative impact of the SDG&E Schools Pilot, based on the preferred IV-2SLS regression estimate, is to lift EV registrations by about 11.9% (19.22 / 162). An average of 16 EV registrations per CBG puts these CBGs in the 70th percentile of the EV registration distribution of CBGs, which implies a slightly high level of baseline EV registration.

SDG&E Parks Pilot

Using the same approach as for the Evaluation Team's analysis of the Schools Pilot impact, we calculated the change in access to public charging due to SDG&E's Parks Pilot investment for each CBG where access was affected by the investments. As shown in Table 102, the program-to-date average change in the composite measure of access was 7.8 per affected CBG, and the average change in the number of chargers was 5.9 per affected CBG. The average normalized EV annual registration per 1,000 households was 15.7 in the affected CBGs in 2020.[125]

[125] Averages of the median income and percentage of multifamily housing units in affected CBGs puts the CBGs in the second median income quartile and the third multifamily housing quartile.

Table 102. Summary Statistics for CBGs Affected by the Parks Pilot Utility EV Charging Stations

Pilot	CBG Mean (Standard Deviation)			
	Change in Composite Measure of Access	Change in Number of Chargers	Normalized Annual EV Registrations	Number of Households
SDG&E Parks Pilot	7.81	5.94	15.74	393.30
	(3.87)	(3.07)	(13.46)	(172.05)
CBGs (N)	16	16	16	16

Notes: The values in this table are averages for the CBGs where access to public charging was affected by SDG&E's investments. The changes are measured between 2020 and EY2022. The normalized EV registration are average annual values in the affected CBGs in 2020. The number of households are based on 2015 through 2019 American Community Surveys. Sample standard deviations are in parentheses.

Table 103 shows estimates of the annual and program-to-date EV registrations attributable to the Utility Parks Pilot charging investments.[126] Based on the OLS long differences model, SDG&E's investments in the Park Pilot charging facilities increased EY2022 annual EV registrations by 1.9 vehicles and program-to-date cumulative EV registrations by 4.2 vehicles. Based on the IV-2SLS long differences model, SDG&E's investments increased EY2022 annual EV registrations by 8.6 vehicles and program-to-date cumulative EV registrations by 13.8 vehicles. The Evaluation Team prefers the IV-2SLS-based estimates because they account for the potential endogenous siting decisions of public charging (that public charging infrastructure may have been built in locations with expected lower- or higher-than-average rates of EV adoption). These estimates are based on the eight activated Parks Pilot facilities operating for a whole year.

Table 103. EV Registrations Attributable to Utility Public Charging Stations

	EY2022 Annual Increase of EV Registrations Driven by the Utility Program		Program-to-Date Annual Increase of EV Registrations Driven by the Utility Program	
	OLS	IV-2SLS	OLS	IV-2SLS
SDG&E Parks Pilot	1.86	8.64	4.20	13.77
	(0.28)	(1.41)	(0.43)	(2.07)

Note: The table shows the EV registrations attributable to the utility investments in public charging infrastructure over all affected CBGs. The Evaluation Team based these estimates on the OLS and IV-2SLS long differences models. The team estimated the OLS long differences model using data for all CBGs in the analysis sample. We estimated the IV-2SLS long differences model for CBGs in the 20 largest cities. The long differences estimates are five-year estimates, which the Evaluation Team divided by five to annualize. For each affected CBG, the team calculated the increase in annual registrations as the product of the regression-based access coefficient divided by five, multiplied by the change in composite public charging access from utility investments (between EY2021 and EY2022 or between baseline 2020 and EY2022), multiplied by the number of CBG households (in thousands). Robust standard errors clustered at the block group level are in parentheses.

The SDG&E Parks Pilot investments in public charging had less impact on EV ownership than the Schools Pilot investments in public charging. Across all 16 affected CBGs, the total annual number of EV registrations is about 256 (16 * 16), so the EY2022 impact of the SDG&E Parks Pilot lifts EV registrations by 3% (8.64 / 256), and the program-to-date impact lifts EV registrations by 5% (13.77 / 256). The relative smaller impact of the Parks Pilot was expected, as access to the Parks Pilot charging facilities

[126] The long differences model estimates indicate the impact of public charging on EV registration over five years. The team divided these estimates by five to annualize them.

(measured by the number of stations, number of chargers, and distance to the stations) was about half of the access to Schools Pilot charging facilities.

Highlights

- The SDG&E Schools and Parks Pilots' investments in public charging infrastructure has had a significant and economically meaningful impact on EV ownership, leading to an increase of 19 and 14 EVs, respectively, for households neighboring the infrastructure in EY2022.
- The impact of the Parks Pilot was lower than that of the Schools Pilot, mainly because there was better access to the Schools Pilot charging facilities (which had a greater number of charging stations and chargers, and a shorter distance to the stations).

Site Visit Findings

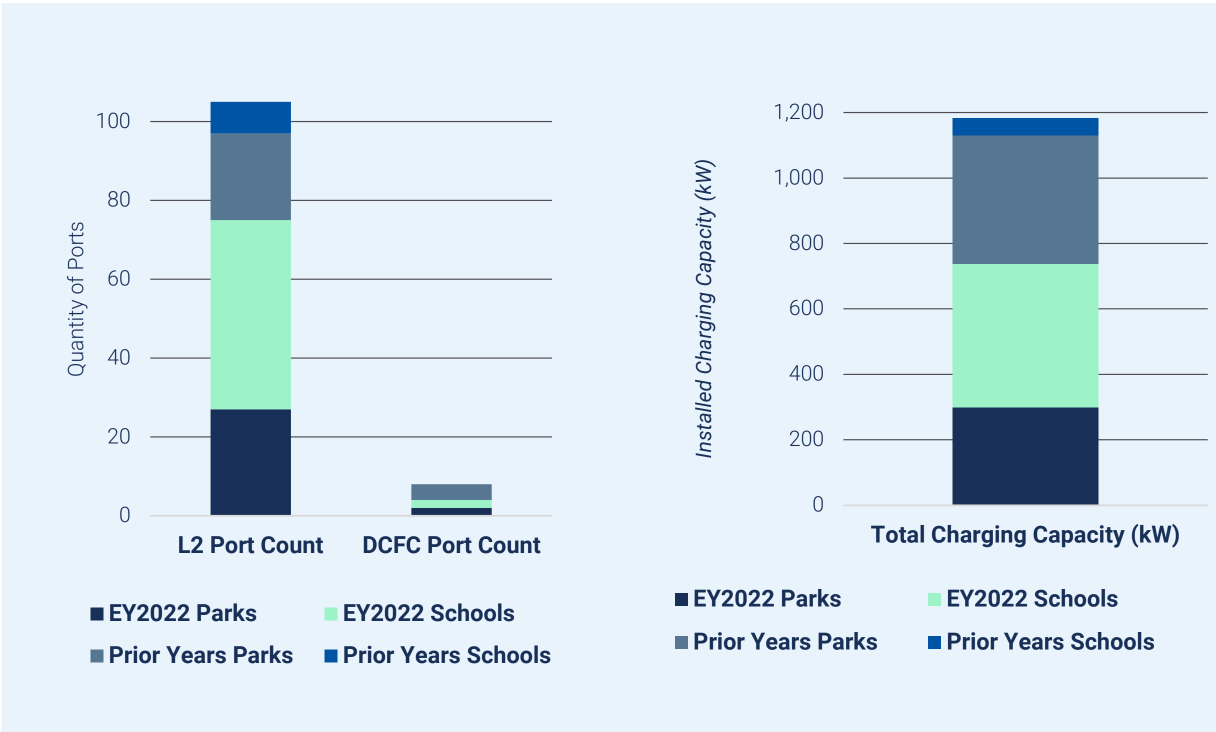
The Evaluation Team visited nine public sites (five school sites and four park sites) that were newly operational in EY2022. While on the site, the team documented the number of L2 ports, DCFC ports, ADA accessibility, and total installed charging power capacity (Table 104).

Table 104. SDG&E Schools and Parks Pilot Site Visit Summary of Activated Sites in EY2022

Site	L2 Ports	DCFC Ports	ADA Accessible	Total Installed Charging Power Capacity (kW)
1. School	12	0	2	78
2. School	10	0	2	65
3. School	8	0	2	52
4. School	10	0	2	65
5. School	8	2	2	177
6. Park	11	0	2	72
7. Park	4	0	1	26
8. Park	8	2	2	177
9. Park	4	0	1	26

Figure 175 presents the program-to-date port counts and capacity, with the team visiting 79 ports representing over 700 kW in EY2022. The Evaluation Team did not visit one school site with six L2 and two DCFC ports that was activated in EY2022.

Figure 175. SDG&E Schools and Parks Pilots Ports and Power Capacity



All EY2022 sites had L2 charging (6.5 kW ports), and one of four parks in EY2022 had DCFC while one of five school locations had DCFC. The Schools Pilot location with DCFC that the Evaluation Team visited was a community college, which appeared to have limited evening access and is located in an industrial business area. Three other schools that the Evaluation Team visited have limited public access for charger use during some evening hours of weekends while the single private school does not have public access. The park sites varied in number of nearby points of interest like stores and restaurants.

As shown in Figure 176, the sites reflected a range in the number of total parking spaces with access to charging. Most accessible sites had a parking-to-charging-port access ratio of more than two, while the least accessible site had charging port access from two additional parking spaces.

Figure 176. SDG&E Schools and Parks Pilots Quantity of Parking Spaces with Access to Charging Ports, Program-to-Date Sites

Many of the visited sites, both school districts and parks, were constructed with host involvement and resulted in ports that reach multiple parking spaces for greater flexibility (see Figure 177 and Figure 178 as examples). This type of design facilitates the turnover of port use without the necessity of moving vehicles, which increases charger utilization.

Figure 177. SDG&E Schools and Parks Pilots Community College L2 and DCFC Installation with High Access

Figure 178. High-Access Head-to-Head Parking at School Workplace

A higher ratio of parking spaces leads to resilience in the event a charging port malfunctions or is otherwise not usable. Several examples are shown from Figure 179 to Figure 180. A higher ratio of parking spaces enables charging port turnover without having to physically move a vehicle. This facilitates utilization of the EV charging stations by allowing the population of EV drivers to more easily turn over the charging ports. High utilization may mitigate the need for additional charging ports. SDG&E has examples of both L2 and DCFC resources with this type of access.

Figure 179. SDG&E Schools and Parks Pilots Examples of DCFC and L2 EVSE with Very High Access to Parking Spaces

As shown in the figure, moving the DCFC (furthest left) by 90 degrees or into the median would have made the charger accessible to more spaces, though the L2 EVSE has very high access to parking spaces.

Figure 180 presents an example of charging ports designated for ADA spaces with significant access to standard parking spaces.

Figure 180. SDG&E Schools and Parks Pilots ADA Charging Ports with Access to Several Parking Spaces Marked with Red Dots

At least one parking space was labeled for each charging station and typically there was signage on charging stations as well as on posted signs. Wayfinding from streets was not as present, as it was in EY2021, although two of the park sites did have signage near the park entrance.

None of the sites with DCFC (n=3) had credit card chip or swipe readers installed, although both DCFC and L2 units were able to accept contactless (NFC) credit cards. All sites provided time-of-use pricing to drivers via charging station screens and included SDG&E branding.

No SDG&E DCFC units appear to have enabled idle fees, which are often used to encourage drivers to move their vehicles to keep charging resources available for the public. This will become increasingly important as more drivers become aware of idle fees and develop charging habits to avoid them.

As shown in Figure 181, SDG&E installed separate metering and services for L2 and DCFC. Although this may require a larger footprint, it offers easier differentiation between the two modes of charging. This example will be good to compare to another utility that is not using separate meter pedestals.

Figure 181. SDG&E Schools and Parks Pilots Site with Separate Meter Cabinets for Different Voltages for DCFC and L2 Chargers

Highlights

- EY2022 SDGE school and park sites have between four and 12 L2 ports per site. Three of these sites also have DCFC ports and three include two ADA-accessible charging spot each. The total installed charging power capacity ranges from 26kW to 177 kW.
- All SDGE school and park sites had charging ports located to be accessible from multiple parking spaces. Some sites averaged more than two parking spaces to one charger, which is the highest observed for Schools and Parks Pilots across all Utilities.
- At least one parking space was labeled for each charging station, and typically there was signage on charging stations as well as on posted signs.
- All sites provided time-of-use pricing to drivers, communicated on screens, and also included SDG&E branding.
- No SDG&E DCFC units appear to have enabled idle fees.

Grid Impacts

The Evaluation Team estimated grid impacts for the SDG&E Schools and Parks Pilots based on the power consumed by 10 operational charging sites (six schools and four parks) activated in EY2022. Analysis results are based on the Utility-provided AMI data for each site and charging session data for each charging port provided by the EVSPs. Table 105 presents a summary of the estimated Schools and Parks Pilots grid impacts in 2022, an annual estimate, and program-to-date actual and 10-year forecasts.

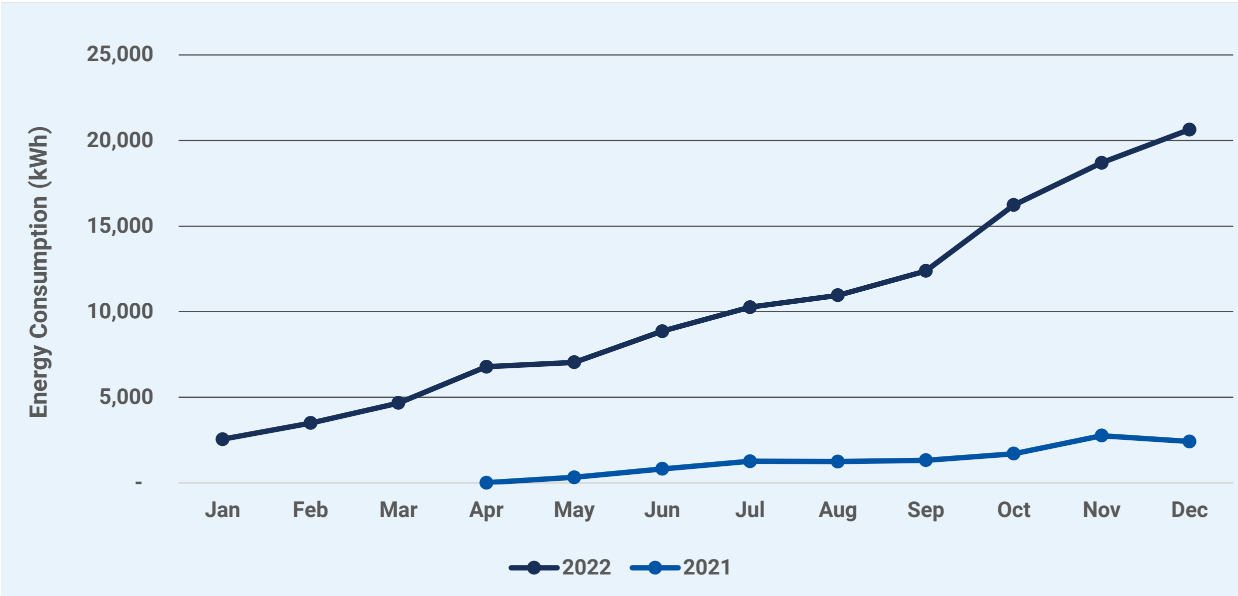
Table 105. SDG&E Schools and Parks Pilot Grid Impacts

Impact Parameter	CY2022		Program-to-Date	
	Actual EY2021 + EY2022	Annualized EY2022	Actual PTD	10-Year Projection PTD
Public Charging – Schools				
Operational Sites	7	6	7	7
Electric Energy Consumption, MWh	25	72	25	767
On-Peak MWh (4 PM to 9 PM) (and % of total)	4 (15.7%)	14 (19.2%)	4 (15.7%)	143 (18.6%)
Maximum Demand, kW (with date and time)	92 (12/16/22 11 AM)	92 (12/16/22 11 AM)	92 (12/16/22 11 AM)	N /A
Maximum On-Peak Demand, kW (with date and time)	84 (12/11/22 4 PM)	84 (12/11/22 4 PM)	84 (12/11/22 4 PM)	N /A
Public Charging – Parks				
Operational Sites	8	4	8	8
Electric Energy Consumption, MWh	100	75	110	1,713
On-Peak MWh (4 PM to 9 PM) (and % of total)	24 (24.3%)	15 (19.8%)	24 (24.3%)	365 (21.3%)
Maximum Demand, kW (with date and time)	164 (7/2/22 10:30 AM)	112 (12/10/22 1:45 PM)	164 (7/2/22 10:30 AM)	N /A
Maximum On-Peak Demand, kW (with date and time)	148 (10/19/22 6:45 PM)	71 (12/29/22 5:30 PM)	148 (10/19/22 6:45 PM)	N /A

The remainder of this section provides detailed findings on monthly consumption, maximum demand, daily energy consumption and demand, weekend verse weekday charging trends, frequency of charging sessions, and connection time.

As shown in Figure 182, energy consumption increased over 2021 and 2022 in activated sites. Between January and December 2022, energy consumption increased by eight times.

Figure 182. SDG&E Schools and Parks Pilot Monthly Energy Consumption in 2021 and 2022



As shown in Figure 183, both demand and energy across all sites increased steadily, with demand reaching 175 kW in the fourth quarter of 2022.

Figure 183. SDG&E Schools and Parks Pilots: Daily Maximum Demand (kW) and Consumption (kWh), Program-to-Date Sites

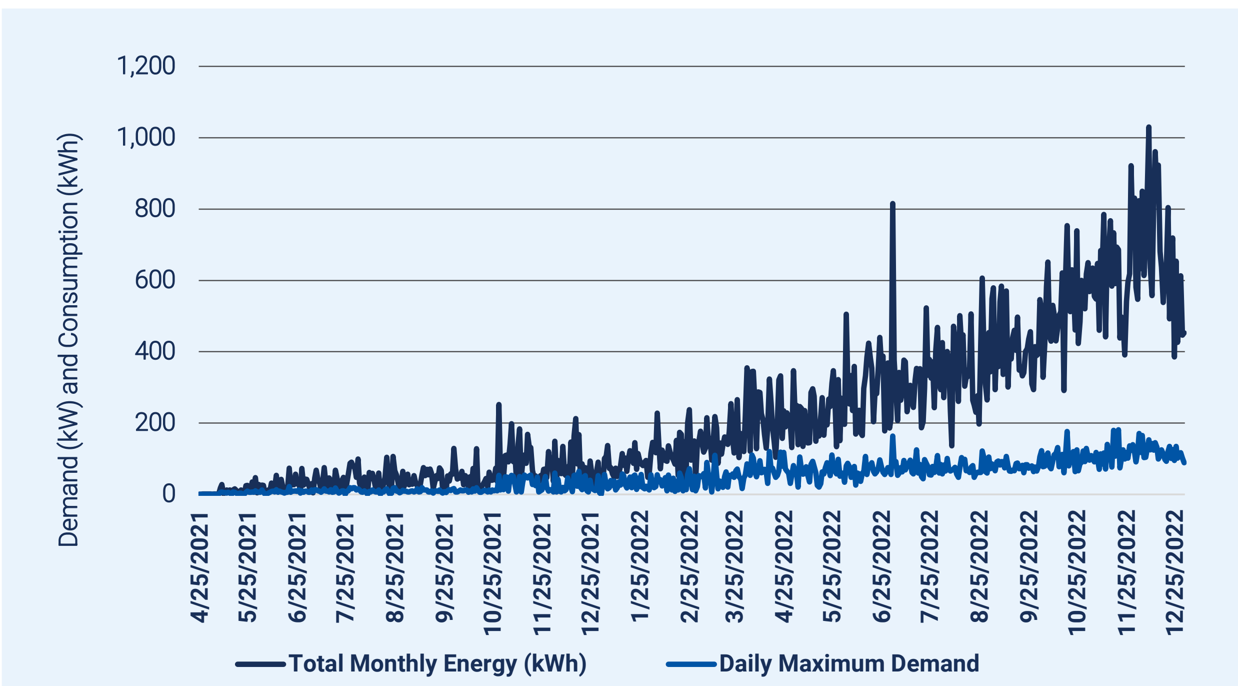
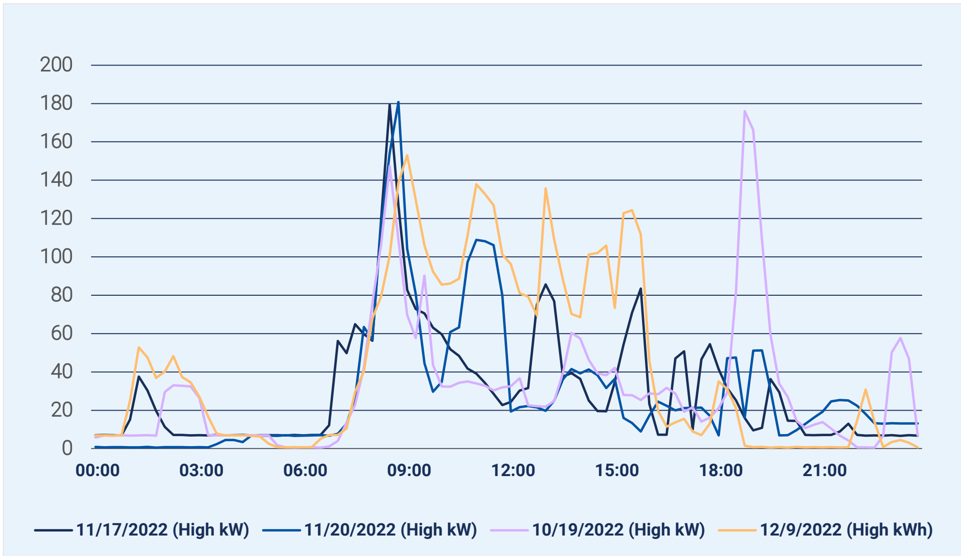


Figure 184 depicts 15-minute average demand for the three highest demand (kW) days and the single highest consumption (kWh) day (for both the Schools and Parks Pilot). As shown in the figure, all peak days spike around 8 AM. Charging sessions that take place in the middle of the night appear to represent DCFC charging based on the Evaluation Team's analysis of charging duration and demand.

Figure 184. SDG&E Schools and Parks Pilots Highest Demand and Consumption Days, Program-to-Date Sites



As shown in Figure 185, weekdays appear to have more demand in the morning whereas weekends show more demand midday, on average. Figure 184 shows several charging sessions from 10 PM to 5 AM: generally, these sites have low usage during that time range. Some of these sites are more proximate to residential dwellings, which may predispose them to overnight charging and higher utilization rates.

Figure 185. Schools and Parks Pilots Weekday versus Weekend Average Demand, Program-to-Date Sites

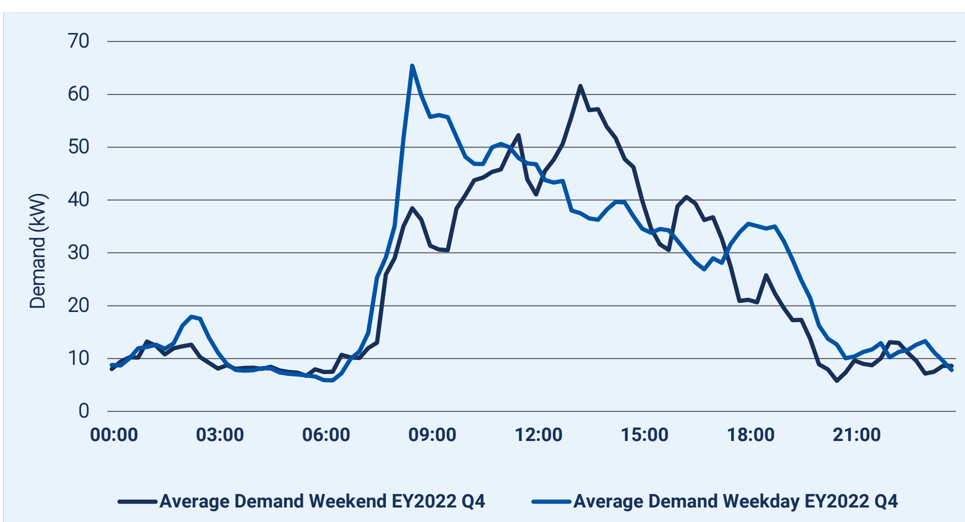
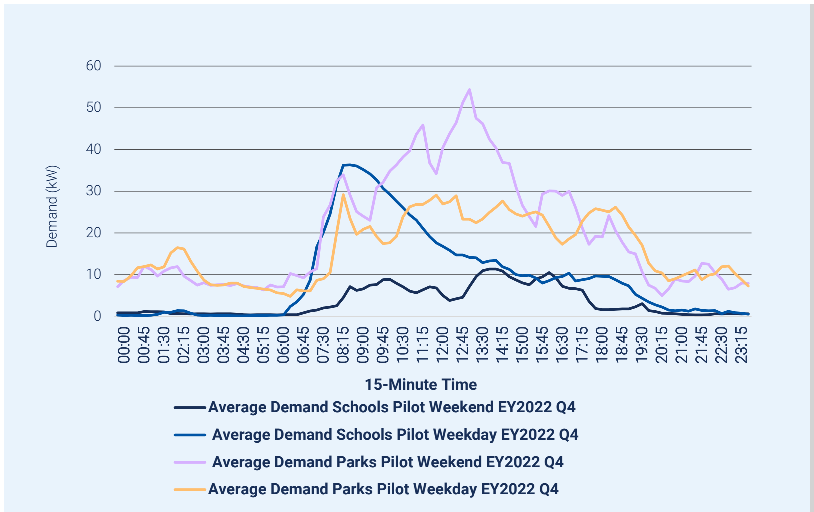


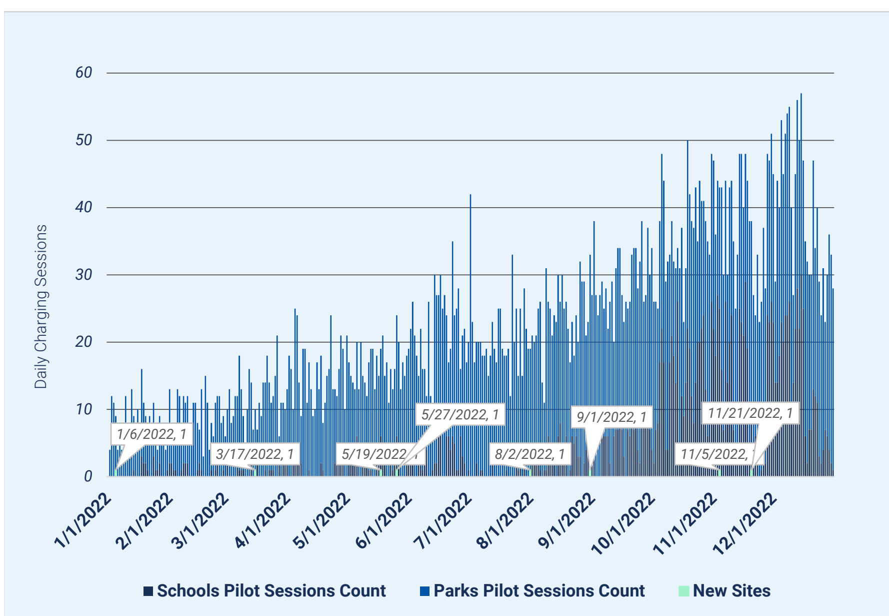
Figure 186 highlights the differences between the Schools Pilot (almost exclusively L2 charging) and the Parks Pilot (mix of L2 and DCFC) average load curves. The Schools Pilot sites (school district workplaces) have very little load on weekends and predictable load on weekday mornings, whereas the Parks Pilot sites ramp up similarly in all mornings but exhibit higher demand on weekends, taking place midday.

Figure 186. SDG&E for Schools and Parks Pilots Weekday versus Weekend Charging, Program-to-Date Sites



As shown in Figure 187, the Schools Pilot appears to account for most charging sessions throughout 2022, though the two pilots have a nearly equal number of sites (seven school sites and eight park sites). Together these sites accounted for 8,200 sessions in 2022 compared to just under 1,000 in 2021. By year-end these sites were collectively recording almost 60 daily charging sessions.

Figure 187. SDG&E Schools and Parks Pilots Charging Sessions Count



Many of the Parks Pilot DCFC charging sessions (shown in Figure 188) reflect that vehicles are connected to chargers for at least 30 minutes beyond the point at which the vehicle is fully charged (known as idle time). Other locations[127] throughout the state use idle-time-based fees to encourage drivers to move their vehicles soon after completing a charge.

Figure 188. SDG&E Schools and Parks Pilots DCFC Charging Session Connection versus Consumption Hours

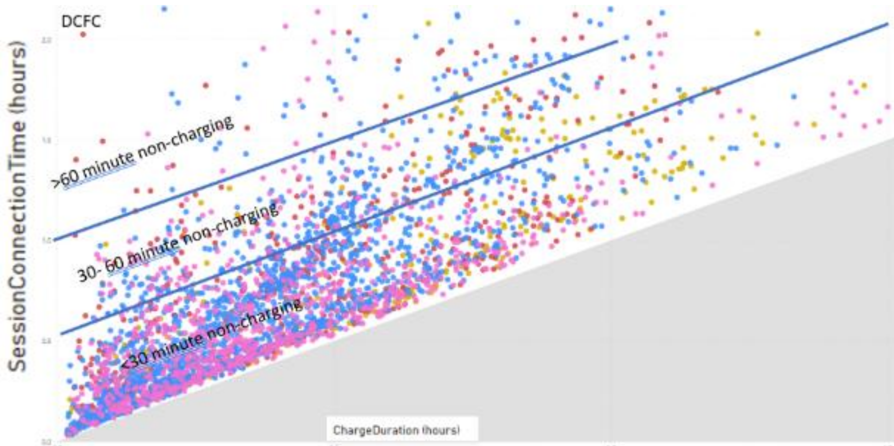
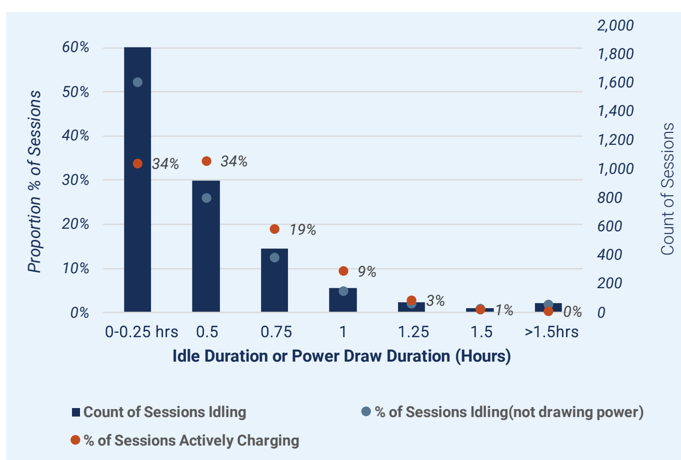


Figure 189 presents data collected from the Schools and Parks Pilots comparing vehicle idle times verses connected time for DCFC chargers only (over 3,500 charging sessions). For over 50% of sessions, drivers disconnected their vehicles within 15 minutes or less after charging was completed; however, in around 25% of sessions, drivers took15 to 30 minutes to disconnect. These data show that almost 25% of sessions have vehicles blocking charging ports for 30 minutes or longer than needed.

Figure 189. SDG&E for Schools and Parks Pilots Idle Times of DCFC Charging Sessions from Pilot



[127] The PG&E Fremont DCFC location has high-cost idle fees to encourage EV owners to turn over parking spaces shortly after completing their session.

Highlights

- Monthly EV charging consumption ramped up throughout EY2022, increasing eightfold throughout the year, representing almost 1,200 kW in charging capacity. This was a substantial increase over installed charging capacity at the end of EY2021.
- Weekdays typically have higher demand in the morning, whereas weekends typically have higher demand midday. However, several sites had charging sessions in the 10 PM to 5 AM time period. Some of these sites have chargers available for overnight residential charging.
- The Schools Pilot appears to account for most charging sessions throughout EY2022, though the two pilots have a nearly equal number of total sites (seven school sites and eight park sites).
- Many of vehicles in the Schools and Parks Pilots that use DCFC charging leave their vehicles connected to chargers for at least 30 minutes beyond the point at which the vehicle is fully charged (idle times).

Petroleum Displacement

The Evaluation Team estimated program-induced petroleum displacement attributable to the six Schools Pilot and four Parks Pilot operational sites for EY2022 using three key pieces of information: electricity used for EV charging, calculated EV annual miles traveled, and equivalent annual counterfactual vehicle petroleum fuel consumption. Using this information, the Evaluation Team estimated the reduction in equivalent gallons of petroleum attributable to the Schools and Parks Pilots.

Table 71 presents the Schools and Parks Pilots' annualized petroleum displacement resulting from EY2022 sites, actual displacement from program-to-date sites, and 10-year projection totals for program-to-date sites.

Table 106. SDG&E Schools Pilot and Parks Pilot Petroleum Displacement Summary

DAC	Usage		Petroleum Displacement (DGE)		
	EY2022 Sites Annualized (kWh) (n=10)	EY2022 Sites Annualized (miles) (n=10)	EY2022 Sites Annualized (n=10)	PTD Sites Actuals (n=15)	PTD Sites 10-Year Projection (n=15)
Inside DAC	99,554	297,703	8,185	10,226	153,465
Outside DAC	47,891	142,921	3,982	1,541	37,112
Total	**147,445**	**440,624**	**12,167**	**11,767**	**190,577**

Highlights

- The 10 operational EY2022 sites resulted in an annualized impact of over 12,000 gallons of petroleum, with 67% of the impact within SDG&E service area DACs.
- Over a 10-year period, the EY2021 and EY2022 sites combined will result in displacing more than 190,000 gallons of petroleum.

Greenhouse Gas and Criteria Pollutant Impact

The Evaluation Team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service because of the SDG&E Schools and Parks Pilots. The Evaluation Team first developed one ICE counterfactual, then calculated the emissions associated with these vehicles under conditions that otherwise matched the EVs in order to provide a baseline. Although EVs have no tailpipe emissions, the fossil-fuel power plants that supply electricity to the vehicle chargers still release some GHGs and criteria pollutants, and the Evaluation Team's analysis accounts for these impacts.

Table 107 presents the GHG reduction resulting from the six operational Schools Pilot sites and four operational Parks Pilot sites in EY2022, along with annualized and 10-year totals, by impact location. Overall, the Pilots resulted in 81% reduction of GHG emissions relative to the counterfactual in EY2022 (94 MT total), with 67% of the impact within DACs.

Table 107. SDG&E Schools and Parks Pilot GHG Reductions Summary

DAC	Usage		GHG Reduction (MT)		
	EY2022 Sites Annualized (kWh) (n=10)	EY2022 Sites Annualized (miles) (n=10)	EY2022 Sites Annualized (n=10)	PTD Sites in CY2021 + CY2022 Actuals (n=15)[a]	PTD Sites 10-Year Projection (n=15)
Inside DAC	99,554	297,703	63	75	1,209
Outside DAC	47,891	142,921	31	12	304
Total	**147,445**	**440,624**	**94**	**86**	**1,513**

[a] Total row may not sum to individual rows due to rounding error.

Of the local emissions, the program had the highest impact in reducing CO, resulting in an estimated annualized reduction of 253 kg and a projected 10-year reduction of more than 5,000 kg (Table 108).

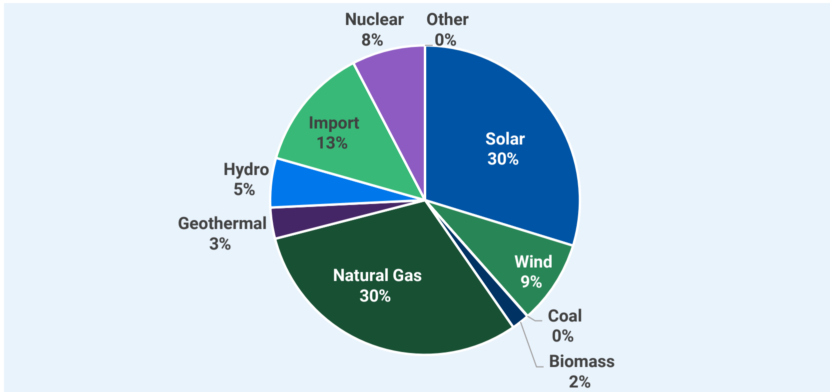
Table 108. SDG&E Schools and Parks Pilot Local Emissions Reductions

Emissions	EY2022 Sites Net Reduction			Program-to-Date Sites Net Reduction	
	Inside DAC	Outside DAC	Total	Actuals	10-Year Projected Impact
PM_{10} (kg)	0.32	0.15	0.48	0.44	7.30
$PM_{2.5}$ (kg)	0.3	0.14	0.44	0.40	6.70
ROG (kg)	5	3	8	7.60	159
CO (kg)	170	83	253	248	5,052

The current mix of electricity from the CAISO grid used for charging vehicles in the SDG&E Schools and Parks Pilots sites is shown in Figure 190.[128] Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 57% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear), 30% natural gas, and 13% imports. With the CAISO grid adding more renewables to meet the Renewable Portfolio Standard, the GHG and criteria pollutant emissions will continue to decrease over time.

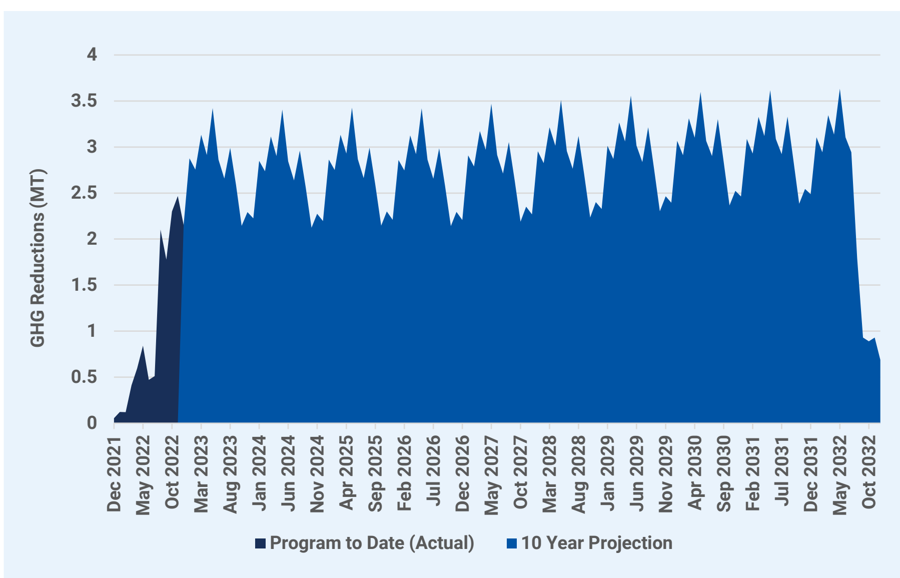
[128] The power associated with imports comes from a mixture of hydro, nuclear, and natural gas plants located outside the CAISO grid.

Figure 190. SDG&E Schools and Parks Net Electricity Mix, Annualized EY2022 Sites



The figure below shows how program GHG reductions have increased to date and are expected to grow over time for EY2021 and EY2022 activated sites. The analysis period ranges from the date that the first site in the program was activated through the end of 2022. The analysis incorporates the net reduction (counterfactual emissions minus utility emissions) for each site in the schools and parks pilots. Program to date emission reductions are shown in dark navy while anticipated benefits based on annualization are presented in royal blue. As each site has its own starting date of operation, the 10-year sunset for each site is observed as a gradual tapering off of program benefits in 2032. While each year's operations appear similar, there are several key factors driving the variations such as seasonality of utility generation sources (high utility emissions will appear as a dip on the curves), holidays occurring on weekends versus weekdays, and sites that became operational late in 2022 having predicted operations year-round in future years.

Figure 191. SDG&E Schools and Parks Program GHG Reductions, Historical and Forecasted, Program-to-Date Sites



Highlights

- The Pilots resulted in an 81% reduction of GHG emissions relative to the counterfactual in EY2022 (94MT total), with 67% of the impact within DACs.
- Of the local emissions, the Pilots had the highest impact in reducing CO, resulting in an estimated annualized reduction of 253 kg and a project 10-year reduction of more than 5,000 kg.
- Based on the real-time grid conditions when the EV charging occurred, the overall energy mix contained about 57% zero emissions or renewable sources of electricity (including solar, wind, hydro, geothermal, biomass, and nuclear) and 30% natural gas.

Health Impacts

The Evaluation Team calculated public health impacts (benefits and costs) of reductions in criteria pollutants from vehicle electrification. Pollutants included in the analysis are primary $PM_{2.5}$ and precursors of secondary $PM_{2.5}$, including NO_x, SO_2, NH_3, and VOCs. The analysis only considers tailpipe emission reductions, rather than the full lifecycle emissions (power plant emissions). The Evaluation Team used the U.S. EPA's COBRA to evaluate the health benefits associated with the emission reductions. COBRA estimates the benefits at the county level for the county in which emissions are reduced. The Evaluation Team disaggregated the county-level effects to estimate the potential health benefits of projects for DACs and non-DACs.

The total value of the health benefits associated with the emission reductions is between $907 and $2,044. Table 109 shows the cumulative health benefits for all impacted counties in California associated with the emission reductions realized by the electrification of EY2021 and EY2022 SDG&E Schools and Parks sites.

Table 109. California Health Benefits for SDG&E Schools and Parks EY2021 and EY2022 Sites

Health Endpoint	Change in Incidence (Annual Cases)		Monetary Value (Annual, 2023 Dollars)	
	Low	High	Low	High
Mortality	0.0001	0.0001	$889	$2,012
Nonfatal Heart Attacks	<0.0000	0.0001	$2	$15
Infant Mortality	<0.0000	<0.0000	$5	$5
Hospital Admits, All Respiratory	<0.0000	<0.0000	$1	$1
Hospital Admits, Cardiovascular	<0.0000	<0.0000	$1	$1
Acute Bronchitis	0.0001	0.0001	<$0	<$0
Upper Respiratory Symptoms	0.0020	0.0020	<$0	<$0
Lower Respiratory Symptoms	0.0014	0.0014	<$0	<$0
Emergency Room Visits, Asthma	<0.0000	<0.0000	<$0	<$0
Asthma Exacerbation	0.0021	0.0021	<$0	<$0
Minor Restricted Activity Days	0.0621	0.0621	$7	$7
Work Loss Days	0.0106	0.0106	$3	$3
Total Health Effects	-	-	**$907**	**$2,044**

As part of this analysis, the Evaluation Team also examined the health benefits within DACs, which may be disproportionately burdened by sources of pollution (including air pollution from ICE vehicles). The

COBRA tool estimates effects at the county level, so the Evaluation Team disaggregated the monetary health benefits by census tract using the relative population of each tract from the most recent American Community Survey. For example, a census tract with 10% of the county's population will be allocated 10% of the value of the health benefits. The approach implicitly assumes that the benefits of emission reductions are distributed evenly throughout the county. If the sites are located in DACs, and the emission reductions are greater in the tracts near the sites, this approach would understate the potential benefit to DACs. Additional information about emission dispersion within counties is needed to provide more precise estimates of the health benefits to DACs and non-DACs. The Evaluation Team then estimated the total benefits allocated to DACs and non-DACs.

San Diego County had the highest proportion of overall benefits with 66% of the total, followed by followed by Los Angeles County (11%), Riverside County (11%), Orange County (5%), and San Bernardino County (3%). Overall, 14% of the benefits are in DACs.

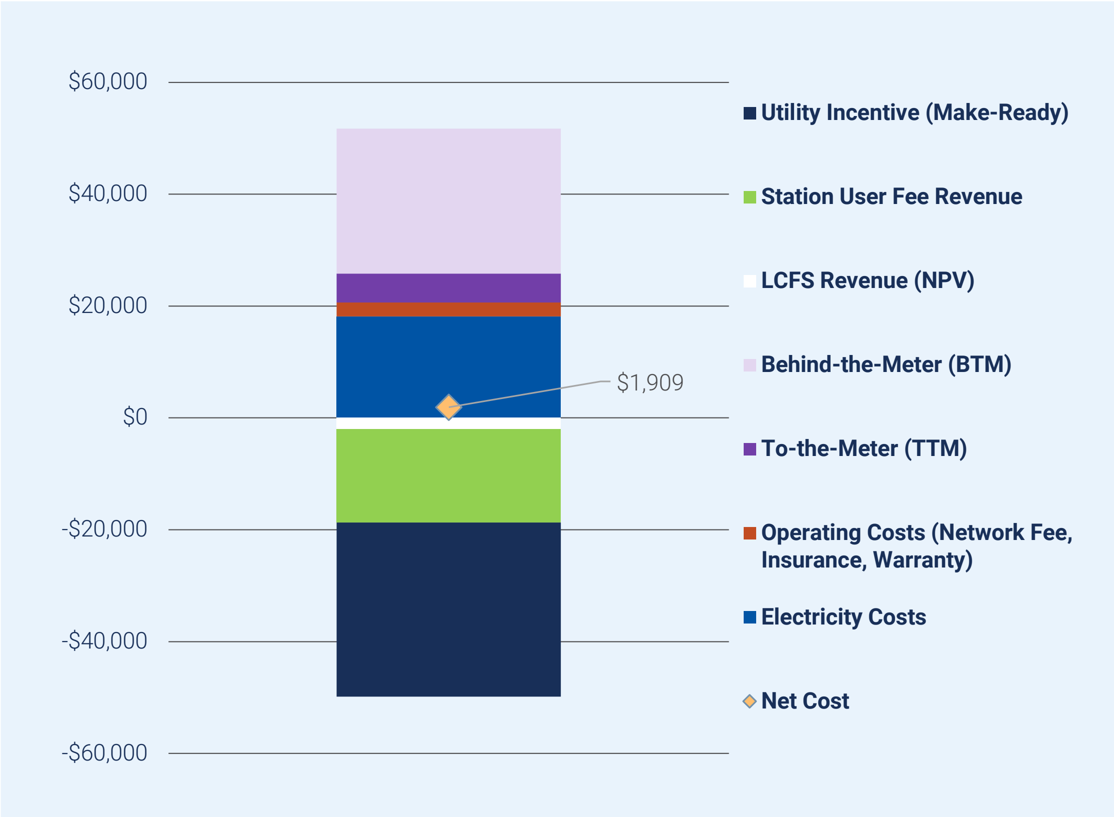
Highlights

- The monetary health benefits from EY2021 and EY2022 SDG&E Schools and Parks Pilots sites range from a low estimate of $907 to a high estimate of $2,044.
- San Diego County had the highest proportion of overall benefits, with 66% of the total, followed by Los Angeles County (11%), Riverside County (11%), Orange County (5%), and San Bernardino County (3%).
- Overall, 14% of the benefits are in DACs.

Total Cost of Ownership

Five sites in the Parks Pilot were financially closed out and able to report cost data for EY2022. While this is insufficient to report a distribution of costs by site, it is sufficient to illustrate the average cost of Parks Pilot sites. All five sites featured L2 chargers, with between four and 10 ports per site. The average TCO per site is shown in Figure 192.

Figure 192. Average Total Cost of Ownership Per Port for SDG&E Parks Pilot



On average, the analysis forecasts a slight cost to the site host, approximately $2,000 per charging port over 10 years. The revenue from charging sessions is nearly equal to the average electricity rate paid by the site host. The estimated operating costs of the charging stations are partially offset by LCFS revenue, and the construction cost is offset by SDG&E's incentives and investment.

SDG&E reported subcategories of costs for the five closed out sites:

- Permitting costs were $1,500 per site; 0.8% of total project costs on average.
- Project management and direct SDG&E labor was $3,594 per site; 1.9% of total project costs on average.
- Design averaged 19% of the total project cost.
- Trenching and excavation averaged 37% of the total project cost.

BTM costs were significantly higher than TTM costs for these projects, at approximately $26,000 per port compared to $5,000 per port for TTM. More specifically, the per port costs included several aspects:

- $5,866 per port for site design
- $250 per port for permitting
- $599 per port for project management and SDG&E labor

- $907 per port for metering
- $11,617 per port for trenching and excavation
- $5,181 per port for TTM infrastructure (which includes some portion of the above cost components)
- $25,943 per port for BTM infrastructure (which includes any of the above cost components not attributed to TTM infrastructure)

The average site cost was $186,742 ($31,124 per port), with permits, project management, and SDG&E labor collectively representing about 3% of project cost.

Highlights

- Five sites in the Parks Pilot closed out in EY2022 and reported cost information (all sites used L2 chargers. The average site has six ports.
- On average, the analysis forecasts a slight cost to the site host, approximately $2,000 per charging port over 10 years.
- The average **site** cost was $186,742 ($31,124 per port), with permits, project management, and SDG&E labor collectively representing about 3% of project cost.

Utility Insights

In addition to monthly check-in calls with key SDG&E staff to discuss the status of the Schools and Parks Pilots, the Evaluation Team conducted a close-out interview with SDG&E staff in March 2023 to review overall Pilot challenges and successes in EY2022. In the following section, these challenges and successes are grouped by those that apply to both Pilots, followed by those that only apply to one Pilot or the other.

Schools Pilot and Parks Pilot

In EY2021, SDG&E staff reported that a central challenge facing the Pilots was that site construction costs were higher than anticipated, as well as labor constraints and supply chain and permitting delays. Staff confirmed that these challenges continued in EY2022:

- **Construction Labor Costs and Supply.** Staff noted that construction labor costs have increased as inflation has risen. In addition, continued from EY2021, staff reflect that since COVID-19, it has been difficult to secure a sufficient labor force.
- **Material Costs.** Staff reported that many materials were generally more expensive than originally anticipated in 2018 (when the Pilot funding caps were decided). For example, the increased pricing of concrete, which is a key element for site development, is driving higher spending on materials.
- **Supply Chain Delays.** Staff confirmed that supply chain delays, which started as a result of COVID-19, continue to be a challenge.
- **Delays in Permitting.** Staff noted significant delays in the Division of the State Architect's permitting approval process throughout EY2022, which also increased administrative costs.

These delays were compounded because SDG&E staff must adapt to different parameters required by different jurisdictions across their territory.

Schools Pilot

In addition to the shared challenges outlined above, staff reported one additional challenge specific to the Schools Pilot:

- **Seasonal Access.** Staff reported that SDG&E had to purchase materials at seasonally higher prices (such as during the summer or other breaks) to accommodate school building schedules when students would generally not be on campus.

Despite these challenges, SDG&E staff reflected key areas of success in engaging and enrolling schools by being flexible within the approved Pilot design:

- **Selected Accessibility.** In EY2021, SDG&E staff noted that when installing public charging infrastructure, many K–12 schools were concerned about student safety if chargers were always accessible to the public (during school hours). Therefore, like other Utility staff, SDG&E staff offered alternative participation options that allowed the schools to keep the chargers limited to private use by faculty, staff, and/or parents (depending on the school's preference). SDG&E continued to offer this policy in EY2022, which was used by newly participating schools.
- **Interest Beyond Light Duty.** In EY2021, SDG&E staff had some initial difficulties with enrollment, as many schools were primarily interested in electrifying their bus fleets instead of installing charging for LDVs (even if just for staff and students). In EY2022, Schools Pilot staff were integrated into managing other EV customer offerings such as PYDFF. Therefore, when customers expressed interest in fleet electrification, SDG&E staff were able to promote the PYDFF program alongside the Schools Pilot to help schools participate in both offerings. SDG&E staff noted that this was successful in helping schools stay engaged with the Schools Pilot.
- **Expanded Interest in EVs.** SDG&E staff noted that in EY2022, several K–12 school that had already completed site installations through the Pilot reached back out to SDG&E hoping to acquire more private (non-public-facing) Utility-owned EVSE infrastructure. In addition, previous participants are actively recommending the Pilot to other schools.

Parks Pilot

As noted in the EY2021 report, initially SDG&E had intended to sign a collective Utility master agreement with the DPR. Due to shifts in the approach between Utilities, SDG&E staff noted several challenges with implementing the Parks Pilot in EY2022:

- **Separating State-Level Negotiations.** Though the plan in EY2021 was for all Utilities to enter into a collective participation agreement with DPR, in EY2022, the Utilities ultimately separated their efforts and SDG&E started coordinating with DPR's state-level office independently because not all Utility legal teams—including SDG&E's—were comfortable with the terms of the final draft of the master agreement for joint use.
- **Staff Turnover.** When DPR staff transitioned, SDG&E staff had to re-orient the new staff member on the purpose of the Pilot, all steps completed to date, and next steps needed. These

staffing challenges caused SDG&E to start from the beginning of the process to address new staff preferences.

- **Negotiations between Legal Teams.** After SDG&E staff helped orient new DPR staff to the contracting process, the final decisions on which parties assume responsibility for costs, liabilities, and risks remains to be worked out between SDG&E's and DPR's legal teams. Despite ongoing negotiations in EY2022, SDG&E and DPR were unable to come to an agreement. However, Pilot staff are hopeful for a contract agreement in EY2023.

A key success in EY2022 was SDG&E's unique experience with serving local[129] parks through the Parks Pilot, which has allowed staff to foster committed, positive, long-term relationships with their local customers:

- **Prompt Responses for Maintenance.** Though most local construction was completed in EY2021, in EY2022 SDG&E staff continued to successfully work with the local park participants and remain engaged and responsive to site host requests to repair installed equipment as needed. SDG&E staff received positive feedback in EY2022 about their response time to equipment malfunctions and their answers to general Pilot questions, and they are continuing to nurture their relationships with these engaged customers.
- **Identify Opportunities for Further Engagement.** SDG&E staff reported that these trusted relationships have allowed them to direct interested customers to other available SDG&E programs.

Highlights

- As site construction continued in EY2022, site costs and delays continued to be a challenge to site construction.
- Though contract negotiations with the DPR were not completed in EY2022, SDG&E staff are hopeful for an agreement in EY2023.
- Providing flexibility in the Pilots' design allowed SDG&E to accommodate the needs of customers and to successfully implement projects for both the Parks Pilot (allowing local park participation) and the Schools Pilot (limiting charging access to only staff, student, and partners at K–12 sites).
- SDG&E has been able to use Pilot engagement as a method of building positive, long-term relationships with customers and of promoting other related programs.

5.2.3. Lessons Learned

The team identified several lessons learned from EY2022. These lessons, presented below with key supporting findings and recommendations, may be applied to future Pilot years and to other similar efforts.

---

[129] Local is defined as city and county parks.

Schools and Parks Pilots

Long-term engagement with customers, like those interested in the Schools and Parks Pilots, lends itself to positive relationship building, which bolsters participation in other programs and satisfaction with SDG&E.

In both the Schools and Parks Pilots, SDG&E has now been working closely with some customers for well over one calendar year. Over the course of implementing the Pilots, SDG&E staff have learned where there is flexibility in the design to make the Pilot as appealing to customers as possible (for example, allowing K–12 schools that are concerned with student safety to keep their chargers private). In addition, because these chargers are Utility owned, SDG&E staff continue to have a relationship with Pilot participants even after EVSE is installed by addressing maintenance concerns or questions that may arise along the way. Through this long-term engagement, SDG&E staff have built positive, stable relationships with these customer segments, and now can directly connect these customers with other SDG&E programs or products of interest.

Market conditions contribute to higher-than-expected site costs.

SDG&E began the Schools and Parks Pilots during the COVID-19 pandemic. COVID-19 had unprecedented economic impacts across nearly every market, driving up costs for materials and labor and disrupting supply chains. These changes were so significant that the estimates SDG&E had created for Decision 19-11-017 (which mandated the Schools and Parks Pilots at their determined funding levels) did not reflect the actual costs for implementation. These struggles continued into EY2022 with inflation impacts and were compounded by additional delays that drove SDG&E to have to purchase materials at seasonally high prices, such as schools only allowing construction during breaks and permit approval taking an exceptionally long time.

SDG&E's Schools and Parks Pilots are successfully promoting regional EV adoption.

SDG&E’s investments in the Schools and Parks Pilots’ public charging infrastructure had a significant and economically meaningful impact on EV ownership in EY2022, leading to an increase of 19 EVs (Schools Pilot) and 14 EVs (Parks Pilot) for households neighboring the infrastructure. The impact of the Schools Pilot was larger than the impact of the Parks Pilot, as there were more charging facilities, and the site locations are generally closer to neighboring households than the chargers for Parks Pilot sites.

The Schools Pilot sites are helping to displace petroleum, reduce GHG and local emissions, and achieve nominal health impacts overall and within DACs.

The SDG&E Schools and Parks Pilots’ sites achieved an EY2022 annualized impact of over 11,000 gallons of petroleum (190,00 gallons over a 10-year period), with 67% of the impact within DACs. In addition, the Pilots resulted in an 81% reduction of GHG, with 67% of the impact within DACs. Overall, 14% of the health benefits are in DACs, and the monetary health benefits from the EY2021 and EY2022 SDG&E Schools and Parks Pilots’ sites range from $907 to $2,044.

Parks Pilot Only

Sufficient time must be built into Pilot implementation planning when anticipating contract negotiations between two or more large organizations.

The plan for the Parks Pilot in EY2021 was for all Utilities to enter into a collective participation agreement with the DPR. However, the SDG&E legal team was not comfortable with the terms of the final draft of the master agreement that had been drafted for joint use. Therefore, in EY2022, the Utilities ultimately separated their efforts and set out to establish independent agreements with DPR.

In part, these delays were due to DPR staff turnover, which meant a pause in furthering negotiations while new DPR staff were oriented to the status of the agreement documents. In addition, SDG&E and DPR's legal teams, in general, have had trouble agreeing to terms around responsibilities for certain costs, liabilities, DPR reimbursement, and risks. However, at the end of EY2022, SDG&E Parks Pilot staff were hopeful for an agreement to be developed in EY2023 given the progress that was completed.

5.3. Vehicle-to-Grid Pilot

5.3.1. Overview

This section provides an overview of SDG&E's V2G Pilot, including background and goals, completed and planned activities, timeline, and Pilot materials.

Pilot Description

SDG&E designed this Pilot to accelerate the market growth and adoption of V2G technologies, to support the goal of enabling EVs to function as distributed energy resources, to potentially improve the Utility load factor, and to reduce GHGs and criteria pollutants. With the V2G Pilot, SDG&E also aimed to address the barriers of upfront financing costs and insufficient return on investments, first-mover risk aversion for pre-commercial technology, unproven charger and vehicle interoperability, and lack of industry standardization.

School buses provide a favorable use case for V2G, with predictable usage patterns and traditionally sitting idle during peak demand periods and summer months when grid constraints are highest. This use pattern allows school buses to take advantage of favorable TOU super-off-peak Utility rates. Electric school buses also have large batteries for energy storage making them potential candidates for V2G assets.

The critical barriers for school bus fleets are reliability, vehicle and infrastructure costs, and the uncertainty and complexity of V2G technology integration. While V2G technology utilization and development are not within Utility control, the Pilot could have a positive impact on these factors and increase confidence in electric school bus and V2G technology by providing several components:

- TOU pricing structure or other programs for site hosts
- Planning, design, and ongoing Pilot data collection and management
- Installation of V2G-enabling infrastructure, including chargers
- Coordination between multiple stakeholders of varying roles related to V2G and smart charging

Through these Pilot activities, SDG&E intended to reduce peak demand at the site, send electricity back to the grid when needed, quantify charger utilization rates and the number of critical peak events when V2G is used, and demonstrate successful implementation of V2G technology.

Pilot Implementation

In 2017, SDG&E solicited a request for information as it was conceptualizing the V2G Pilot and then selected finalists to participate in a request for proposals. SDG&E selected First Priority GreenFleet's proposal, which included the bus OEM (Lion Electric), site host (CVUSD), and EVSE provider (BTC Power).

In January 2018, SDG&E filed Application 18-01-012, which included the V2G Pilot with the goal of helping SDG&E understand how it can use EVs as distributed energy resources to improve the load factor and reduce GHG emissions and local air pollution. In the application, SDG&E submitted a request to install, maintain, and own charging infrastructure associated with the electrification of 10 school buses capable of V2G operation and bid into the CAISO markets. The Pilot would be the first to employ V2G-enabled school buses to participate in the CAISO energy market, using 25 kW (discharging) V2G bidirectional chargers.

In August 2019, the CPUC approved the Pilot with a budget of $1.7 million. In April 2020, SDG&E filed Advice Letter 3528-E requesting three modifications to the Pilot, which the CPUC accepted in May 2020:

- Install V2G charging stations at an existing service line rather than a separate service line
- Use DCFC EVSE rather than alternating current
- Reduce the number of V2G bus from 10 to six

In a second Advice Letter, SDG&E assumed the project management role from First Priority Green Fleet and due to Rule 21 requirements, transferred the charging provider from BTC Power to Nuvve. SDG&E selected Nuvve because it offers a DCFC charger produced by Rhombus, which uses a ground-mounted inverter as opposed to an onboard inverter. The final Pilot team included several organizations:

- **SDG&E:** Project manager
- **CVUSD:** Site host
- **Lion Electric:** School bus provider
- **Nuvve:** Charging provider
- **Baker Electric:** Construction manager
- **ViriCiti:** School bus telematics provider

The Nuvve chargers were installed and operational with unidirectional capability in the summer of 2021. Due to multiple delays with the various technology integrations, bidirectional commissioning was completed in June 2022.

Figure 193 shows the layout of the CVUSD site, with the school bus parking area and charger locations for this Pilot circled in red.

Figure 193. SDG&E V2G Pilot CVUSD Site Layout

Table 110 shows the Lion Electric school bus CVUSD procured for this Pilot. The five LionC bus were retrofitted from L2 unidirectional capability-only to be DCFC V2G-capable. The LionD bus had DCFC V2G capability off the production line.

Table 110. SDG&E V2G Pilot CVUSD School Bus Summary

Quantity	Manufacturer	Model	Battery Capacity, kWh	Driving Range, mi	Charge/Discharge Rate, kW	Charging Time, hours
5	Lion Electric	LionC	132	100	25	5 to 9
1	Lion Electric	LionD	210	155	45	2.5 to 5

The six Rhombus V2G bidirectional chargers are each rated for a power output of 60 kW. The chargers communicate with the aggregator, electric grid, and electric bus. The Rhombus chargers meet V2G certification and regulation standards, including:

- UL 1741: Standard for inverters, converters, controllers, and interconnection system equipment for use with distributed energy resources.
- IEEE1547: The technical specifications for, and testing of, the interconnection and interoperability between Utility electric power systems and distributed energy resources.

Figure 194 and Figure 195 show CVUSD's Lion Electric bus and Nuvve chargers, respectively.

Figure 194. SDG&E V2G Pilot Lion Electric School Bus

Photos provided by Cajon Valley Union School District.

Figure 195. Nuvve DCFC

Photo provided by Cajon Valley Union School District.

While the selected Nuvve Rhombus chargers have a 60-kW power output, CVUSD's first generation LionC bus only accept up to 25 kW and the third generation LionD bus are limited to 45 kW.

Due to unforeseen challenges, several Pilot design changes have been necessary since approval:

- CVUSD's five LionC bus needed to be retrofitted to accept DC power and allow for bidirectional charging and discharging.
- The maximum bus discharge power resulted in the site being unable to participate in CAISO's program, which has a minimum export power requirement of 100 kW. This threshold would require all six chargers to export at least 17 kW simultaneously, which would likely be a rare occurrence. However, the site was eligible for SDG&E's ELRP and Critical Peak Pricing (CPP) program, where critical peak events are called when energy and demand charges spike. Participating sites are not required to reduce demand but when they do, they can receive compensation and avoid increased electrical costs during these events. ELRP requires a minimum power output of 25 kW per hour, which is calculated as an average demand over the hour. Since CVUSD's routes typically end by 4:30 PM, the vehicles can participate by discharging when they return to the bus yard.
- At the time of commissioning, the building and EV chargers shared the same SDG&E billing meter on the AL-TOU rate, with separate research meters for the chargers. In this configuration, the chargers were not eligible for the EV rate, resulting in high charging costs for the site. This configuration was initially used to enable the electric school buses to discharge to the building to offset load during CPP program events and provide resiliency when needed. In response to CVUSD's concern over high charging costs and the CPUC's recent sub-metering protocol, SDG&E reconfigured the meters and put the chargers on the electric vehicle high-power (EV-HP) rate, allowing cost savings for CVUSD.
- After switching the chargers to the EV-HP rate, SDG&E determined that there was no added value for the site to participate in the CPP program, since there is no difference in the CPP program and EV-HP rates. However, if a CPP program event is called separate from an ELRP event, the vehicles can support building load reduction, which is still on the AL-TOU rate, which may demonstrate vehicle-to-building benefits.
- Due to parking space length constraints at CVUSD's other V2G site installed under the PYDFF program, CVUSD moved three of their new, third-generation Lion Electric bus with longer chassis to the Pilot site. These third-generation bus have BMW batteries, which can accommodate up to a 45-kW charge/discharge rate, while the first-generation bus are limited to a 25 kW charge/discharge rate.
- Nuvve and Lion Electric's adoption of ISO 15118-20 during the term of this Piot required extending the software development timeline to allow for bidirectional operation.

Pilot Timeline and Status

SDG&E is conducting three test phases during the V2G Pilot data collection, as shown in Table 111. Due to the commissioning and bidirectional capability delays, SDG&E extended the evaluation data collection period through December 2023.

Table 111. V2G Pilot Test Phases and Timeline

Test Phase	Description	Timing
1	TOU charging and resiliency testing in the event of a building power shutoff	Summer 2022 through December 2023
2	ELRP participation	Summer 2022 through October 2023 (ELRP events occur from May 1 through October 31)
3	CPP program participation	Summer 2022 through October 2023 (CPP events occur from May 1 through October 31)

During summer 2022, the site participated in SDG&E's ELRP, which offers compensation for load shedding and allows customers to export power to the grid (such as through EVs) between 4 PM and 9 PM from May 1 to October 31. These events were communicated to Nuvve and the customer the evening before the event. SDG&E provides $2.00 per kilowatt-hour exported or shed compared to a baseline and events are triggered up to 60 hours per year. During EY2022, the Pilot participated in nine ELRP events, providing 650 kWh back to the grid and earning approximately $1,300.

Pilot Materials Summary

In EY2022, SDG&E completed marketing, outreach, and education about the V2G Pilot, publishing two blog posts (Figure 196) and hosting a media event (Figure 197). Additionally, SDG&E presented project status, findings, and lessons learned at various expos and conferences, including DistribuTech, Act Expo, V2G Technical Advisory Board, and other V2G focused forums. The blog posts received over 2,000 views (over 1,600 unique visitors). SDG&E hosted the press event on July 26, 2022, to unveil the V2G Pilot site, with public officials highlighting the V2G technology. SDG&E did not use paid advertisement for these marketing efforts.

Figure 196. SDG&E V2G Pilot NewsCenter Articles

Sources: SDG&E NewsCenter. August 10, 2022. *SDG&E Unveils Region's First V2G Project.*
https://www.sdgenews.com/article/sdge-unveils-regions-first-v2g-project
SDG&E NewsCenter. July 26, 2022. *SDG&E and Cajon Valley Union School District Flip the Switch on Region's First Vehicle-to-Grid Project; Featuring Local Electric School Bus Capable of Sending Power to the Grid*.
https://www.sdgenews.com/article/school-district-flip-switch-regions-first-vehicle-grid-project

Figure 197. SDG&E and CVUSD Press Event on July 26, 2022

5.3.2. Findings

As discussed in the *Overview* section, the SDG&E V2G Pilot was fully commissioned in June 2022, but the bus and chargers were not used regularly until January 2023. As a result, the Evaluation Team did not perform an impact analysis in EY2022 but anticipates that there will be enough vehicle and charger operation to conduct an impact analysis including grid impacts, petroleum displacement, GHG and criteria pollutant reductions, health impacts, and TCO analysis during EY2023. This report provides limited insights based on a site visit, in-depth interviews, and market research completed for EY2022, including insights from Utility staff.

Site Visits

The Evaluation Team performed a verification site visit after successful commissioning in November 2022. The Evaluation Team confirmed the quantity, model, and output capacity of the installed Rhombus DCFCs (Figure 198). The connector types are CCS1 (J1772 and two DC pins), and each port has a 20-foot charging cord.

Figure 198. Nuvve Rhombus DCFC Chargers
(left: separate power cabinets and dispensers; right: Rhombus nameplate)

During the site visit, the site host expressed concern about the number of software updates and delays to get the bus ready for regular school bus services, the potentially reduced Pilot cost-effectiveness from limited battery power output, and vehicle fit-and-finish issues, such as ergonomic issues with the parking brake and unconventional mirrors. They also expressed frustrations with the charging station hardware and software network. The site host indicated that co-benefits (such as improved air quality and driver comfort and noise pollution reduction) could not be determined at that time, since the vehicles had not been used regularly.

The Evaluation Team plans to investigate and check-in on these issues with the site host during EY2023.

Highlights

- The team verified that six Rhombus DCFC with 60 kW output were installed as reported.
- The site host was still experiencing issues with the chargers and vehicles at the time of the site visit and expressed concern with hardware and software-related delays in operations.

Utility Insights

The team spoke with the SDG&E Pilot representative during December 2022. This section summarizes Utility insights into V2G challenges and lessons learned during the second year of the Pilot.

- The Pilot successfully participated in the ELRP in EY2022 and is expected to continue participation in EY2023.
- The Pilot allowed SDG&E to establish a streamlined pathway for interconnection project applications. While policies had existed before the Pilot, no sites had gone through the process. As of the interview, three or four sites had gone through the process, which now takes about one month between application submission and approval.
- SDG&E now provides supplemental incentives for V2G-capable charging stations in their PYDFF program to address higher interconnection, commissioning, and hardware/software upgrade costs.
- SDG&E recommends that project sites procure new EVs with off-the-lot DC bidirectional capability and choose EVSE with demonstrated interoperability to the selected vehicles. This recommendation is due to the difficult and protracted experience of having to retrofit the AC unidirectional electric school buses in the Pilot.
- SDG&E is working with the CPUC to develop a V2G-specific export rate.
- The bus OEM is concerned that V2G operation will have a negative impact on battery life. Due to these bus battery warranty concerns, the buses were limited to a charge/discharge range of 75%/45% during V2G operation to protect the batteries, limiting the amount of energy that can be discharged to the grid or building. SDG&E is working with CVUSD and Lion Electric to address battery warranty concerns and remove battery restrictions, which would allow the site to fully discharge the batteries.
- There is a lot of interest from U.S. and international parties in the Pilot outcome.

Highlights

- The Pilot highlighted the need for a streamlined interconnection application process, supplemental V2G project incentives, and a V2G-specific rate.
- To address bus battery warranty concerns, the buses are throttled during V2G operation, which limits the amount of energy that can be fed back to the grid or building.

Site Host Insights

The Evaluation Team did not interview the CVUSD team during EY2022. The Evaluation Team will conduct a final interview with CVUSD in fall 2023.

Vendor Insights

The section includes details of the Pilot challenges, lessons learned, and recommendations from Nuvve and Lion Electric.

Nuvve

The Evaluation Team interviewed the Nuvve team in January 2023 to collect Pilot insights.

- The enrollment process for SDG&E's ELRP was straightforward.
- Nuvve is working with SDG&E to reconcile differences in the EVSE and AMI datasets.
- In Q4 EY2022, Nuvve implemented charging optimization for the site by adding TOU charging parameters to their software. TOU charging is critical to V2G profitability, so having software that can optimize charging and discharging will improve the cost-effectiveness of this Pilot for CVUSD.
- Nuvve reported that a major barrier in implementation has been the newness of V2G applications, with both software and hardware technological limitations. They expect that these limitations will diminish as the technologies continue to mature over time, but these expectations still need to be vetted.
- Nuvve pointed out that the appropriate rates for V2G applications are not clear and warrant additional discussion with the CPUC and Utilities.

Lion Electric

The Evaluation Team interviewed the Lion Electric site managers in February 2023, who provided several insights:

- Lion Electric sees the primary role of the electric school buses to be transportation vehicles, not a distributed energy resource. Therefore, battery health is of higher importance than V2G dispatch operation. To preserve battery health and longevity, Lion Electric placed charge/discharge limits on the batteries during V2G operation to minimize degradation.
- The bus batteries were restricted to 45% to 75% of capacity during V2G operation at the time of the interview to ensure a 12-year lifespan for the bus batteries. The bus can charge from 0% to 100% during the first charge but cannot discharge if they are charged above 75%. Lion Electric is working with the site and SDG&E on these discharge limitations. Lion Electric sets similar limitations across battery types (such as LG and BMW batteries).
- Lion Electric is collecting battery state of health in Lion Beat, which provides daily data on internal resistance and usable capacity. On L2 charging, they have found minimal degradation for V2G operation, but have seen higher levels of degradation on V2G projects compared to unidirectional charging. Lion Electric will work with the site host to set up access to Lion Beat during 2023.

Highlights

- V2G application-related hardware and software still needs to be tested and vetted to understand interoperability and battery degradation impacts.
- Different stakeholders have different priorities when it comes to EVs and V2G effectiveness.

Market Research

During EY2022, the Evaluation Team conducted research into other statewide activities related to V2G projects and the impacts of V2G operation on EV batteries. This section provides a summary of the Evaluation Team's research.

California Energy Commission V2G Equipment List

During 2022, the California Energy Commission (CEC) released the V2GEL,[130] intended to provide a list of bidirectional charging equipment certified to UL 1741 for customers and hopefully to streamline Utility interconnection. It is strictly voluntary and does not consist of any interconnection requirements, nor does equipment need to be on the list as a requirement for interconnection.

To participate in V2G an owner will need a charger with UL 1741 certification and smart inverter functions (UL 1741 Supplement A or Supplement B). Manufacturers apply to the Utility, then the Utility verifies the equipment, does a study to verify safety and grid stability, and extends permission to operate. Then the owner may export power to the grid.

The CEC decided to track both versions of UL 1741: Supplement A and Supplement B. The V2GEL clearly indicates if equipment was certified to Supplement A and/or Supplement B and may track UL 1741 Supplement C once available. The list only includes DC equipment at launch but likely will track AC eventually. There was consensus that AC V2G standards are not mature enough to track currently. The list also only initially includes chargers, plus any other V2G equipment that gets UL 1741 certification. The V2GEL accommodates optional reporting of auxiliary information (such as ENERGY STAR certification).

The V2GEL is an important step in facilitating the adoption of V2G technologies.

V2G Impacts on EV Batteries

During EY2022, the Evaluation Team developed a set of interview questions and scheduled in-depth interviews with two EV battery experts to explore V2G integration impacts on electric bus battery capacity and optimal charging strategies and conditions. Key findings are presented below.

- **State-of-charge:** As an example, limiting the charging range of the battery from 20% to 80% may result in a couple of thousand cycles, but charging from 0% to 100% might only get a couple of hundred cycles before the capacity, and therefore the range of the batteries, is noticeably limited. The chemistry of the cells also impacts the rate of degradation and range limitations around the state of charge of the cells. Several factors affect the degradation and health of the battery: the cell chemistry of the anode, cathode, and electrolyte; the configuration and dimensions of the cells; and how the battery charges and discharges.
- **Charging rate:** For personal vehicles with smaller battery packs, charging at a higher power such as 60 kW will degrade the battery faster than a large MDHD fleet vehicle. The lower the charge

130 California Energy Commission. Last updated 2023. "Vehicle-to-Grid Equipment List (V2GEL)." https://v2gel.energy.ca.gov/

rate relative to the capacity, the more the life of the battery can be prolonged. In V2G applications, power requirements for discharging electricity to the grid need to be considered alongside the degrading effects of discharging at a higher power. Additionally, the ideal discharging rate is highly chemistry dependent, such as nickel cobalt aluminum oxide–anode batteries working well in higher rates of operation but nickel manganese cobalt–anode batteries being more optimized for energy density rather than higher power output.

- **Temperature:** Temperature directly affects the resistance of the cells, and modern vehicles have temperature regulation in packs. In cold weather the anode could start plating lithium. Above 104°F, increased degradation of the electrolyte begins, and the cell will lose capacity. Some batteries will degrade at temperatures as low as 95°F. Vehicles should ideally be in a temperature-regulated space, otherwise the batteries could spend too much energy keeping the battery cool. Manufacturer battery specification sheets can give additional guidance on battery temperature management best practices.
- **Battery management systems:** Battery management systems are critical for battery health and should measure the voltage and temperature of every cell in the pack to avoid unnecessary degradation of the pack. Bidirectional communication between the vehicle battery and the charger can provide quality charging and discharging options.

When optimizing for V2G, there are tradeoffs that must be considered with implications on economics, degradation, and energy use. Since V2G has not been widely implemented, limited data exists to understand optimal V2G operation for maintaining battery health. During EY2023, the Evaluation Team plans to work with the Pilot team to collect battery state of health data.

Highlights

- The CEC's V2GEL maintains a list of UL 1741–certified bidirectional charging equipment and is an important step in facilitating the adoption of V2G technologies.
- EV battery degradation impacts from V2G operation are highly dependent on battery chemistry and temperature management, V2G application, and charging rate. Additional research and data collection is necessary to understand optimal V2G operation on battery health.

5.3.3. Lessons Learned

There were three EY2022 lessons learned from the V2G Pilot.

V2G charging costs are lower when EVSE are billed on the EV-HP rate, rather than the AL-TOU rate.

In response to CVUSD's concern over high charging costs and the CPUC's recent sub-metering protocol, SDG&E reconfigured the meters and put the chargers on the EV-HP rate, allowing cost savings for CVUSD.

EV battery degradation impacts are of high concern to vehicle and battery manufacturers.

Battery state of health and warranty concerns resulted in the implementation of battery charge and discharge throttling for the vehicles in the V2G Pilot. Additional research and data collection is necessary to understand optimal V2G operation on battery health. The V2G Pilot team is working to understand the impacts, how to mitigate risks to the site host and vehicle manufacturers, and potentially remove the V2G limitations.

Retrofitting unidirectional EVs is challenging and costly.

SDG&E recommended that the pilot site procure new EVs with off-the-lot DC bidirectional capability and choose EVSE with demonstrated interoperability to the selected vehicles, such as from the California Energy Commission's (CEC) V2GEL. This recommendation is due to the difficult and protracted experience of having to retrofit the AC unidirectional electric school buses selected for the Pilot.

6. Liberty Transportation Electrification Programs

6.1. EV Bus Infrastructure Program

6.1.1. Overview

This overview provides a description of the Liberty EV Bus Infrastructure Program and a site status update. While some initial and preliminary findings for EY2022 are included below, additional insights will be collected in 2023 via a site visit, a fleet manager interview, EVSP charging session data, monthly customer utility bills, and vehicle telematics or operational logs. The final report for Liberty's EV Bus Infrastructure Program will be included in the EY2023 report in the fall of 2023.

Program Description

In October 2018, CPUC Decision 18-09-034[131] authorized Liberty Utilities to complete a transit electrification site for the Tahoe Transit District (TTD). The initial plan included two Proterra (Rhombus) 60 kW DCFCs for three Proterra buses at Lake Tahoe Community College (LTCC), where the buses could charge overnight. The site was budgeted at $223,000 based on Liberty estimates. Liberty expanded the site scope based on the customer's updated charging specifications. The scope update included two additional 500 kW overhead fast chargers (pantographs) at LTCC and the associated infrastructure to support over 1 MW of new load.

Liberty did not provide incentives or grants for equipment or vehicles. Instead, they provided distribution upgrades totaling $876,272 to support TTD in their fleet electrification efforts. TTD received Congestion Mitigation and Air Quality funds to purchase two Proterra battery electric buses, which, paired with California's Transportation Development Credits and Proposition 1B (transportation bond measure), fully funded the cost of those buses. TTD also received a Low Emission-No Emission Section 5339(c) grant, which fully funded the purchase of a third Proterra bus.

Although the site scope expanded, Liberty remained committed to supporting the site through completion including the following:

- Traditional Utility-side upgrades including a significant line extension since there was a long distance between the distribution supply and the transformer.
- A new transformer and 3,000 ampere switchgear.

Site Status

In EY2022 the TTD's site at LTCC site was completed by the activation of the two 450 kW ABB pantograph chargers (see Figure 199). The TTD electric buses entered into revenue service in July 2022.

Liberty completed initial site work in EY2021, and TTD had activated two 60 kW Proterra DCFCs. TTD's plan was to have the three electric buses charge overnight on the DCFCs located at the LTCC bus stop and that they would use the pantographs (also installed at the LTCC bus stop) between runs. There are

---

131 September 27, 2018. *Decision 18-09-034: Decision on the Priority Review and Standard Review Transportation Electrification Projects*. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M231/K030/231030113.PDF

two bus shelters at the stop and an equipment shed behind the bus stop that houses the charging equipment. The installation process and all distribution upgrades were completed in March 2021, which concluded Liberty's role in setting up the infrastructure for the project. The Utility expects to provide operational support including planning for and scheduling charging cycles. Liberty is also working with TTD on separate applications for new charger services for other locations in its service territory. Additional projects are expected to apply under the new EV Infrastructure Rule.[132]

Until July 2022, the three Proterra transit buses had only been used for training purposes only and had not been actively deployed on routes. Also notably, due to supply chain challenges, the specification from Proterra had to change from 500 kW pantograph chargers to 450 kW pantograph chargers.

Figure 199. TTD's Proterra Electric Bus Charging on the 450 kW ABB Pantograph at LTCC

[132] Liberty Utilities (Calpeco Electric) LLC. December 6, 2021. "Rule 24 Electric Vehicle Infrastructure." https://california.libertyutilities.com/uploads/CalPeco%20Tariffs/CalPeco%20Rule%2024.pdf

6.1.2. Findings

While the TTD started regularly charging buses at this site in July 2022, the Cadmus team will complete the impacts evaluation as part of EY2023 report when a complete set of 12-months of operational data (i.e., utility meter and billing, fleet telematics and/or operational logs) becomes available. The evaluation will include fleet manager interview, site visits findings, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, and health impacts as part of the final analysis and reporting in the fall of 2023. This report provides limited insights based on EVSP vendor interview and preliminary grid impacts. These findings are presented below.

Vendor Interview

The EVSP vendor participated in an interview and shared observations about numerous aspects of the system design and installation process.

The project began during a time of transition in transit bus charging standards. The new J3105 standard for overhead charging was under development. Therefore, there were questions as to whether these transit buses should employ inverted pantographs (top-down) or bus-up. In North America, the common practice is top-down, as that allows for easier engineering of the buses. The pantograph is fixed to the EVSE and descends to charge the bus. In a bus-up system, the pantograph is attached to the bus, and extends upward to connect to the EVSE. The project held initial discussions about the optimal charging structure, which resulted in some construction delays and inefficient expenditures. This was not limited to the top-down and bus-up option, but also included en-route charging that may have been unnecessary at the time given the range of the buses and the length of their routes. However, such infrastructure may prove useful as additional electric buses are added.

EVSPs now have more sophisticated analytical tools for modeling managed charging and EVSE needs. These tools will enable a full complete design approach, including load simulation to identify the optimal charging solution. At the time of this project initiation, such tools were not yet developed, and there was an urgency to install the systems quickly; this resulted in a non-optimal system design. There were delays in communicating all of the required specifications to the engineering design firm. The location of the system, at a community college, required the involvement of the state architect’s office, which represented an additional layer of complexity.

The EVSP was supportive of Liberty’s involvement, only noting that there were considerable delays in the infrastructure upgrades in part caused by supply chain issues (which affected the EVSP as well).

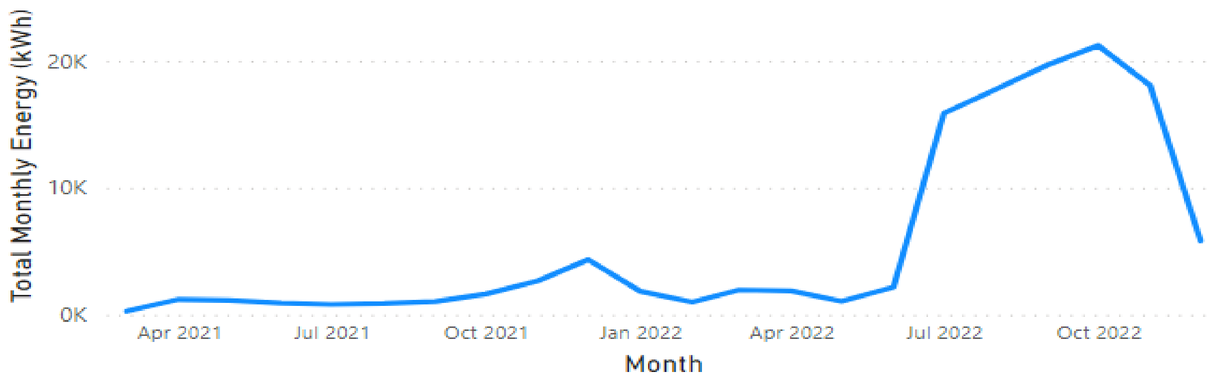
Highlights

- Transit bus overhead charging standards development impacted charger selection timing.
- Considerable delays in the infrastructure upgrades were in part caused by supply chain issues.
- EVSPs now have more sophisticated analytical tools for modeling managed charging and EVSE needs which were not yet available during this project’s planning stage.

Grid Impacts

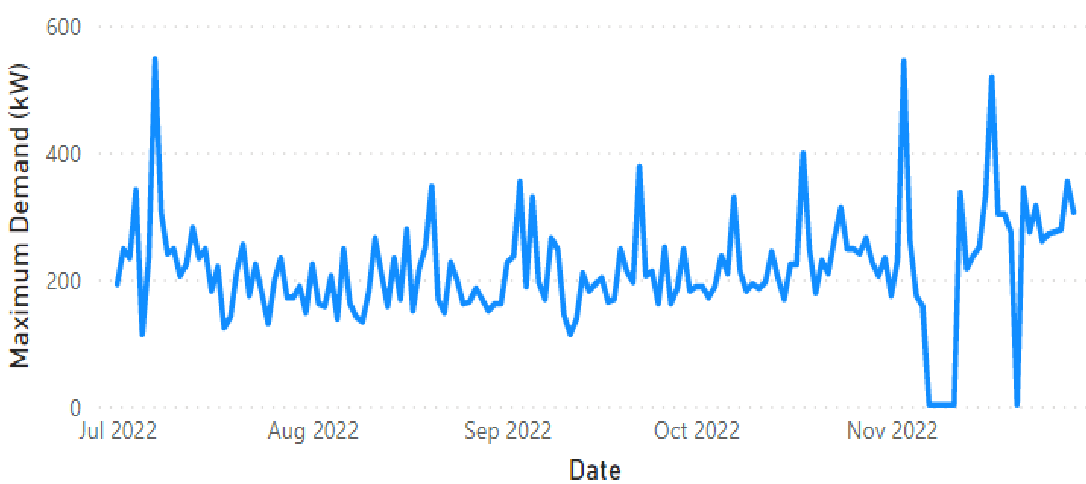
The utility meter for the Liberty EV Bus Infrastructure project at the Tahoe Transportation District was set in March 2021; however, significant usage at the site did not begin until July 2022 (16 months later). As shown in Figure 200, the average monthly usage from July through November 2022 was between 16 MWh and 21 MWh. The daily usage averaged around 650 kWh, ranging from 500 kWh to 1,000 kWh, and did not vary significantly between weekday and weekend.

Figure 200. TTD Site Monthly Energy Usage



With two 450 kW pantograph chargers and two 60 kW DCFCs the total TTD site installed charging capacity is just over 1 MW. As Figure 201 exhibits, the average daily maximum demand was around 200 kW or 20% of the installed capacity during July to November 2022 operation, with several days reaching 400 kW and a few as high as 550 kW which equates to 55% of the installed capacity.

Figure 201. TTD Site Maximum Daily Demand (July - Nov 2022)

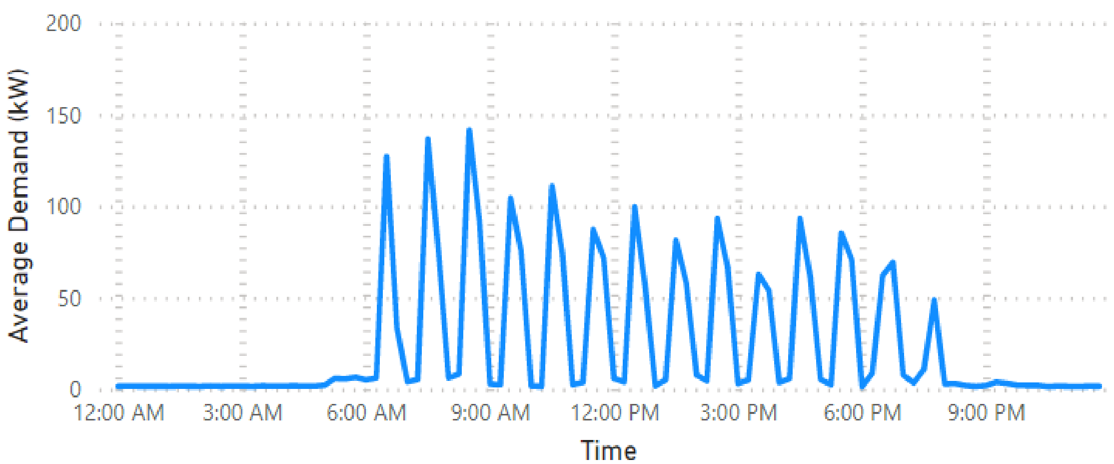


The energy use from July through November 2022 during 4 pm to 9 pm, which is the peak demand time with the highest-cost energy, was relatively consistent between 20% and 25% as shown in Figure 202.

Figure 202. TTD Site Monthly Energy Use between 4 PM and 9 PM (July - Nov 2022)

The average daily load curve during July to November 2022 TTD site operation shows hourly charging sessions between 6 AM and 8 PM. The average charging session demand is around 100 kW, ranging from 50 kW to 150 kW.

Figure 203. TTD Site Average Daily Load Curve (July - Nov 2022)



A sample billing analysis from November 2022 (highest consumption month with 21 MWh) shows an average cost of energy for this site as $0.21 per kWh. TTD site is on the TOU A-1 EV rate schedule[133], benefiting from a demand charge holiday granted by Advice Letter-125[134].

---

[133] Liberty Utilities (Calpeco Electric) LLC. January 5, 2022. "Schedule No. A-1 TOU EV Small General Service." https://california.libertyutilities.com/uploads/CalPeco%20Tariffs/Schedule%20No.%20A-1%20TOU%20EV%20Small%20General%20Service.pdf

[134] Liberty Utilities (Calpeco Electric) LLC. October 1, 2019. "Advice Letter No 125-E-A (U 933-E)." https://california.libertyutilities.com/uploads/CalPeco%20ALs/AL%20125-E-A%20A1%20DCFC%20Rate.pdf,

Highlights

- Liberty's TTD transit bus site was fully activated in EY2022 and has been consuming up to 20 MW of energy monthly.
- The maximum daily demand is consistently around 200 kW (20% of installed capacity) but has occasionally exceeded 500 kW.
- Between 20% and 25% of the energy use at this site occurs between 4 PM and 9 PM resulting in sample average billing costs of $0.21 per kWh.
- The site exhibits regular hourly charges of around 100 kW for approximately 15 minutes during weekend and weekday hours of 6 AM to 8 PM.

6.2. Schools and Parks Pilots

6.2.1. Overview

This overview provides a detailed description of the Liberty Schools and Parks Pilots, as well as summaries of the Pilot implementation process, Pilot materials review, EY2022 performance metrics, budget summary, and a major milestone timeline. Following the overview, we present the EY2022 finding, highlights, and lessons learned.

Pilot Description

Schools Pilot: Through its Schools Pilot, Liberty aims to increase access to available charging at schools and educational facilities throughout its service territory. Liberty provides charging infrastructure to support electric school buses and light-duty charging for parents, teachers, and students. At the time of Decision 19-11-017, Liberty identified 17 potential sites, with 15 at K–12 schools, one at LTCC, and one bus barn for the Lake Tahoe School District. There are no DAC requirements for the Liberty Pilots, as there are no CES 4.0–defined DACs in the service territory.[135] Per Decision 19-11-017, across all sites, Liberty plans to install 56 L2 charging ports and two DCFCs. Liberty's ownership model for all charging stations in the Schools Pilot includes EVSE, network software, transformers, permitting, electrical work, and trenching. Liberty also installs safety bollards and snow melt and lighting equipment, where appropriate.

> **Schools Pilot Targets**
> - 56 L2 and 2 DCFC charging stations
> - 17 schools

> **Schools Pilot Design Goal**
> Empower schools to offer public charging to staff, students, parents, and the greater community.

Parks Pilot: Because the Tahoe region is a destination for many nonresidents, Liberty staff designed the Parks Pilot to increase access to available charging at state parks throughout its service territory for park staff fleet vehicles and visitor vehicles. Prior to Decision 19-11-017, Liberty staff worked with parks staff to determine the most attractive sites for EVSE by considering the needs of the parks and the proximity to town and regional centers, retail centers, beaches, recreation areas, education facilities, and large marinas. Through the Pilot, Liberty plans to install five dual-pedestal charging stations, each with two charging ports, at three California park locations. Similar to the Schools Pilot, Liberty's ownership model for all charging stations covers the cost of

> **Parks Pilot Targets**
> Five dual-pedestal charging stations with two charging ports each at three sites.

> **Parks Pilot Design Goal**
> Encourage state parks and beaches to charge their own EV fleets and offer charging to staff and patrons with light-duty vehicles.

---

[135] The bus barn for Lake Tahoe School District is included in the Schools Pilot as a part of Liberty's goal to replace 50% of the district's diesel bus fleet (as of 2019) with electric school buses.

EVSE, networking software, transformers, permitting, electrical work, and trenching.

Liberty designed both Pilots to help meet the growing demand for EV charging from residents and visitors to the Lake Tahoe region. Through these Pilots, Liberty will increase the share of EV miles traveled in the Tahoe region, which supports the community's move toward their sustainability and environmental improvement objectives, including reducing GHG emissions and criteria air pollutant emissions.

Implementation

Liberty staff began site recruitment in 2019 in preparation for Decision 19-11-017 by directly engaging with potential sites prior to filing. In EY2021 and EY2022 staff focused their efforts on trying to gain interest from schools and parks. Liberty plans to complete one final wave of recruitment in EY2023 by reaching back out to all nonparticipating schools before considering recruitment complete.

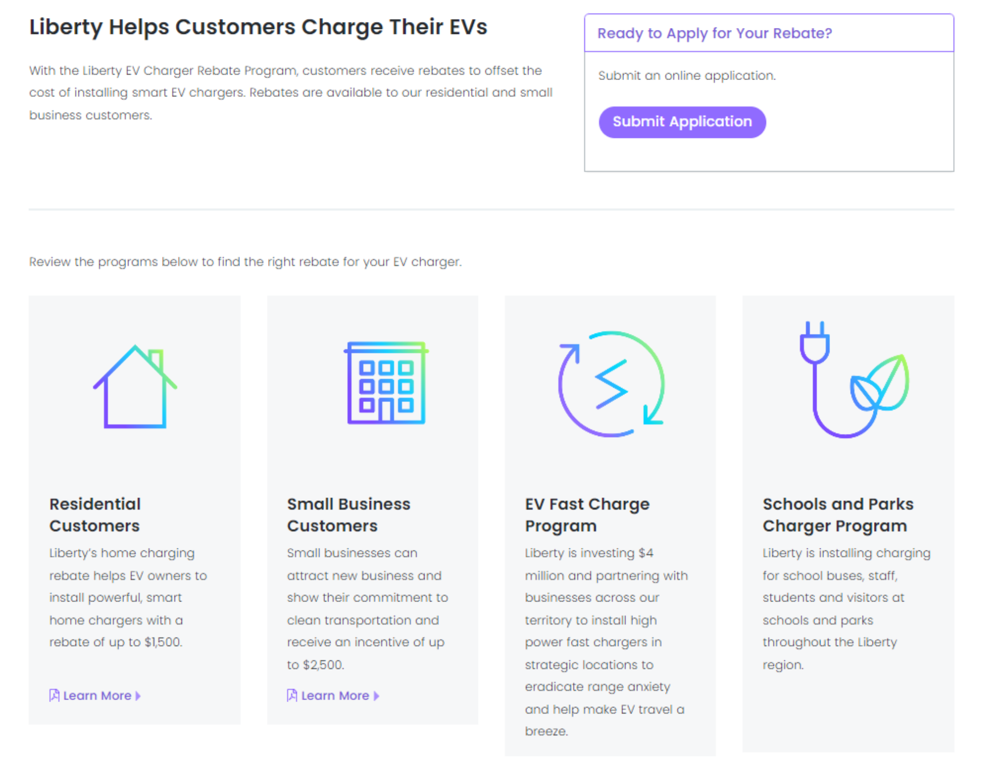
Figure 204 details Liberty's implementation process for all sites in both the Schools and Parks Pilots.

Figure 204. Schools and Parks Pilots Implementation Process

Program Materials Summary

As noted in the EY2021 report, Liberty launched a website (see the screenshot in Figure 205) to help promote and provide visibility for the Pilots. Though no additional outreach was completed in EY2022, Liberty maintains Pilot information on the website and is planning more outreach in EY2023.

Figure 205. Liberty Website with Schools and Parks Pilots Information



Program Performance Metrics

Liberty did not have any activated Schools Pilot or Parks Pilot sites in EY2022. However, Liberty staff are in the contracting phase with the EVSE in one committed school district with multiple sites and are following up with two other school districts, hoping to finalize contracts by the end of the two-year enrollment window.

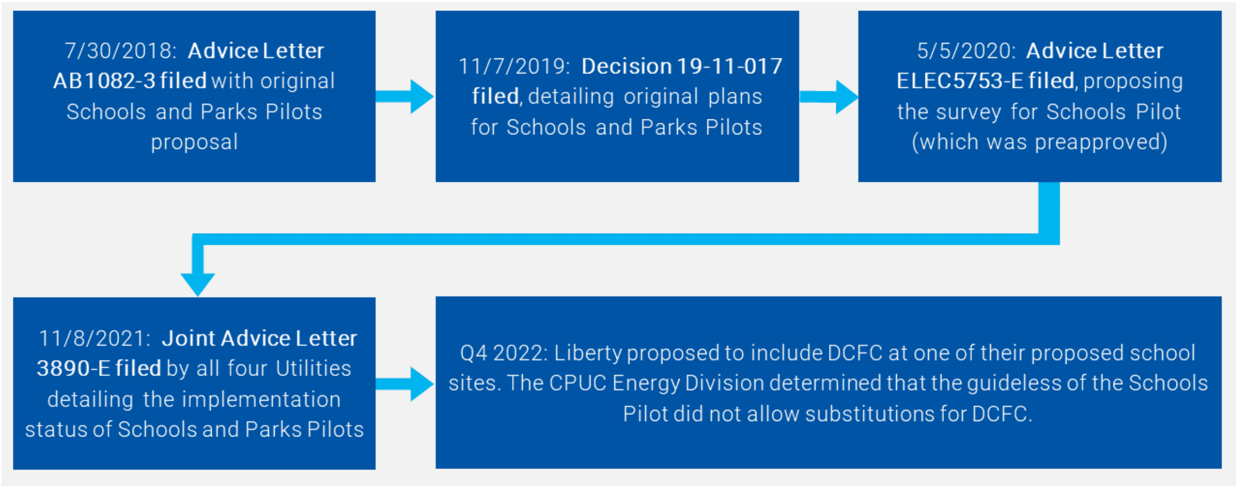
Budget Summary

Through EY2021, Liberty spent $19,135 of $3.9 million on the Schools Pilot and has spent none of the approved $0.78 million Parks Pilot funds.

Timeline

At the end of EY2022, Liberty proposed to install DCFC at one of their proposed school sites. Though the CPUC Energy Decision was positive about the request, it determined that the guidelines of the Schools Pilot bill did not allow substitutions for DCFC. Though there were no additional milestones in EY2022, Figure 206 shows all major milestones since the Pilots' inceptions.

Figure 206. AB 1082 and 1083 Major Milestones Timeline



Findings

As discussed in the *Overview* section, neither Liberty Pilot had any activated and operational sites in EY2022. As a result, the Cadmus team did not complete any visual site visits in EY2022 and plans to complete the first round of impacts assessment—including incremental EV adoptions, grid impacts, petroleum displacement, GHG and criteria pollutant reductions, and health impacts—as part of the EY2023 analysis and reporting. The subsections below provide limited insights based on Utility staff interviews.

Utility Staff Insights

In addition to monthly check-in calls with key Liberty staff to discuss the status of the Schools and Parks Pilots, the Cadmus team conducted a close-out interview with staff in March 2023 to review overall Pilot challenges and successes in EY2022. The following sections have these challenges and successes organized by Pilot.

Schools Pilot

Although all schools in Liberty's service territory are eligible for the Pilot, Liberty has only secured one school for the Pilot to date. In EY2021 and continuing into EY2022, Liberty staff reported struggling with a lack of interest from schools in the prescriptive Pilot design:

- **Lack of Interest.** When Liberty first started engaging schools to participate in the Pilot, school staff were overburdened with urgent concerns caused by the COVID-19 pandemic and could not focus on participating in the Pilot. However, even as concerns about COVID-19 slowly faded and ultimately no longer posed a barrier in EY2022, staff reported a continued lack of interest in the Schools Pilot, specifically citing a higher degree of interest in business charging rather than light-duty charging and continued concern about student safety:
    - **Interest in Buses.** Many schools in Liberty's territory were more interested in receiving bus charging than charging for light-duty vehicles.

  - **Concern for Student Safety.** Most K–12 schools in Liberty's territory expressed concern over the Pilot's original design intention of keeping the light-duty charging accessible to the public during or after school hours, despite the flexibility in accessibility allowed within the Pilot design.
- **Prescriptive Design.** Liberty staff noted several ways that the detailed rules specified in the Schools Pilot design prevented them from being able to serve customers:
  - **Other Opportunities Arise.** Schools in Liberty's territory expressed potential interest in other programs, pilots, and initiatives intended to accelerate EV adoption. Specifically, between the time of Pilot inception and the time Liberty was engaging Schools, two schools had already committed to participate in other programs to acquire charging on their campuses.
  - **DCFC Charging.** Liberty staff cited one school that expressed interest in receiving DCFC; however, this is not a Pilot offering and Liberty was unable get permission to install DCFC.

Though most schools in Liberty's territory are currently not interested in participation in the Schools Pilot, Liberty staff remain optimistic about the future of transportation electrification within schools, noting that they expect to successfully install some EV charging in EY2023 and reflecting on the long-term positive customer relationships:

- **Committed Site.** In EY2023, Liberty plans to install eight chargers at a community college through the Pilot.
- **Fostering Positive, Long-Term Relationships with Schools Customers.** Though Liberty may not see much participation in the Pilot, through its implementation, Liberty staff have connected with their customers outside of typical utility-customer exchanges. Liberty staff have been purposefully mindful to learn the overall needs and preferences of their school customers for transportation electrification. Liberty staff transparently prioritize customer needs over specific programs to demonstrate to customers that Liberty will continue to watch for opportunities that fit best school needs.

Parks Pilot

As noted in the EY2021 report, Liberty had initially intended to sign on to a collective utility master agreement with the DPR. However, due to shifts in various Utility approaches in EY2022, Liberty staff noted challenges coordinating with local state park staff and dealing with state-level negotiations:

- **Separating State-Level Negotiations.** Though the plan in EY2021 was for all Utilities to enter into a collective participation agreement with DPR, in EY2022, the Utilities ultimately separated their efforts and Liberty started coordinating with DPR's state-level office directly. However, since Liberty had not been closely involved in the negotiations prior, staff were starting from scratch and could not get momentum with the DPR office until mid-EY2022.
- **Local State Park Priorities.** Prior to the separation of negotiations at the state level, Liberty spent EY2021 and part of EY2022 attempting to coordinate directly with local state park representatives to complete any pre-work ahead of formal participation agreements being

signed. Unfortunately, local state park staff were often too burdened with other park priorities and needs to discuss the Pilot in any detail with Liberty staff.

Despite not being able to start negotiations with the DPR until mid-EY2022, Liberty staff felt that their efforts set them up for success in EY2023 and beyond:

- **State-Level Buy-In.** In the EY2022 meetings with the DPR, Liberty felt that the state parks staff were motivated to develop terms and a Master Participation Agreement that would cover all individual state parks in Liberty's territory. Liberty staff are hopeful that this process will go smoothly since DPR is leading development of the participation agreement language.
- **Existing Local Connections.** Because Liberty spent time in EY2021 establishing communication and rapport with local state park staff, Liberty staff feel that they will be well-positioned in EY2023 to quickly begin specific site design and negotiations, particularly with the state-level leadership who provide direction to help make Pilot implementation a priority for local state park staff.

Highlights

- Liberty is facing a lack of Pilot participation interest from schools in its territory, in part due to Pilot design limitations.
- Through promoting the Schools Pilot, Liberty staff built long-term relationships with school staff and is positioned to support them in future TE efforts.
- Now that Liberty is negotiating directly with the DPR, staff feel positive about making significant progress on site selection and design in EY2023.

6.2.2. Lessons Learned

The Evaluation Team identified a number of lessons learned from EY2022. These lessons, presented below with key supporting findings and recommendations, may be applied to future Pilot years and to other similar efforts.

School Pilot Only

Highly prescriptive Pilot designs may be more susceptible to potential participants becoming disinterested due to specific design requirements.

Liberty's Schools Pilot has a specific, targeted market sector to serve with a clear intention of increasing public charging in the Lake Tahoe area. However, Liberty staff have encountered barriers unique to K–12 schools that delayed Pilot activity in both EY2021 and EY2022. In EY2021, COVID-19 pulled school staff attention away from the Schools Pilot and to more pressing concerns for student health. There was also a concern for student safety if publicly accessible chargers were installed on campus—even though it became clear in EY2022 that schools could still be enrolled in the Schools Pilot but opt to have their chargers private, many of the schools in Liberty's territory had already decided the Schools Pilot was not a good fit for their school because of the public chargers. Other design restrictions—such as not being able to offer DCFC despite having the budget—prevented Liberty from serving the schools that were willing to work within the other confines of the Pilot.

Long-term engagement with customers, like those eligible for the Schools Pilot, lends itself to positive relationship building which allows Liberty staff to better understand the greater overarching needs of customers when promoting transportation electrification.

Over the course of implementing the Pilot, Liberty staff have struggled with disinterest for the AB Pilot from nearly all customers who are eligible. Despite that, Liberty staff have simultaneously seen interest in other transportation electrification opportunities, such as with buses, DCFC, and participation in other TE programs. Even though it may not result in participation in AB 1082, by engaging with Schools customers for well over a year when trying to recruit for this Pilot, Liberty has learned what Schools need and want out of transportation electrification. As the TE market accelerates, Liberty will be in a better position to support Schools customers when other opportunities arise.

Parks Pilot Only

Sufficient time must be built into Pilot implementation planning when anticipating contract negotiations between two or more large organizations.

The plan for the Parks Pilot in EY2021 was for all Utilities to enter into a collective participation agreement with the DPR. During this time, Liberty staff had been following the path set forward by the other Utilities during joint negotiations. Therefore, in EY2022, when the Utilities ultimately separated their efforts and set out to establish independent agreements with DPR, Liberty staff had to start cultivating a relationship and engaging with the State Office of DPR. Though Liberty staff were not able to start negotiations with DPR until mid-2022, at the end of EY2022, Liberty Pilot staff were hopeful for an agreement to be developed in EY2023 given the progress that was completed.

Appendix A. Methodology

This section describes the evaluation methodologies for the MDHD programs, Public Charging programs (AB 1082 [Schools Pilot], AB 1083 [Parks Pilot], and EV Fast Charge program), and V2G programs, including data collection and analysis activities. The Evaluation Team collected primary or secondary data (data collection) and we transformed that data to produce findings (analysis). Some methodologies are identical across programs, while others are specific to a given program.

Table 112 lists the evaluation activities conducted for each program for EY2022. The individual program chapters discuss the evaluation activities, methodology, and findings.

Table 112. EY2022 Data Collection and Analyses, by Program

Type of Data Collection and Analysis	Program									
	Liberty		PG&E			SCE		SDG&E		
	MDHD	Schools and Parks Pilots	MDHD	Schools and Parks Pilots	EV Fast Charge	MDHD	Schools and Parks Pilots	MD HD	Schools and Parks Pilots	V2G
Data Collection										
Program Data and Materials	x	x	x	x	x	x	x	x	x	x
AMI/EVSP Data			x		x	x	x	x	x	x
Site Visits			x	x	x	x	x	x	x	
Interviews	x	x	x	x	x	x	x	x	x	x
Surveys			x			x		x		
Delphi Panel			x			x		x		
Analysis										
EV Adoption					x		x		x	
Grid Impacts			x		x	x	x	x	x	
Counterfactual Development	x	x	x	x	x	x	x	x	x	
Petroleum Displacement			x		x	x	x	x	x	
GHG and Criteria Pollutant Reductions			x		x	x	x	x	x	
Health Impacts			x		x	x	x	x	x	
Total Cost of Ownership			x		x	x		x	x	
Site Visit Findings			x		x	x	x	x	x	
Co-Benefits and Co-Costs			x			x		x		
Interviews and/or Survey Findings	x	x	x	x	x	x	x	x	x	x
Market Effects			x			x		x		

[a] Meter data were collected from Liberty for 2022 but were not analyzed in this report; results will be published in Q4 2023.

The Evaluation Team developed an evaluation methodology for the data collection and analyses to address three research objectives.

- **Research Objective 1.** Determine whether transportation electrification (TE) investments accelerated widespread TE, reduced petroleum dependence, helped meet air quality standards, reduced GHG emissions, and achieved the goals of the Charge Ahead California Initiative.[136]
- **Research Objective 2.** Determine whether TE investments maximized benefits and minimized costs, including co-benefits and co-costs, and the extent to which the costs and benefits accrued to disadvantaged communities (DACs).
- **Research Objective 3.** Maximize learnings from analyzing data collected during program implementation.

The scope of activities was aimed at addressing the specific characteristics of each program evaluated at an appropriate level of rigor and to report findings at a meaningful level of detail. The evaluation activities conducted for each program were largely influenced by the number of sites in the participant population for that program and within the market sector.

The Evaluation Team reviewed program participation and adjusted the sampling methodology, scope, and timeline of activities to derive maximum efficiencies. This report provides impact and process evaluation findings that were mainly derived using a census approach to gather site-level inputs from AMI and EVSP data, site visits, or surveys from activated sites. For activities that involved a more granular approach to data collection, where program or market sector participation levels were insufficient to allow reporting at any meaningful level of detail, the Evaluation Team updated the scope and timeline of activities to be reported as part of the next evaluation cycle.

Sites in Evaluation Report

Throughout this report, we use the following terminology to describe the participating sites or sites included in the evaluation effort:

- **Utility Construction Completed:** Sites where the Utility has completed their scope (TTM, TTM and BTM, and turnkey installation)
- **Activated:** Sites with charging stations installed and available for use
- **Operational:** Sites where AMI and/or EVSP energy usage data were received from the Utility or EVSP
- **Closed Out:** Sites where all financial documentation has been finalized by the Utility and rebates have been paid

[136] Environment California. December 17, 2021. "Charge Ahead California Budget Request 2022." https://environmentcalifornia.org/programs/cae/charge-ahead-california

Medium-Duty Heavy-Duty Programs Evaluation Methodology

This section outlines the data collection and analysis methodologies for the MDHD programs.

Data Collection Methodology

To assess the MDHD programs the Evaluation Team collected program performance metrics, program materials, AMI and EVSE data, site visit data, and conducted surveys and interviews.

Program Performance Metrics

Data on program performance metrics included information about program applications such as count of charging ports, number of EVs procured, site status (in a DAC or outside of a DAC), time in each program phase, and site costs, where available. These data support an understanding of program performance, such as the median number of days sites spent in different program phases, the percentage of applicants from different market sectors, site costs, and program spending.

We collected and securely transferred this data between the Utilities' secure SharePoint sites or other secure file transfer systems and our own Microsoft Azure cloud-based environments. The Evaluation Team completed this transfer monthly for most data, with some variation in timing among PG&E, SCE, and SDG&E. Once we received data from each Utility, we moved it to the Cadmus data warehouse for secure storage and retrieval.

Program Materials

To understand how the programs are operating and communicating with customers, the Evaluation Team reviewed available program-related materials, such as Decisions, Advice Letters, and Program Advisory Committee (PAC) presentations. We reviewed the changes in program design, implementation, and the legal and regulatory environments which impact the programs, including site and vehicle requirements, outreach and onboarding approaches, and required materials from participating fleets. The program material review is important to establish a foundational understanding of program design, to track changes in design over time, and to understand implementation progress.

Table 113 shows a list of the types of data (for both program performance metrics and program materials) the Evaluation Team reviewed.

Table 113. Medium-Duty Heavy-Duty Program Materials Reviewed

Program Materials Reviewed
• PAC presentations • Program data such as number and type of EVSE installed, and VAPs • Regulatory documents such as Decisions and Advice Letters • Public reports such as the Joint IOU EV Load Research and Charging Infrastructure Cost Report • Utility websites: ▪ EV Fleet Charging Guidebook ▪ Calculators and tools ▪ Programs and handbooks ▪ Application and application preparation and information documents ▪ Fact sheets and case studies ▪ Vehicle availability lists and approved EVSE product list ▪ Funding information ▪ Original equipment manufacturer (OEM) information • Marketing materials: ▪ Emails and email collateral ▪ Webinars • Program documents: ▪ Agreements and contracts ▪ Technical requirements ▪ Registration forms • Utility information: ▪ EV rate schedules ▪ EVSE maps ▪ DAC maps

AMI/EVSP Data

The Evaluation Team used AMI data to estimate charger usage, a key input for subsequent analyses and estimations of program impacts, such as impacts to the grid, petroleum displacement, emissions reductions through EV adoption, and associated health impacts.[137] The team collected and securely transferred all AMI data between the Utilities and Microsoft Azure cloud-based environments. Our team used Azure Databricks to transform and standardize the data, which we then imported into an SQL server data warehouse. We performed these transfers monthly, with some variation in timing among the Utilities. Once we received this data, we input it into the Evaluation Team's data warehouse for secure storage and retrieval and aggregated it for subsequent calculations and analysis. Time-stamped energy consumption data were recorded in 15-minute intervals.

A second critical data source was EVSE data provided by participating EVSPs. The electric Utilities developed a process for screening and approving EVSPs based in part on their ability to provide essential monthly charging data of EVSE sessions, intervals, stations, and ports.

[137] Note that Liberty Utilities does not have AMI so the team collected regular meter data instead.

Together, AMI and EVSE data provided the basis for analyzing program performance at a granular level, such as the ability for customers to shift loads to off-peak times in response to time-varying rates. The Evaluation Team used data from EVSPs to examine port utilization, which is based on the time in which a vehicle parked at a charging station and is consuming energy. Port utilization rates can be expected to rise as the program matures, consumers and fleets acquire more vehicles, and the effects of the COVID-19 pandemic begin to subside.

The Evaluation Team worked to acquire complete AMI and EVSE data for every charging session from the Utilities and EVSPs. In some limited cases where AMI data was not available from the Utility, the team worked with the Utility to obtain these data and incorporate them into future analyses. In some cases where AMI data was not available, either a customer provided a sub-metered dataset or the team synthesized data from existing EVSE data.

Synthesized Data

Some AMI data was missing for some periods of time for certain sites across the Utilities. Consequently, the Evaluation Team generated representative AMI data for these sites based on available EVSP data through a synthesis process using a conversion factor of the ratio between EVSP data and AMI data. We derived specific conversion factors for each site by evaluating the ratio of total kilowatt-hours delivered as reported by EVSPs, which in most cases existed for the same project at a different time period, or for similar charging stations and vehicles. The resulting factors ranged from 0.56 to 0.97 for EVSP data to AMI data. In the rare case where there was no specific match, the team used a standard factor of 0.85 to account for electricity losses between the meter and the EVSE.

Annualized Data

The team considered all operational sites for annualization.[138] In the previous annual evaluation, we annualized all sites with greater than six months of usage data and considered annualizing sites with between three and six months of usage data depending on observed usage patterns. For EY2022, to provide a more complete picture of the entire program to date and the impacts of the existing program performance over a full 10-year life, the Evaluation Team annualized all sites. Experience has shown that sites that have an abbreviated period of performance (less than six months) will inherently have lower utilization than fully developed sites. As a result, annualized sites with an operational time of six months or less will underrepresent the full 10-year impact; however, excluding those sites would create an even greater underrepresentation.

The team annualized each site by separating a representative 12-month operation period, which can be projected into the future until the site reaches its 10-year life. We determined the 10-year life by evaluating when the operational use of the EVSE would begin and projecting forward 10 years from that point. For sites that have more than 12 months of operating data, we annualized the most recent 12 months. For sites where less than 12 months of fully developed usage data exists, we removed months

---

[138] The Evaluation Team annualized electricity usage data for sites with operational AMI data (data indicating that EVs were actively being charged). We extrapolated partial year site electricity usage data out to a full year to make site-to-site and year-over-year comparisons.

of data before the point where the site reached 75% of the maximum monthly use and replaced that data with a synthesis of all months of data following 75% of the maximum utilization.

Site Visits

Site visits are an important part of the data collection process, as they provide an on-the-ground view of the sites, as well as access to stakeholders such as fleet and facility managers who may be included in surveys and in-depth interviews. Site visits help answer questions related to the integration of infrastructure- and vehicle-focused programs. They also allow us to confirm what vehicles and charging hardware were delivered and are in operation and how routes, utilization, and duty-cycles impact performance and electricity demand.

The Evaluation Team attempted a census approach for site visits. The team performed 39 MDHD site visits out of the 41 activated sites during EY2022. The Evaluation Team was not granted access to the remaining three sites. Table 114 shows a breakdown of the activated MDHD site visits by market sector.

Table 114. 2022 Site Visit Sample by Market Sector

Utility	Program	School Bus	Medium-Duty Vehicles	Heavy-Duty Vehicles	Transit Bus	eTRU	Total
PG&E	EV Fleet	4	2	3	3	1	13
SCE	Charge Ready Transport	9	1	1	1	2	14
SDG&E	PYDFF	9	1	1		1	12
Total		**21**	**4**	**5**	**4**	**4**	**39**

Note: One SDG&E Truck Stop site was visited and is classified as Heavy-Duty in this table. The eTRU site for SDG&E is actually Airport Ground Support Equipment (GSE).

The Evaluation Team collected data during in-person site visits for fleets operating under the PG&E EV Fleet program, the SCE CRT program, and the SDG&E PYDFF program. We arranged appointments through the Utilities with their customer-site hosts to visit the charging stations installed through the MDHD programs and the associated vehicles.

During the site visits, the team collected qualitative and quantitative information that provided us with an understanding of fleet composition and operations. We compared this data against Utility-provided information for individual sites. The team collected the make, model, and number of EVs on site, types of conventional vehicles or equipment replaced, charging equipment, charge management capabilities, electrical infrastructure, future vehicle/equipment replacement plans (including future vehicle adoption), and public funding sources, as well as interest in on-site solar and/or storage at the site. The team held meetings on the premises with facility managers and other personnel to learn about the particulars of each site. Where the site host was able to answer and the fleets had more than three months of operational experience, the team asked questions about satisfaction with the Utility program, charging infrastructure, and EVs. We also asked about any co-benefits or co-costs the site host has experienced or anticipates. Additionally, we inquired about the availability of telematics or fleet usage records to characterize their operations. The team emulated this same process for each visit with the same questions and conversation. We entered data into an in-house web-based tool for site visit data collection after each site visit to compile notes and photos for aggregate analysis.

Deep Dives

The Evaluation Team engaged with six participants (three each in PG&E and SCE territories) for deep dive assessments. Our first year of deep dives included detailed examinations of site usage metrics and assessments of vehicle and charging performance, user experience with EVs and EVSE, and site characteristics. The deep dives allow the team to gather insights based on projects that appear to provide significant learnings for stakeholders. This data collection enabled an iterative, two-way conversation between the Evaluation Team and site host.

In EY2022, we identified sites for deep dives from the previous year's evaluated MDHD sites and selected them based on several criteria. Sites of interest included those with significant demand, consumption, or installed charging capacity; a demonstrated ability to expand EV infrastructure; the presence of load management; unique vehicles or charging equipment; a large fleet size; and a fleet manager who was willing to participate.

For any site hosts that agreed to participate in the deep dive process, we asked them to share additional site data and to discuss their experiences with the electrification process and operation of EVs. We also asked these site hosts to administer a survey to their vehicle operators to gauge feedback on EV and charger performance during normal operations.

Interviews, Surveys, and Expert Opinions

Interviews

The Evaluation Team completed a series of interviews to address the research objectives relevant to the MDHD bundle. Specifically, the team interviewed Utility staff members and EVSPs.

For the Utility staff interviews, the Evaluation Team interviewed each program manager from SDG&E, PG&E, and SCE. For SCE, we also interviewed the manager of the related Transportation Electrification Advisory Services program. During each interview we covered specific topic areas:

- **Program Design**: Confirmed program design and changes, confirmed program goals, asked about site selection criteria, and gathered insight on program cost thresholds
- **Program Implementation**: Reviewed program status and progress (specifically in DACs) and asked about program successes, challenges, and next steps
- **Lessons Learned**: Asked about opportunities for implementation efficiencies, as well as reasons for possible changes in the program activity level and opportunities for program improvement

The Evaluation Team tailored each interview guide based on information previously provided by the Utilities to ensure an effective use of time. The interview team consisted of various Evaluation Team members to ensure coverage across all relevant evaluation areas.

The Evaluation Team interviewed vendors (specifically EVSPs) about their experiences with the Utility programs. During these interviews we followed a guide that covered five topic areas:

- **Infrastructure Installation and Interoperability:** Successes, challenges, and recommended program changes for EVSE installation. Causes of EVSE installation costs and EVSE vehicle interoperability issues.
- **Fleet Owner, Site Host, and Driver Experience:** Feedback received by the EVSP from fleet owners, site hosts, or MDHD EV drivers. Experience with occupant/tenant issues and recommendations for program expansion.
- **Data Collection and Load Management:** Current data collection requirements and recommendations for additional data parameters to collect. Load management capabilities of EVSE systems and the use of these capabilities by fleets.
- **Barriers to Electrification:** General overview of barriers to the further adoption of MDHD EVs.
- **Technology Fit with Fleet Electrification:** Expected technological changes and the outlook for naturally occurring uptake.

The Evaluation Team completed interviews with five EVSPs (Blink, ChargePoint, EV Connect, Nuvve, and Proterra) that are collectively responsible for 266 active or pending MDHD EV projects.

Surveys

The Evaluation Team surveyed fleet managers of activated sites that participated in the program who had complete contact information. The purpose of the survey was to cover several topics:

- Identify factors that facilitated successful fleet electrification and lessons learned
- Explore the benefits and costs of transportation electrification for fleets
- Assess the experience of fleet managers with the program and infrastructure
- Gauge market impacts and trends and identify market barriers
- Assess program attribution

The Evaluation Team conducted the survey via an online survey platform, Qualtrics, and delivered the survey via email to the site hosts through the contact information provided by PG&E, SCE, SDG&E, and Liberty. To encourage participation, the Evaluation Team sent several follow-up emails to contacts, made phone calls to nonrespondents when phone numbers were provided, and followed up with additional contacts through contact information collected from site visits. Additionally, the Evaluation Team offered each respondent a $50 gift card.[139]

For EY2022, the Evaluation Team attempted to reach a census of program participants in all MDHD programs. See Table 115 for sample sizes by Utility. The Evaluation Team only included sites with valid contact information in the sample and sites with unique contact information (i.e., if two activated sites had the same contact, only one was selected for surveying).

---

[139] We did not offer this gift card to public agency sites in SCE's service territory.

Table 115. EY2022 Fleet Manager Survey Sample

	PG&E	SCE	SDG&E	Liberty
Number of surveys sent	12	14	11	1
Number of completed surveys	6	4	7	0

The Evaluation Team also surveyed site hosts who withdrew from the PG&E, SCE, or SDG&E program (known as withdrawn fleet managers).[140] During the sample selection process, the Evaluation Team worked with the PG&E, SCE, or SDG&E program managers to ensure that the survey was only sent to sites that were eligible for and later withdrew from the program—not to those sites that applied but were not eligible. Surveying only eligible sites strengthened the insights gathered through these surveys and allowed us to focus on the reasons for withdrawal that PG&E, SCE, or SDG&E might be able to address.

The survey covered many topic areas, several of which were similar to the fleet manager survey:

- Identify the factors that facilitate successful fleet electrification and lessons learned
- Explore the benefits and costs of transportation electrification for fleets
- Gauge market impacts and trends and identify market barriers
- Understand the reasons for withdrawing from the program

For EY2022, the Evaluation Team attempted to reach a census of sites that withdrew from the PG&E EV Fleet, SCE CRT, and SDG&E PYDFF programs. We invited withdrawn fleet managers to complete the survey via email and sent them several follow-up emails. Additionally, the SCE account managers conducted outreach to withdrawn sites to via email to help increase the response rate. To encourage participation, the Evaluation Team offered a $50 gift card to respondents who completed a survey.[141] See Table 116 for sample sizes by Utility for the fleet withdrawal survey. The Evaluation Team only included sites with valid contact information in the sample and sites with unique contact information (i.e., if two withdrawn sites had the same contact, only one was selected for surveying).

Table 116. EY2022 Fleet Withdrawal Survey Sample

	PG&E	SCE	SDG&E
Number of surveys sent	6	34	2
Number of completed surveys	2	2	0

Delphi Panels

To support the estimation of market effects, the Evaluation Team conducted Delphi panels to develop baseline electrification adoption curves.

A Delphi panel is a method developed to reach a group consensus by aligning the range of opinions from a panel of subject matter experts. Certain components are particular to Delphi panels including the use

140 Note that the Liberty MDHD program only includes one site and there were no withdrawn sites.

141 We did not offer this gift card to public agency sites in SCE's service territory.

of a group of anonymous experts with opinions collected through a series of two to three sequential, structured questionnaires. Opinions from the first round are summarized and provided to the experts for the second round, and they are asked to re-evaluate their original responses. They can either agree with the overall opinion or provide evidence or argument for their own opinion. The rounds continue until a majority consensus is reached. The Delphi method is particularly useful in areas of limited data. A panel moderator controls and manages interactions among the experts, with communication typically conducted remotely.

The Evaluation Team conducted two Delphi panels for the EY2022 report: one on the transit bus market and one on the parcel delivery vehicle market. For both panels, we recruited experts within each respective vehicle market to develop a consensus forecast of the market baseline for electrification in California through 2030.

The Evaluation Team recruited seven transit bus market experts in June 2022, and they provided two rounds of structured feedback in June and July 2022. We provided all panelists with the same background information, including historical transit bus market data from a recent EMissions FACtor model (EMFAC) download[142] and data derived from the ACT regulation.[143]

In the first round, we asked experts to provide a forecast of the electric transit bus market share (specifically, the share of battery electric transit bus out of all transit bus acquired by public transit agencies) assuming no intervention by the Utilities, along with a rationale for the shape of their forecast. This estimate did not include private transit bus fleets, such as employer parking lot shuttles or private university shuttles. The Evaluation Team aggregated the first-round results, calculated the median forecast,[144] and shared the anonymized market predictions with the panel in the second round. The experts reviewed all forecasts and had the opportunity to either agree with the median estimate or submit a new estimate. This process typically continues until convergence occurs (when over half of panelists agree), which happened for this panel in the second round.

The Delphi panel for the parcel delivery vehicle market followed the same methodology. The Evaluation Team recruited eight parcel delivery vehicle market experts in January and February 2023, and they provided two rounds of structured feedback in March 2023. The Evaluation Team provided all panelists with the same background information, which defined the delivery vehicle market sector as vehicles primarily used for last mile parcel delivery. This includes cargo vans, step vans, and box or straight trucks ranging from weight classes 2b to 8. The background information also included historical market data on

---

142 EMFAC is a platform managed by the California Air Resource Board (CARB) that complies vehicle emissions factors and contains a vehicle fleet database based on vehicle registration data from the California Department of Motor Vehicles.

143 The ACT regulation is a manufacturers’ ZEV sales requirement and a one-time reporting requirement for large entities and fleets.

144 Although Delphi panels typically use an average of experts’ responses, for this study we employed the median to mitigate the impact of outlier responses.

parcel delivery vehicles from a recent EMFAC download and data derived from the ACT regulation and the proposed ACF regulation.[145]

In the first round, we asked experts to provide a forecast of the market share of battery electric delivery vehicles in California (specifically, the share of new parcel delivery vehicles for a given model year that are battery electric and registered in California) assuming no intervention by the Utilities, along with a rationale for the shape of their forecast. During the first round, we included a one-time request for experts to provide their forecast for the total number of parcel delivery vehicle unit sales in California (including both ICE and battery electric delivery vehicles in the forecast). The Evaluation Team aggregated the first-round results, calculated the median forecast, and shared the anonymized market predictions with the panel in the second round. The experts reviewed all forecasts and had the opportunity to either agree with the median estimate or submit a new estimate. This process typically continues until convergence occurs (when over half of panelists agree), which happened for this panel in the second round.

For both the transit bus and parcel delivery vehicle panels, the Evaluation Team recruited experts from different organizations to provide input. The composition of the panels is shown in Table 117. As every organization and expert carries their own biases, it was crucial for the Delphi panels to feature individuals from a variety of backgrounds. We also required that experts on the panel have a background in and recent experience (in the last two years) with their respective vehicle market or transportation electrification policy in California, and that they had no conflicts of interest (financial or otherwise) that would impact their objectivity. We did not permit multiple experts originating from the same organization to participate in the panels.

Table 117. Delphi Panelist Composition

	Academia	Nonprofit	Manufacturer	Industry	Third-Party Evaluator	Regulator
Transit Bus Panelists	2	1	1	1	2	0
Delivery Vehicle Panelists	3	3	1	1	0	0

Truck Choice Model

The Evaluation Team employed the University of California, Davis (UC Davis) Truck Choice Model (TCM) to establish a baseline for ZEV truck adoption and thereby enable assessment of the net-to-gross impacts of the Utility MDHD programs. The TCM is a multinomial logit model that predicts vehicle choice by fuel type and vehicle application via a generalized cost equation. The model has been used extensively in recent years to better understand how California policies and programs impact fleet operator purchase decisions of alternative fueled MHDVs. We used the TCM to predict the likelihood

145 As of this writing, ACF is still a proposed regulation, expected to go into effect in August 2023. It includes a manufacturers' ZEV sales requirement and lays out electrification targets for public and high-priority fleets.

that each fleet would have adopted MDHD EVs in its next procurement in the absence of the Utility programs.

The model draws on multiple inputs including vehicle purchase price, maintenance costs and fuel costs, non-monetary costs (such as aversion to new and uncertain technologies, and lower availability of fuel infrastructure), and incentives or subsidies. UC Davis has compiled the information for model inputs over several years. Additional data specific to this analysis includes Utilities' MDHD program data, specifically the rebates and incentives provided for EVSE installation. These are reported by the Utilities directly as part of the SRP evaluation and as part of their SB 350 reporting. The Evaluation Team adhered to guidance provided by the Utilities regarding which data was reliable enough to be used for model inputs.

The Evaluation Team applied data from the completed projects to estimate the average TTM and BTM utility investment or incentive. These averages are shown separately for each segment in Table 118.

Table 118. Estimated Cost of TTM and BTM Utility Funding on a Per-Charger Basis for Each Segment

Segment	TTM Investment	BTM Incentive
Medium-duty delivery	$50,000	$70,000
Transit bus	$58,000	$47,000
School bus	$33,000	$30,190
Short-haul	$58,000	$47,000

The Evaluation Team ran the model using the three trajectories (No Support, TTM Support, TTM + BTM Support) to determine the change in the share of BEV sales under the various trajectory conditions.

Analysis Methodology

The following subsections provide an overview of the analyses for the MDHD bundle. These analyses include determining the characteristics of counterfactual vehicles[146] and assessing grid impacts, petroleum displacement, GHG and criteria pollutant reductions, and health impacts. The Evaluation Team also estimated the TCO and addressed research objectives using data collected from site visits, Utility interviews, and surveys. As discussed below, we conducted additional calculations for the petroleum displacement, emissions reduction, and health impact analyses to consider these impacts on DACs in particular.

Grid Impacts

The team estimated electric grid impacts for MDHD on-road and off-road vehicles that consumed electricity from charging stations installed through the MDHD programs. The following subsections describe the approach, data sources, and analyses performed to estimate grid impacts.

[146] Counterfactual data are used to establish a counterfactual fuel economy (miles per gallon) and vehicle emissions factors to estimate petroleum displacement, emission reductions, and health impacts.

The team collected, cleaned, compiled, and analyzed site-level, granular (15-minute interval) Utility AMI (meter) data and EVSP data. For the analysis we used the primary and secondary data sources shown in Table 119.

Table 119. MDHD Grid Impacts Data Inputs

Category	Source
Primary Data	Utility AMI data, charging session data from EVSPs, site details (capacity of various Utility and charging equipment), site visits, and surveys
Secondary Data	Time-varying Utility rates in effect at sites, historical CAISO data (demand, supply sources, renewable curtailments), and load management plans

We uploaded AMI and EVSP data to the data warehouse and calculated results using the internal Power BI dashboard. Foundational program analysis included total electricity consumption (kilowatt-hours) for MDHD vehicles (on-road and off-road), and new demand (kilowatts) added to the grid. The team established trends based on the proportion of electricity usage during the highest cost period (defined as 4 p.m. to 9 p.m. daily) versus other time periods. We calculated load factors based on usage and determined utilization rates based on the installed capacity for each site.

The Evaluation Team assessed daily and weekly charging behaviors and captured patterns that accounted for differences in weekday and weekend operations. We used load curves by vehicle category to identify trends of operating versus charging. Effectively doing this required filtering out periods representing when vehicles were not in full operation, had ongoing technical problems, or were not fully integrated with the EVSE or other equipment.

We used CAISO data on electricity supply at different times combined with AMI meter data and EVSE charging session information to compare EV program load curves with overall system demand. The 24-hour load curves provided key insights into how the grid was impacted by each program.

The team assessed charging flexibility to determine the extent to which managed charging could increase benefits, such as by lowering electricity prices paid (based on time-of-use rates), reducing emissions (from charging when lower-emissions resources were powering the grid), and having the least impact to the grid (minimal new demand). While the grid impacts analysis included data for all operational sites, the team annualized AMI data to support analyses that included forecasts such as for petroleum displacement and GHG and criteria pollutant emissions reductions. Through the annualization of AMI data the team identified the region of stable operation, then leveraged this data to generate a statistically representative full year of operation.

Counterfactual Development

The team identified the market sectors in each Utility program and the counterfactual vehicle and fuel type that corresponds with each market sector. A counterfactual vehicle is the vehicle type that would have been used in absence of the program.

Rather than assessing the composition of each legacy fleet (conventional ICE vehicles displaced by the program), we established a generic counterfactual vehicle type. In total, the Evaluation Team used 18 counterfactual vehicles, defined by weight class and fuel type. The team assigned all sites an initial counterfactual vehicle type based on Utility program applications. We then refined this information based on additional vehicle information included as part of participants' VAPs submitted to Utilities.

Each counterfactual vehicle type had a corresponding fuel economy (miles per gallon) for on-road vehicles or fuel consumption (gallons per hour) for off-road equipment as well as emissions factors (GHG and criteria pollutants). Additionally, we determined the electricity consumption rate used by the corresponding EV (in kilowatt-hours per mile for on-road vehicles and kilowatt-hours per hour for off-road equipment).

To characterize the counterfactual vehicles, the Evaluation Team processed EMFAC data for on-road vehicles and Off-Road Inventory Online (ORION) data for off-road vehicles as default sources for efficiency and emissions. We input these tables into the Cadmus data warehouse. Where electricity consumption rates were not available for a particular vehicle or equipment type, we used supplemental data sources to determine an appropriate rate. Table 120 shows the primary and secondary data inputs.

Table 120. MDHD Counterfactual Data Inputs

Category	Source
Primary Program Data	Utility VAPs, site visits, fleet manager surveys, and OEM interviews
Secondary Data	CARB EMFAC and ORION (default source for efficiency and emissions), Priority Review Projects fleet data (from the final report),[a] other demonstration reports (from CARB, CEC, and the National Renewable Energy Laboratory), MDHD vehicle registration data as available, Department of Motor Vehicles Motive Power Report, and California Department of Motor Vehicles Motive Fuels Report

[a] Energetics Incorporated. April 2021. *California Investor-Owned Utility Transportation Electrification Priority Review Projects: Final Evaluation Report.* https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/sb-350-te/california-te-prp-final-evaluation-report-presentation.pdf

The final output is a lookup table that maps all the relevant market sectors to each of the CPUC-defined market sectors and their associated counterfactual vehicle type (such as electric Type C school bus and diesel Type C school bus).

Petroleum Displacement

For this analysis, the Evaluation Team estimated the reductions in counterfactual vehicle fuels compared to the electricity usage attributable to the MDHD programs. Expected fuel types and typical end-uses included diesel (such as trucks and school bus), CNG (such as transit and shuttle bus), propane (such as forklifts), and gasoline (such as trucks and vans). Based on the *Counterfactual Development* analysis, we presented all displaced fuel as petroleum-based in diesel gallon equivalent units.

To conduct the petroleum displacement analysis, the team converted the electricity used from EVs (based on Utility-provided AMI data) to petroleum displaced using an electricity consumption rate to calculate the EV miles traveled or equipment hours of use. We used the same number of EV miles or hours for the counterfactual ICE vehicle that would have been used in the absence of the MDHD programs. To calculate the petroleum displacement in gallons per site, we divided the ICE vehicle miles or hours by the counterfactual on-road vehicle's fuel economy (miles per gallon) or multiplied by the off-road equipment's fuel consumption (gallons per hour). We then converted the amounts of petroleum displaced to diesel gallon equivalents for ease of comparison. Then the team calculated the petroleum displaced by each MDHD program by Utility, in DACs, and by market sector.

Data inputs included Utility program data (market sector and vehicle type), data from site visits and fleet manager surveys, historical counterfactual vehicle fuel consumption, EMFAC and ORION databases, Utility AMI data, and EVSE charging session data. Table 121 shows the data collection categories and sources.

Table 121. MDHD Petroleum Displacement Data Collection

Category	Source
Primary Data	(1) Utility program data (on vehicle types, quantities, and other details) (2) Utility electric AMI data (in 15-minute intervals) (3) EVSE charging session data (4) Site visit and survey data for site-specific inputs - EV fleet make/model - Daily/annual vehicle utilization (miles) and schedules - EV charging schedules - Counterfactual fleet fuel type and average fuel economy/historical fuel usage - Estimated annual idling hours per vehicle
Secondary Data	EV and counterfactual ICE fuel efficiency (from counterfactual EMFAC lookup table and other sources)

For this analysis the team leveraged the Cadmus data warehouse and counterfactual lookup tables, Power BI dashboard, and other sources and outputs from the *Grid Impacts* analysis. AMI data are the basis for these calculations. Table 122 shows the analysis steps.

Table 122. MDHD Petroleum Displacement Analytical Steps

Step	Description
Identify counterfactuals and secondary data	For each vehicle type, identify gallons per mile or gallons per hour and kilowatt-hours per mile efficiency from: - MDHD counterfactuals and - EMFAC/ORION[a] for both EV and ICE real-world efficiencies
Identify EV energy consumption	Identify annual kilowatt-hours consumed by EVSE at each site from grid impacts analysis
Account for charging losses	Use 15% loss from grid to vehicle battery for vehicle charging, assume no loss for electric truck refrigeration units
Calculate vehicle miles or hours (for offroad applications)	Calculate EV miles or hours based on kilowatt-hours consumed and vehicle efficiency
Estimate petroleum displacement	Estimate petroleum displacement based on ICE vehicle miles or hours and efficiency, converted to a diesel gallon equivalent

[a] California Air Resources Board. April 2022. EMFAC2021. https://arb.ca.gov/emfac/

Greenhouse Gas and Criteria Pollutant Impact

The MDHD programs are expected to reduce the amount of GHGs and criteria pollutants emitted as fossil-fuel-powered on- and off-road MDHD vehicles are replaced by EVs. This section describes the approach, data sources, and analyses performed to estimate these reductions.

The Evaluation Team first calculated GHG and criteria pollutant emission reductions from the petroleum displaced by the EVs incented through the programs.[147] The GHG emissions estimates included CO_2, N_2O, and methane (CH_4). The criteria pollutant reductions we analyzed included $PM_{2.5}$ and PM_{10}, carbon monoxide (CO), NO_x, and oxides of sulfur (SO_x). Additionally, the team estimated reductions of ROGs, which are not criteria pollutants but contribute to the formation of ground-level ozone, which is a criteria pollutant.

Next, the team examined the increase in emissions attributed to the electricity used by the EVs. We calculated the emissions from EV electricity use by examining the emissions profile of the grid at the time of charging using the published CAISO grid mix at five-minute intervals. Since the electric grid emissions profile varies substantially by time-of-day and season, we estimated reductions using actual 8,760-hour load curves based on Utility AMI meter data.

The difference between the counterfactual vehicles' petroleum emissions and the EVs' electricity emissions was the net reduction in emissions for the more global-scale pollutants (GHG, NO_x, and SO_x). For criteria pollutants with localized health effects such as CO, PM, and ROG, the emissions are presented as an absolute reduction from the counterfactual.

The Evaluation Team used the GHG and criteria pollutant inputs shown in Table 123 regarding electricity usage, resource mix, emissions, vehicle types, and petroleum displaced.

Table 123. GHG and Criteria Pollutant Data Inputs

Category	Unit	Source
Site-level AMI data in 15-minute intervals	kWh	Utility AMI (~1 month delay between measurement and reporting)
Overall electricity demand by five-minute interval	MW	CAISO demand (real time)
CO_2 grid emissions by five-minute interval	metric tons	CAISO emissions (real time)
Resource mix by interval	% by generator fuel	CAISO supply (real time)
NO_x, SO_x, CH_4, and N_2O emission rates	g/kWh	EPA eGRID (2021)
CO_2 emission rate	kg/kWh	EPA eGRID (2021)
CO_2-equivalent emission rate	kg/kWh	EPA eGRID (2021) as derived from emission rates above
Vehicle tailpipe emissions (CO_2, CH_4, N_2O, CO, NO_x, PM_{10}, $PM_{2.5}$, SO_x, and ROG) by vehicle and fuel	g/mile	CARB EMFAC (2021)
Vehicle type (vehicle classification code for linkage to emission tables)	standard category	Evaluation Team analysis in *Petroleum Displacement* section
Petroleum use by month	unit measure for fuel type	Evaluation Team analysis in *Petroleum Displacement* section
Petroleum fuel type	fuel type	Evaluation Team analysis in *Petroleum Displacement* section
Petroleum fuel energy content	MMBtu/unit	U.S. DOE Alternative Fuels Data Center

[147] The Evaluation Team counted tailpipe emissions for the counterfactual vehicles and electricity grid emissions for EVs. We did not consider upstream emissions for the counterfactual vehicles (such as petroleum refining). Additionally, we did not include emissions from brakes and tires for the counterfactual vehicles and EVs.

The analysis comprised four steps. The team used the CAISO application programming interface, the EMFAC dataset, and the U.S. EPA's eGRID data to perform this work:

1. **Counterfactual emissions:** We determined emissions from counterfactual vehicle fuel usage using EMFAC emissions data for specific displaced fuels in (g/mile) along with the determined miles driven from the petroleum displacement methodology.
2. **Electricity emissions:** We used CAISO five-minute demand and resource mix data reported by zone to establish an emission record for each pollutant. We averaged five-minute interval emissions data and applied this to each 15-minute AMI interval, then applied the CAISO-specific emissions factors for that resource provided by the U.S. EPA's eGRID dataset.
3. **GHG calculation:** We used the United Nations IPCC GWPs for CO_2 equivalence (CO_2e) on a 100-year timeframe based on the IPCC AR5. For EY2022, we used GWP-100 factors of 28 for methane (CH_4) and 265 for N_2O. Equation 1 presents the GHG calculation based on CO_2e:

Equation 1. GHG Calculation

$$CO_2e = CO_2 + 28 * CH_4 + 265 * N_2O$$

4. **GHG and criteria emissions reductions:** The overall reduction in GHGs, NO_x, and SO_x was net of annual emissions from the displaced counterfactual fossil fuel equipment and the electricity consumed by the adopted electric equipment. The overall reduction in $PM_{2.5}$, PM_{10}, CO, and ROG was represented by the annual emissions from the counterfactual vehicle, as these pollutants present localized effects on populations rather than the more globalized effects of the other pollutants. The team calculated these emission reductions for sites both in and outside DACs.

For the prediction of future emissions savings, it is expected that the California Utility grid will further reduce power plant emissions in future years in alignment with the CPUC IRP process. The team determined the hourly mix of electricity in future years from the most recent IRP RESOLVE models available and applied the changing mix for future years out to 10 years of operation for each site. We treated the emissions factors for these resources as static using the most recent U.S. EPA eGRID dataset for CAISO resources.

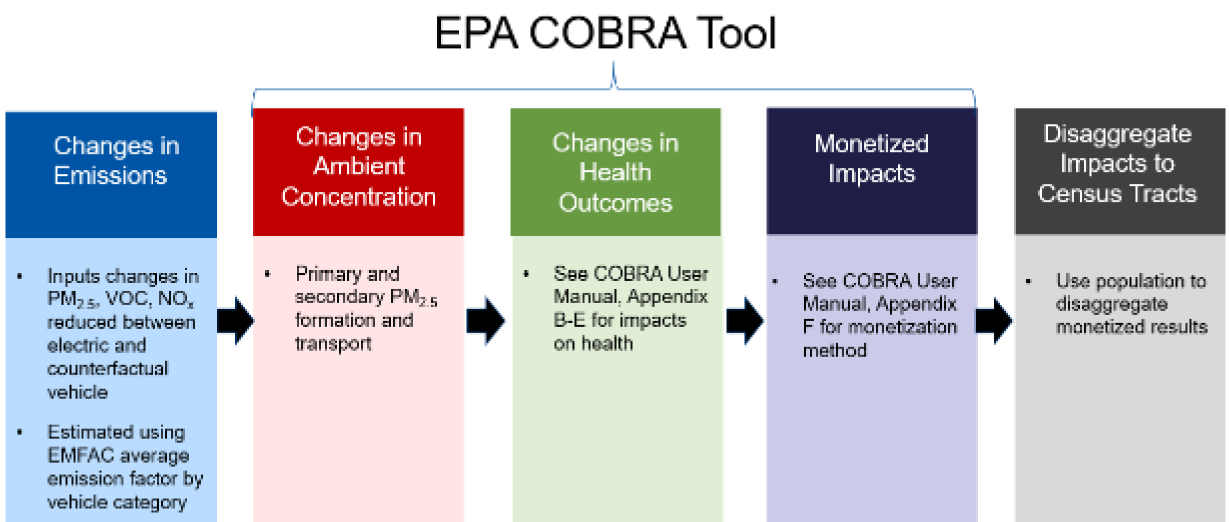
Health Impacts

As EVs replace traditional ICE vehicles, petroleum-based fuels are displaced. These displacements reduce GHG and air pollutant emissions, which may lead to health benefits in regions where EVs are being adopted. To understand the effects of the MDHD programs on air pollution and related health benefits, the team estimated the monetized value of health benefits of each individual Utility-funded site by running the emission reductions through the U.S. EPA's COBRA. As part of this analysis, we also examined the impact on DACs. For Liberty, PG&E, and SCE, DACs are identified in the California Communities Environmental Health Screening Tool, CalEnviroScreen, developed by California's Office of

Environmental Health Hazard Assessment. SDG&E uses a service territory definition of DAC.[148] This section describes the approach, data sources, and analyses performed to estimate health impacts associated with the MDHD programs.

The Evaluation Team used a five-stage methodology shown in Figure 207.

Figure 207. Five-Step Process for Estimating Health Impacts by Census Tract



Step 1: Changes in Emissions. These estimates are annualized emission reductions by project site for EY2022 in tons for $PM_{2.5}$, VOCs, and NO_x. The Evaluation Team aggregated emission reductions by county and used those as inputs into the U.S. EPA COBRA tool, which uses several fields:

- **Sector** – Highway vehicles or off-highway sector
- **Subsector #1** – Diesel for most vehicle applications
- **Subsector #2** – Subsector of highway or non-road
- **Discount rate** – 3% assumed, which reflects the interest rate consumers might earn on government-backed securities

Steps 2 through 4: We run using the COBRA desktop tool. The Evaluation Team uploaded the annual reductions in emissions for $PM_{2.5}$, VOCs, and NO_x and the tool outputs estimates as shown in Table 124. In this analysis VOCs are assumed to be the same as ROGs, which are the output from EMFAC.

Step 5: We disaggregate county-level results to Census tracts using population weights.

148 As per Advice Letter 2876-E, SDG&E found that only 27 census tracts in its territory were considered DACs using the top quartile in the CalEnviroScreen statewide definition. However, the service territory definition is broader and produced a calculated 180 DAC census tracts in SDG&E service territory.

Table 124. Mapping of Vehicle types to Sector, Subsector #1, Subsector #2

Vehicle Type	Sector	Subsector #1 (Counterfactual Fuel Type)	Subsector #2 (Counterfactual Fuel Type)	Discount Rate
LDVs (at public charging sites)	Highway vehicle	Gasoline fuel	Light-duty	3%
Airport ground support equipment (GSE)	Off-Highway	Non-road diesel	Airport service	3%
Cargo handling equipment	Off-Highway	Non-road diesel	Industrial	3%
Forklift	Off-Highway	Non-road diesel	Industrial	3%
Heavy duty vehicle	Highway vehicle	Diesel fuel	Heavy duty	3%
Medium duty vehicle	Highway vehicle	Diesel fuel	Heavy duty	3%
Other heavy-duty vehicle	Highway vehicle	Diesel fuel	Heavy duty	3%
Port cargo truck	Highway vehicle	Diesel fuel	Heavy duty	3%
School bus	Highway vehicle	Diesel fuel	Heavy duty	3%
Electric truck refrigeration unit (eTRU)	Highway vehicle	Diesel fuel	Heavy duty	3%
Truck stop electrification	Highway vehicle	Diesel fuel	Heavy duty	3%
Transit bus	Highway vehicle	Compressed natural gas	Heavy duty	3%

Step 2: Changes in Ambient Concentration. The U.S. EPA COBRA tool has a feature that uses the reductions in emissions to estimate the change in ambient concentration. The tool also accounts for transport and transformation of the pollutants (for example, into ozone).

Step 3: Changes in Health Outcomes. The U.S. EPA COBRA tool uses epidemiological models to estimate the health impacts of these emission changes at the county level. COBRA's estimates reflect the current scientific thinking on the relationship between particulate matter and human health, as well as the economic valuation of these health effects. In particular, the U.S. EPA draws from the PM Integrated Science Assessment.[149] Additionally, the U.S. EPA's methodology for characterizing health impacts has been reviewed by two National Academy of Sciences panels and multiple U.S. EPA Science Advisory Boards. Because the health impacts of air pollution and approaches to value these impacts are areas of active research, the selection of studies used in COBRA may evolve over time, as new evidence and studies emerge. More information is available in the online COBRA documentation.[150] Note that COBRA estimates health impacts for all 3,033 counties in the United States (because of the transport of the pollutants).

Step 4: Monetized Impacts. The U.S. EPA COBRA tool estimates the economic value (in 2017 USD) of the change in health impacts from the emission changes at the county level. These values are converted to

[149] U.S. Environmental Protection Agency. Last updated June 27, 2022. "Integrated Science Assessment (ISA) for Particulate Matter." https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter

[150] U.S. Environmental Protection Agency. Last updated November 1, 2022. "CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool COBRA." https://www.epa.gov/cobra/users-manual-co-benefits-risk-assessment-cobra-screening-model

2023 USD using the multiplier of 1.23 (that is, $1.00 in 2017 is the same as $1.23 in 2023).[151] Economic value is estimated differently depending on the health impacts (such as by estimating avoided lost wages, avoided medical costs, the amount people are willing to pay to avoid a negative health impact [such as a respiratory symptoms], or the value of statistical lives [VSL] approach, which uses value-of-life studies to determine a monetary value of preventing premature mortality). COBRA reports both a low impact and a high impact, representing uncertainties in the estimates. The low estimate represents results based on an evaluation of mortality impacts of $PM_{2.5}$ by the American Cancer Society.[152] The high estimate represents results based on the Harvard Six Cities mortality study.[153] Rather than average the results of these studies, the U.S. EPA's standard practice has been to report the estimated change in mortality separately as low and high values.

Step 5: Disaggregate Impacts to Census Tract. The Evaluation Team disaggregated the county-level monetized health impacts by census tract using the relative population from the most recent American Community Survey (where we allocated 10% of the monetized health impacts to a census tract with 10% of the county's population). From there, the team estimated DAC versus non-DAC impacts.

Total Cost of Ownership

For the MDHD TCO analysis, the Evaluation Team examined the costs of owning and operating EVs for fleets. We conducted these fleet TCO analyses for each Utility program in EY2022 since the inputs to the analysis (particularly electricity costs and program incentives) vary by Utility.

While electric MDHD vehicles have a much higher incremental purchase price than traditional diesel vehicles, EVs typically cost less to power and maintain. The team assessed the TCO of MDHD EVs compared to that of counterfactual vehicles over a 10-year period.

To conduct this TCO analysis, we conducted a side-by side comparison of the NPV of 10-year vehicle costs for the fleets participating in the Utility MDHD programs. These costs normally include upfront costs (such as vehicle acquisition and EVSE installation) as well as rebates and incentives. The ongoing costs included fuel costs (electricity or diesel) as well as maintenance of vehicles and of EVSE.

The initial analysis revealed that purchase price and purchase incentives overwhelmingly dominated the TCO analysis. Given the considerable uncertainty in these estimates (as fleet purchases of MDHD vehicles do not adhere to a fixed price but are instead highly negotiable) we omitted these cost elements in order to highlight the role of the utility infrastructure investments and incentives. The

---

151 U.S. Bureau of Labor Statistics. 2023. "CPI Inflation Calculator." https://www.bls.gov/data/inflation_calculator.htm

152 Krewski, Daniel et al. May 2009. "Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality." *Res Rep Health Effects Institute* (140): 5–114. https://pubmed.ncbi.nlm.nih.gov/19627030/

153 Lepeule, Johanna, Francine Laden, Douglas Dockery, and Joel Schwartz. March 28, 2012. "Chronic Exposure to Fine Particles and Mortality: An Extended Follow-Up of the Harvard Six Cities Study from 1974 to 2009." *Environmental Health Perspective* 120(7): 965–970. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404667/

resulting analysis shows the difference in infrastructure and operating cost between EVs and internal combustion equivalents but does not include vehicle cost nor vehicle incentives.

The team used actual program data wherever possible, including actual electricity cost data for charging the vehicles. As more program data becomes available through surveys and Utility data collection in subsequent evaluation years, we expect primary data to increase. Table 125 shows the TCO data inputs for EY2022.

Table 125. TCO Analysis Data Inputs

Data Inputs	Details	Source
Vehicle Market Sector	Examples are school bus, transit bus, and package delivery trucks	Based on Utility MDHD program site data
Number of Years in Operation	10	Assumption made by Evaluation Team as part of methodology development
Annual Vehicle Miles Traveled (VMT)	Annual VMT for vehicles at each site	Derived from reported electricity consumption at each site, divided by number of vehicles and by vehicle efficiency
Vehicle Efficiency	Kilowatt-hours per mile (electric) Miles per diesel gallon equivalent (diesel or CNG)	Secondary data from Alternative Fuel Data Center 2018 [a]
Fuel Costs (counterfactual)	$ per gallon	Calculated average from Energy Information Administration 2022 California ultra-low-sulfur diesel. 2.2% annual increase estimated.
Fuel Costs (electricity)	$ per kilowatt-hour	Primary data from fleet electricity usage divided by fleet electricity billing data. 2.2% annual increase estimated.
Maintenance and Repair Cost Per Mile Estimate (counterfactual)	$ per VMT	Estimate of $0.13 per mile from other Cadmus analyses. 2.2% annual increase estimated.
Maintenance and Repair Cost Per Mile Estimate (electricity)	$ per VMT	Estimate of $0.07 per mile from other Cadmus analyses. 2.2% annual increase estimated.
Discount Rate	%	Used 7% across all programs
EVSE Networking and Maintenance Costs (Annual)	Per charger subscription for networking plus estimated maintenance and repair of chargers	Sourced from observed network providers. Due to their recent development, MDHD sites do not have robust primary maintenance cost data. External secondary data can suggest an average or reasonable first-year maintenance cost per charger type (L2, DCFC) and the rate of change of maintenance costs for each charger type.
Infrastructure Costs	Utility-side (TTM) and customer-side (BTM) costs of installing EVSE	Total site infrastructure costs based on reports from EY2022 MDHD program sites includes all infrastructure and installation costs: construction, trenching, line extensions, transformer upgrades, switch gear, and labor.
Utility Incentives	To understand the cost impact of MDHD program incentives on these fleets	Program data

Data Inputs	Details	Source
LCFS Credit Revenues	To understand the cost impact of LCFS credit revenue on these fleets	Calculated credits using CARB Credit Value Calculator based on annual kilowatt-hours used per vehicle. Used credit price of $60. Assumed that grid electricity carbon intensity declines by 3% per year.

[a] U.S. Department of Energy. Last updated February 2020. "Average Fuel Economy by Major Vehicle Category." https://afdc.energy.gov/data/10310.

As annual VMT influences annual operating costs, estimating VMT prefaces the determination of annual variable costs and credits. The Evaluation Team derived VMT from site electricity consumption data and assumed vehicle efficiency. The Evaluation Team assumed that VMT per vehicle will remain constant over a 10-year period.

In some cases, EVSE may be installed for more vehicles than are currently present, with additional EVs in the VAP. The Evaluation Team calculated TCO based on the expected total number of vehicles in the VAP. For example, if a site's VAP calls for 20 vehicles, but only 10 EVs are acquired at present, the Evaluation Team calculated TCO as if 20 vehicles were present; to do otherwise would be to overburden the existing vehicles with the cost of infrastructure installed to support future vehicles.

The analysis presents TCO graphically in a format that highlights the role of rebates and incentives. For EY2022 there existed more complete data on these incentive amounts for fleets than in EY2021. The LCFS credits represent an additional incentive; we also incorporated LCFS credit estimates into the TCO to understand their impact on the financial feasibility of fleet electrification.

Site Visits

The team visited MDHD program sites that were activated during EY2022 to provide quantitative and qualitative infrastructure insights. This section describes the approach, data sources, and analyses performed for EY2022 MDHD site visits.

The team took a census approach, conducting visits at 39 of 41 EY2022 activated sites. The team collaborated with the Utilities and site hosts, as appropriate, to access each site and complete the site visits.

For the analysis, the team used detailed notes and photos taken during each site visit as well as data provided by the Utilities. After each site visit, the team compiled the notes and photos and entered data into the Arkenstone data collection platform. We used these data to support the grid impacts and petroleum displacement analyses since they rely on site-specific energy consumption, which can be impacted by the reliability of charging systems for EVs and by integrating EVs into a fleet's operation.

The team then analyzed the data to document several types of quantitative and qualitative insights:

- Confirm the number and type of conventional vehicle and fuel types to support counterfactual analysis adjustments in future evaluation years.
- Confirm the installed charging hardware and whether an EVSP (charging station network provider) is being used, as well as the number and type of EVs delivered compared to the vehicle and EVSE acquisition plans provided by Utilities as part of the program data. The results indicate:

  Total installed charging capacity (kW)

  Expandability, which may be indicated by the size of transformers, details of service panels (amperage and space for circuit breakers), pre-installed conduit, available parking area, and other vehicle types used by fleets.
- Visually identify variables leading toward final design and construction decisions (such as whether transformers are new, upgraded, or pre-existing) with the support of on-site hosts or Utility staff for interpreting site cost under TCO analysis.
- Confirm co-funding for vehicles and charging infrastructure that helps address ratepayer cost benefits.
- Determine reasons behind lessons learned, challenges, and operability (EVs and or charging hardware) such as software, hardware, staffing, and passenger loads that support the site utilization rates.
- Comparison of site visit findings to Utility PMO (vehicle/EVSE acquisition plans) and PAC meetings.

Co-Benefits and Co-Costs

The Evaluation Team collected information on co-benefits and co-costs for fleet managers through fleet manager surveys and interviews and fleet driver surveys. For the fleet manager surveys specifically, the team asked both closed- and open-ended questions to understand which co-benefits and co-costs fleet managers experienced. The survey was designed to build upon data collected in the previous year by using the results to expand the number of co-benefits and co-costs evaluated and retaining a similar survey structure year over year. Given that some fleets have been operating for a short time, the Evaluation Team took a qualitative approach to assessing co-benefits and co-costs, asking respondents to provide a relative rating of size (significant benefits, some benefits, or no benefits). Additionally, the team worded these questions to focus on what they *expect,* not what they have experienced, because many of the co-benefits are felt by drivers and the local communities, and not by the fleet managers specifically. To supplement the survey responses, we incorporated relevant data from the site visits. While we did not formally ask about co-benefits and co-costs during the site visits, the Evaluation Team was able to obtain anecdotal information from site representatives.

Deep Dives

Analysis for deep dives included synthesis of multiple data sources such as site visits, surveys, interviews, project documentation with selected sites.

- **Fleet Manager Interviews:** The team interviewed fleet managers via phone from six selected sites in November and December 2022. We focused the interview questions on EV and charger performance and satisfaction, as well as the vehicle acquisition process. During each interview, we also requested data from fleet managers on historical fuel and mileage logs, vehicle telematics data, and historical maintenance costs.
- **Driver Surveys:** The team distributed driver surveys after discussing logistics with the fleet manager during the interview. At five of six sites, we administered paper surveys per the request of the fleet managers, which were distributed by the fleet manager. The final site requested a digital survey. The surveys covered the driver experience, benefits of electrification, and operational impacts.
- **Operational Analysis Presentation**: Where requested by the fleet manager, the Evaluation Team scheduled a one-hour virtual meeting with each deep dive participating fleet to present the results of the analysis (based on at least the past 12 months of operational data).
- **Second Year Activities**: Sites with a significant change in operations may require an extended deep dive analysis for another year (such as where a significant number of vehicles were added or where the site implemented load management strategies). The team requested that these fleet managers participate in a brief follow-up phone interview in EY2023 to enable an iterative dialogue.

Net Impacts

MDHD Fleet Manager Self-Report NTG Methodology

The Evaluation Team's approach for MDHD program enhanced self-report NTG analysis was informed by data obtained as part of surveys with key project decision-makers such as program participating fleet managers. The team estimated freeridership and spillover ratios for each program to determine program-specific self-reported NTG ratios using the following calculation:

Net-to-Gross Ratio = 1 – Freeridership Ratio + Participant Spillover Ratio

Freeridership is defined as participants who report they would have adopted the MDHD EVs in the absence of the MDHD make-ready program. Participant spillover in the MDHD fleet sector is defined as increased EV adoption by participants, beyond direct participation in the program, that can be attributable to their experience participating in the MDHD program.

For the MDHD fleet manager self-report freeridership analysis, the team assessed three aspects:

- **Acceleration from program.** Whether the make-ready and infrastructure savings led them to purchase MDHD EVs sooner than they had originally intended in absence of the MDHD program.
- **Awareness of the program.** Whether fleet managers were aware of the program at the time they decided to implement the transportation electrification project.
- **Influence from program.** The degree of influence the program had on their purchases.

For the MDHD fleet manager participant spillover analysis, the team assessed three aspects:

- **Additional electrification after program participation.** Whether the participant fleet manger electrified more of their fleet after participating in the MDHD make-ready program without incentives from the MDHD program.
- **Sources of funding.** Whether the participant fleet manager received financial support from any organization for the additional fleet electrification projects.
- **Influence from program.** The degree of influence participating in the MDHD program had on their decision to electrify more of their fleet without Utility program support.

Self-report information was a core component of analyzing the net effects directly attributable to MDHD programs. The team used the CPUC nonresidential customer self-report NTG framework as the base from which we developed the MDHD fleet manager NTG methodology approach.[154] The nonresidential NTG methodology that has been used since the 2006-2008 energy efficiency program evaluation cycle was developed to address the unique needs of nonresidential customer projects developed through energy efficiency programs offered by the four California Utilities and third-party implementers. This method relies exclusively on the standardized self-report approach to estimate project and domain-level NTG ratios, since other available approaches and research designs are generally not feasible. The Evaluation Team developed the MDHD self-report approach NTG methodology in accordance with the relevant EM&V guidelines including the California Energy Efficiency Evaluation Protocols (April 2006), as well as the most recent updates made to the nonresidential NTG framework that incorporated an alternative to a legacy program attribution index (PAI) scoring component (PAI-1 score) of the core NTG calculation.[155] For the purposes of this MDHD self-report approach NTG methodology, the Evaluation

[154] California Public Utilities Commission, Energy Division. February 20, 2015. *Methodological Framework for Using the Self-Report Approach to Estimating Net-to-Gross Ratios for Nonresidential Customers.*

[155] Quantum Energy Analytics and DNV-GL. March 26, 2021. *Final Impact Evaluation: NonResidential Lighting Sector Program Year 2019*. Appendix A. Prepared for California Public Utilities Commission. https://www.calmac.org/publications/PY2019_NonresLgtImpact_FinalRpt.pdf
Itron, ERS, and Tierra Resource Consultants. March 31, 2020. *PY2018 Small/Medium Commercial (SMB) Sector ESPI Impact Evaluation: Final Report.* Prepared for California Public Utilities Commission. https://pda.energydataweb.com/api/view/2361/2018_Small_Medium_Com ESPI_Evaluation_Final_with_Appendices.pdf

Team has adopted the alternative scoring structure documented in the referenced evaluation reports, herein referred to as PAI-1A[156] score, to replace the legacy PAI-1 score.

In recognition of the varying degrees of project complexity and the underlying decision processes, the CPUC framework includes three levels of detail—all built around the same core questions but incorporating different sources and review as the size and complexity of projects increases. Table 126 describes the potential data sources that can be used for each of the three levels of NTG analysis.[157]

Table 126. Net-to-Gross Rigor and Data Sources

NTG Rigor	Program Files [a]	Decision-Maker Survey	Vendor/Dealer Survey	Secondary Research Findings
Basic NTG	X	X	X	
Standard NTG	X	X	X	
Standard NTG – Very Large	X	X	X	X

[a] Program files for MDHD make-ready projects can contain data on equipment costs, expected savings, funding sources and amounts, and decision maker and vendor contact information.

Decision-maker (fleet manager) surveys are a key source of attribution data under all three levels of NTG rigor. The team used three separate sets of questions to assess three components of the core NTG ratio, with each score on a 0.0 to 1.0 scale representing a different way of characterizing Utility program influence.

- **Program attribution index 1A (PAI-1A) score** captures what type of transportation electrification (TE) investment participating fleet managers would most likely have procured if the Utility program had not been available, resulting in a score of a 0.0 to 1.0.
- **Program attribution index 2 (PAI-2) score** captures details from participating fleet managers on the perceived importance of the Utility program (rebates, recommendation, training, or other program intervention) relative to non-program factors in the decision to implement the specific TE project that was eventually completed. The team determined this score by asking fleet managers to assign importance values (using a 0 to 10 scale) to both the program and most important non-program influences so that the two values totaled 10. The importance of the Utility program, on the 0 to 10 scale, divided by 10 equals the score for the project on a 0.0 to 1.0 scale. We halved the score if the fleet manager said they had already made their decision to procure the specific program-qualifying TE project before they learned about the program.
- **Program attribution index 3 (PAI-3) score** captures the likelihood (on a 0 to 10 scale) of various actions the fleet manager might have taken at the time they did, and in the future, if the Utility program had not been available (the counterfactual). Ten minus the likelihood rating of

156 PAI-1A is the PAI-1 alternative.

157 Participant fleet manager surveys were the primary source of the SRA NTG ratio in EY2022. When available, the team incorporated information from other data sources in the final determination of a project's NTG ratio.

procuring the exact same program-qualifying TE project, divided by 10, equals the score for the project on 0.0 to 1.0 scale.

Core NTG Ratio Scoring

The team calculated the resulting self-report approach core NTG ratio for a project, prior to accounting for participant spillover, as the average of the PAI-1A, PAI-2, and PAI-3 values. One minus the core self-report approach NTG value equals the freeridership ratio for a project.

Participant Spillover Calculation

To measure participant spillover, the Evaluation Team asked fleet managers if, due to their participation in the MDHD program, they chose to electrify more of their fleet without incentives from the MDHD Utility fleet electrification program. We then asked follow-up questions about the type and number of EVs that fleet managers purchased without support from the MDHD Utility fleet electrification program. The team asked fleet managers if they received financial support from any organization for any of the EV types they reported purchasing after participating in the MDHD program and, if they had, we asked what specific organizations had provided that financial support and the amount of financial support received. An electrification project is not eligible to be classified as participant spillover attributable to the MDHD program if a participating fleet manager received financial support from an organization for the additional fleet electrification activity.

The Evaluation Team asked participating fleet managers how important their participation in the MDHD Utility fleet electrification program was on their decision to electrify more of their fleet without MDHD program support. A participant spillover electrification project is one for which the fleet manager rated the importance of their MDHD program participation as an 8, 9, or 10, on a 10-point scale where 0 meant *not at all important* and 10 meant *extremely important*. An electrification project that received a rating of 8, 9, or 10 and did not receive financial support from another organization was eligible to have the full amount of estimated spillover benefits attributed to the MDHD Utility program.

The team assigned benefits values to spillover projects based on evaluated gross program benefits. A participating fleet manager's project participant spillover ratio equaled the sum of additional spillover benefits reported by the fleet manager divided by the total gross program benefits achieved by the MDHD project:

$$Participant\ Spillover\ Ratio = \frac{\sum Spillover\ Benefits\ for\ Responding\ Fleet\ Manager}{\sum MDHD\ Program\ Benefits\ for\ Responding\ Fleet\ Manager}$$

Final Self-Report Approach NTG Ratio

The team separately estimated freeridership and spillover rates for each surveyed project to determine the final project-specific self-report approach NTG ratios using the following calculation:

Net-to-Gross Ratio = 1 – Freeridership Ratio + Participant Spillover Ratio

Self-Report Approach NTG Integration with Truck Choice Model to Determine Final NTG Ratio

The Evaluation Team determined the final NTG ratio for a MDHD project by applying the self-report approach NTG ratio or by applying the UC Davis Truck Choice Model. Figure 208 illustrates the situations in which we used the self-report approach NTG ratio.

Figure 208. Freeridership Determination for MDHD Projects

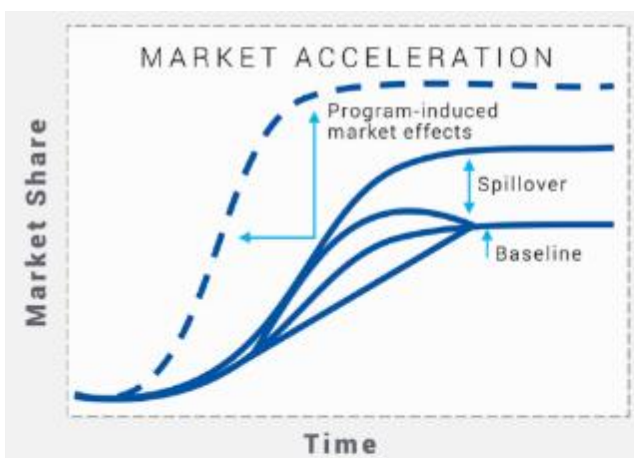
SURVEY RESPONSE	Fleet indicates with certainty they would not have purchased the EVs but for the Utility program	Fleet indicates they were able to purchase more EVs because of Utility program	Fleet survey response is uncertain or contradictory	Fleet indicates with certainty they would have purchased without Utility program
FREERIDERSHIP DETERMINATION	100% attributed (no modeling required)	Attribute 100% of the savings from the incremental purchase supported by program	Apply Truck Choice Model to calculate the probability of EV purchase without Utility program	100% FR (no modeling)

Market Effects: Electrification Market Share Baselines

Measuring market effects is intended to inform Research Objective 1: "whether transportation electrification (TE) investments accelerated widespread TE."

Market effects arise from changes in the structure of a market or the behavior of market participants in the form of increased adoption of clean energy products, services, or practices causally related to market interventions (such as program incentives and trainings). In the context of the MDHD programs, effects in the MDHD market are the adoption of EVs by fleets that did not directly participate in the programs. As illustrated in Figure 209, market effects capture the difference between actual adoption (dotted line) and the combination of naturally occurring baseline market adoption and direct program participation. Market effects cause a shift in the adoption curve to the left as well as upward, indicating faster and higher levels of EV adoption compared with the baseline scenario where no Utility market interventions occurred.

Figure 209. Market Effects: Acceleration and Transformation



Estimating market effects requires knowing the actual adoption, program participant net impacts, and naturally occurring baseline market adoption. Ideally, measurement of the naturally occurring baseline occurs prior to significant program activity since the baseline represents adoption in a scenario without Utility market intervention.

Transit Bus Electrification Naturally Occurring Baseline

The Evaluation Team conducted a two-round Delphi panel with seven transit bus market experts to develop a consensus forecast of the market baseline for transit bus electrification in California through 2030. The baseline assumes no market development efforts by the electric Utilities.

The seven panelists provided their inputs through an online survey, which the Evaluation Team programmed to capture electrified market share in 2022, 2024, 2026, 2028, and 2030. The online survey allowed the panelists to see their forecasted adoption curve generated in real time and to make adjustments dynamically.

In the first round, we asked experts to provide a forecast of the electric transit bus market share (specifically, the share of battery electric transit bus out of all transit bus acquired by public transit agencies) assuming no intervention by the Utilities, along with a rationale for the shape of their forecast. This estimate did not include private transit bus fleet, such as employer parking lot shuttles or private university shuttles. The Evaluation Team aggregated the first-round results, calculated the median forecast, and shared the anonymized market predictions with the panel in the second round. The experts reviewed all forecasts and had the opportunity to either agree with the median estimate or submit a new estimate. This process typically continues until convergence occurs, when over half of panelists agree. Five panelists agreed with the median and two submitted new forecasts during the second round. As over half of the experts agreed with the original median forecast, we used that median forecast as the consensus forecast.

While the main purpose of this Delphi panel was to develop a consensus market baseline forecast, the Evaluation Team recognized that panelists' rationales contained valuable qualitative information, and we summarized these rationales. Based on this summary, the team drew insights into those factors that panelists believe will accelerate or impede transit bus electrification in California.

The panelists considered the impact of the ICT, with some creating forecasts of trajectories below the ICT requirements (suggesting either incomplete compliance or compliance through alternative technologies) and some creating forecasts above the requirements.

Parcel Delivery Vehicle Electrification Naturally Occurring Baseline

The Evaluation Team conducted another Delphi panel on the parcel delivery vehicle market, using the same methodology. We defined the parcel delivery segment for panelists as vehicles primarily used for last mile parcel delivery, including cargo vans, step vans, and box or straight trucks ranging from weight classes 2b to 8. The panel included eight market experts to develop a consensus forecast of the market baseline for parcel delivery vehicle electrification in California through 2030, assuming no market development efforts by the electric Utilities.

The eight panelists provided their inputs through an online survey, which the Evaluation Team had programmed to capture electrified market share in 2023, 2024, 2026, 2028, and 2030. The online survey allowed the panelists to see their forecasted adoption curve generated in real time and to make adjustments dynamically.

In the first round, we asked experts to provide a forecast of the electric parcel delivery vehicle market share in California assuming no intervention by the Utilities, along with a rationale for the shape of their forecast. The Evaluation Team aggregated the first-round results, calculated the median forecast, and shared the anonymized market predictions with the panel in the second round. The experts reviewed all forecasts and had the opportunity to either agree with the median estimate or submit a new estimate. Five panelists agreed with the median and three submitted new forecasts during the second round. As over half of the experts agreed with the original median forecast, we used that median forecast as the consensus forecast.

While the main purpose of this Delphi panel was to develop a consensus market baseline forecast, the Evaluation Team recognized that panelists' rationales contained valuable qualitative information, and we summarized these rationales. Based on this summary, the team drew insights into those factors that panelists believe will accelerate or impede parcel delivery vehicle electrification in California.

The panelists considered the impact of the proposed ACF regulation, which includes sales targets for last mile delivery vehicles, and the ACT regulation. The median forecast shows sales of parcel delivery vehicles falling below the ACF requirements for delivery vehicles and the ACT requirements for Class 4 through Class 8 vehicles in 2030, but above the ACT requirements for Class 2b and Class 3 vehicles. Panelists suggested competition with the LDV market for battery supply and OEM manufacturing capacity, a potential global recession, and high infrastructure costs as rationales for forecast trajectories coming in below the ACF and ACT requirements.

Truck Choice Model

The UC Davis TCM is structured as a nested multinomial logit model in a Microsoft Excel spreadsheet. The model represents a discrete choice formulation that includes a number of important factors that will influence individual decision-makers' preferences among a suite of vehicle technology options. These factors include private economic costs, such as vehicle purchase price, maintenance and fuel costs, non-monetary costs (such as aversion to new and uncertain technologies and lower availability of fuel infrastructure), and incentives or subsidies. The choice formulation assumes a variation in the utility of trucks for decision makers.

The team disaggregated trucks into several categories that encompass specific vehicle types and use patterns. We then segmented these truck categories into risk groups that have different factors impacting truck purchases. The team applied the discrete choice model to each of these risk groups to generate the market shares for each vehicle technology.

The model calculates a total generalized cost, which is the numerical summation of both monetary and non-monetary factors: capital cost, fuel cost, green public relations, uncertainty, incentives, refueling inconvenience, maintenance cost, carbon tax, and model availability. For monetary factors, the model calculates the cost in U.S. dollars. The model quantified non-monetary factors by certain functions and subsequently expresses those in U.S. dollars. For each truck type (such as short haul delivery, medium-duty delivery, transit bus, and school bus) the model calculated the generalized cost for each technology type (diesel, natural gas, hybrid, fuel cell, battery electric, gasoline). Using these generalized costs, the model calculates the market shares.

The model has been used extensively in recent years to better understand how California policies and programs impact fleet operator purchase decisions of alternative fueled MDHD vehicles. Using the TCM, the Evaluation Team predicted the likelihood that each fleet would have adopted MDHD EVs in its next procurement in the absence of the Utility program.

The Evaluation Team developed a version of the TCM with a focus on the vehicle segments most heavily represented in the Utilities' programs. We incorporated actual program cost data including Utility rebates and incentives. The model produced three trajectories for each vehicle segment: adoption with no utility investment, adoption with utility investment only in the TTM infrastructure (as required by AB841), and adoption with the full suite of Utility programs, rebates, and incentives.

Process Evaluation

The following subsections discuss the process evaluation for MDHD surveys and interviews.

Surveys

The Evaluation Team used survey data regarding fleet motivations for participating in Utility electrification programs, fleet motivations for withdrawing from the program, fleets' experience with the process, barriers to electrification, costs and benefits, and operational constraints.

To gather the survey data, the Evaluation Team invited respondents to complete surveys via email. The team developed two surveys: one for managers of participating fleets and one for managers of fleets that had withdrawn from the program. We designed the survey questions to align with the evaluation objectives and focused the questions on understanding fleets' experience with the program.

Seventeen fleet managers responded to the fleet manager survey and two responded to the fleet withdrawal survey. The Evaluation Team compiled survey data to produce and interpret graphical analysis of the survey responses.

The Evaluation Team primarily analyzed the fleet manager and fleet withdrawal surveys at the Utility stratum. For select questions and when sample size allowed, we further stratified the sample by DAC status and vehicle type to provide additional insights to the analysis. The team created graphical data representations to interpret survey data, draw conclusions about fleets' experiences, and identify trends in fleets' experiences with electrification. In future evaluation years, the Evaluation Team expects a larger sample size, which will allow for a more robust analysis among different strata. Due to the small sample sizes, the Evaluation Team did not apply any significance testing to EY2022 survey data.

Interviews

The team also conducted in-depth interviews with the four participating Utilities to gather qualitative insights regarding Utility experience with the program process, barriers to electrification, program design, costs and benefits, and operational constraints. We used this interview data to provide context to information from other sources, such as PAC presentations.

The team synthesized Utilities’ responses to in-depth interview questions to draw conclusions about the topics covered in the interview. We analyzed each Utility’s responses separately but used a nearly consistent set of questions across Utilities.

We synthesized the vendor (EVSP) responses to highlight general concerns across all of the Utility programs (such as delays due to supply chain constraints). We included such findings in the report sections corresponding to SCE, SDG&E, and PG&E. Most vendor comments applied to the programs of all three of these Utilities, so the corresponding report sections are generally similar. Where vendors singled out specific Utility programs in their comments, we only included such comments in that Utility’s section of this report. Liberty’s program was distinct with a single EVSP vendor who did not provide EVSP services under the other programs.

Public Charging (Schools, Parks, and EV Fast Charge) Evaluation Methodology

This section outlines the data collection and analysis for the Public Charging program evaluation.

Data Collection Methodology

The following subsections discuss data collection for the Public Charging program evaluation, including program data, materials, AMI and EVSE data, site visits, and Utility interviews.

Program Performance Metrics

Program data provides essential insights into program performance. The Evaluation Team collected and securely transferred Utility data between the Microsoft Azure cloud-based environments and a secure SharePoint site. The team sought to transfer data monthly, with some variation in timing among PG&E, SCE, and SDG&E.[158] Once we received data from these Utilities, we moved it to the Cadmus data warehouse for secure storage, retrieval, and analysis. The Evaluation Team then unified the data imported from each Utility to provide a single resource output to adhere to SB 350 reporting.

These data included program application status and timing (from initial engagement to site activation for those site that were complete and operational in EY2022), as well as details such as the number of ports by type/level, site status by DAC, program, application phase timing, and number of applications operational and activated.

Program Material

The Evaluation Team reviewed available EY2022 program-related material such as marketing education and outreach documentation, Advice Letters, the *Joint IOU EV Load Research and Charging Infrastructure Cost Report* (filed on March 31, 2023), and PAC presentations. The annual program material review is important to maintain an understanding of the program, as well as of changes and implementation progress.

Table 127 shows a list of the material types the Evaluation Team reviewed by Utility in EY2022.

---

158 Liberty provided no site data for EY2022 (as no public charging sites were completed).

Table 127. Public Charging Materials Reviewed

Utility	Program Materials Provided
Liberty	• No new materials for EY2022
PG&E	• (Schools and Parks Pilots and EV Fast Charge) PAC presentations • (Schools and Parks Pilots and EV Fast Charge) Regulatory documents (the Advice Letter) • (Schools and Parks Pilots and EV Fast Charge) *Joint IOU EV Load Research and Charging Infrastructure Cost Report* • (Schools and Parks Pilots only) Marketing materials • (Schools and Parks Pilots only) School curriculum
SCE	• Regulatory documents (the Advice Letter) • *Joint IOU EV Load Research and Charging Infrastructure Cost Report* • PAC presentations • Marketing materials
SDG&E	• PAC presentations • *Joint IOU EV Load Research and Charging Infrastructure Cost Report* • Marketing materials

AMI/EVSP

The Evaluation Team used AMI data to estimate charger usage, a key input for subsequent analyses and estimations of program impacts, such as impacts to the grid, as well as petroleum displaced, emissions reduced by EV adoption, and associated health impacts. The team collected and securely transferred AMI data between the Utilities and Microsoft Azure cloud-based environments. We used Azure Databricks to transform and standardize the data, which we then imported into an SQL server data warehouse. We performed these transfers monthly, with some variation in timing among the Utilities. Once we received the data, we input it into our data warehouse for secure storage and retrieval and aggregated it for subsequent calculations and analysis. Time-stamped energy consumption data were in 15-minute intervals.

A second critical data source was EVSE data provided by participating EVSPs. The electric Utilities developed a process for screening and approving EVSPs based in part on their ability to provide essential charging data of EVSE sessions, intervals, stations, and ports monthly.

Together, AMI and EVSE data provided the basis for analyzing program performance at a granular level, such as the ability for customers to shift loads to off-peak times in response to time-varying rates. The team used data from EVSPs to examine port utilization, which is based on the time in which a vehicle is parked at a charging station and consuming energy. Port utilization rates can be expected to rise as the program matures, consumers and fleets acquire more vehicles, and the effects of the COVID-19 pandemic begin to subside.

The Evaluation Team worked to acquire complete AMI and EVSE data for every charging session from the Utilities and EVSPs. In some limited cases where AMI data was not available from the Utility, the team worked with the Utility to obtain these data and incorporate them into future analyses. In other cases where AMI data was not available, either the Utility provided a customer sub-metered dataset or the team synthesized data from existing EVSE data.

Synthesized Data

Where some complete AMI data were missing or where AMI data was missing for some periods of times, the Evaluation Team generated representative AMI data for these sites based on available EVSP data through a synthesis process using a conversion factor of the ratio between EVSP data and AMI data. Specifically, we derived conversion factors for each site by evaluating the ratio of total kilowatt-hours delivered as reported by EVSPs, which in most cases existed for the same project at a different time period or existed for similar charging stations and vehicles. In the rare case where there was no specific match, the team used a standard factor of 0.85 to account for electricity losses between the meter and the EVSE.

Annualized Data

The team considered all operational sites for annualization.[159] In the previous EY2021 evaluation, we only annualized sites with greater than six months of data. We considered annualizing sites that had reached a minimum of three months of usage but less than six months, depending on the observed usage patterns. For EY2022, to provide a more complete picture of the entire program to date and the impacts of the existing program performance over a full 10-year life, the Evaluation Team annualized all sites. We have found that sites with an abbreviated period of performance (less than six months) inherently have lower utilization than fully developed sites. As a result, annualized sites with an operational time of six months or less will underrepresent their full 10-year impact; however, excluding those sites would lead to a greater underrepresentation.

We annualized site data by separating a representative 12-month operation period, which can be projected into the future until the site reaches its 10-year life. Next, we determined the 10-year life by evaluating when the operational use of the EVSE would begin and projecting forward 10 years from that point in time. For sites with more than 12 months of fully developed utilization, the team used the most recent 12 months. For sites with less than 12 months of fully developed utilization, we removed the months of data that did not yet reach 75% of the maximum monthly use, then replaced that data with a synthesis of all months of data following 75% of the maximum utilization.

Site Visits

Site visits to program charging stations are an important data collection element, as they provide an on-the-ground view of installed sites. For EY2022, the Public Charging site visits brought supplemental qualitative insights, especially regarding lessons learned (such as why some sites may have higher usage than others). The team attempted a census of visits to activated sites for EY2022, conducting 26 site visits, as shown in Table 128.

---

[159] The evaluation team annualized electricity usage data for sites with operational AMI data (data indicating that EVs were actively being charged). To accomplish annualization, we extrapolated partial year site electricity usage data out to a full year to make site-to-site and year-over-year comparisons.

Table 128. EY2022 Site Visits by Utility and Program

Utility	Program	Sites Activated	Sites Operational	Site Visited
Liberty	School Pilot	-	-	-
	Parks Pilot	-	-	-
PG&E	EV Fast Charge	5	5	5
	Schools Pilot	1	1	1
	Parks Pilot	-	-	-
SCE	School Pilot	12	8	12
	Parks Pilot	-	-	-
SDG&E	School Pilot	6	6	5
	Parks Pilot	4	4	4
	TOTAL	**28**	**24**	**27**

Interviews

In-depth interviews provide critical insight on the original intent, actual implementation, and success of the Pilots and programs, as well as the potential to scale up. For EY2022, we conducted close-out interviews with core staff overseeing the public charging programs[160] across the four Utilities in March 2023, for a total of five interview sessions. We developed interview guides outlining key topic areas and questions for discussion to ensure that we covered each topic area during the phone interview. Topics included staff roles and responsibilities, program design and implementation, and areas of challenge and success.

Analysis Methodology

This section provides an overview of analyses for the Public Charging bundle, including estimating EV adoption and grid impacts, developing the vehicle counterfactual, and determining petroleum displacement, GHG and criteria pollutant reductions, and health impacts, as well as preparing for a TCO analysis, qualitative site visits, and Utility interview analysis. As further discussed below, the petroleum fuel reductions, GHG and criteria pollutant reductions, and health impacts analyses include a DAC carve out to consider these impacts on DACs.

EV Adoption

The team conducted an EV adoption analysis to estimate the effects of utility investments in public charging infrastructure on household ownership of EVs.[161] Recent research shows that growth in the availability of public charging networks can lift EV purchases.[162] However, the specific mechanism through which the availability of public charging affects EV purchases is not clear. Understanding this mechanism may help the Utilities and other investors in public EV charging facilities to make more

---

160 This specifically pertained to the Schools Pilot, Parks Pilot, and PG&E EV Fast Charge program.

161 These investments were made through Utility EV pilots and programs including the PG&E EV Fast Charge program and Schools and Parks Pilots.

162 See Springel, Katalin. 2021. "Network Externality and Subsidy Structure in Two-Sided Markets: Evidence from Electric Vehicle Incentives." *American Economic Journal: Economic Policy*, 13 (4): 393–432.

productive investments. This section describes the Evaluation Team's approach and data sources to estimate EV adoption as influenced by the Public Charging programs.

The team estimated the effect of public charging stations on EV adoption for populations neighboring public charging stations[163] with a two-stage analysis:

1. Historical analysis of public EV charging impacts on vehicle ownership
2. Analysis of ownership attributable to PG&E EV Fast Charge program investments.

In the first stage, the team estimated the effects of access to any neighboring public charging on EV ownership.[164] In the second stage, which was an attribution analysis, the team applied the regression coefficient estimates of public charging access in the first stage to the specific utility investments in public charging to estimate their impact on EV ownership (for the EV Fast Charge program, Schools Pilot, and Parks Pilot).

The end results are provided in the Utility EV Adoption findings sections as the estimated changes in annual EV ownership (EV registration), which are a function of changes in annual access to public EV charging stations while accounting for potential non-random siting of public EV charging.

Analysis Data and Sample Selection

The Evaluation Team assembled a census block group (CGB) panel dataset on annual EV ownership and access to public EV charging for calendar years 2015 through 2020 to perform the analysis. The team assembled the panel data from free, publicly available secondary data sources on EV registrations, public EV charging infrastructure, census demographic data, and census geography (census block group [CBG] and census block) shape files. Table 129 lists the data sources.

---

163 There are two main channels through which the availability of public charging networks may affect EV purchases. The first is a network effect, through which EV owners gain increased access to the public charging stations because of the stations' placement at destinations such as workplaces, commercial establishments, schools, and parks. The availability of EV charging equipment at convenient locations (for midday charging away from home) is expected to increase the convenience of owning an EV (such as lessening range anxiety) and to increase the probability of EV ownership. The second channel is a neighborhood effect on the driving population living in areas neighboring the public EV charging stations. The availability of nearby charging infrastructure is expected to lower the cost of EV ownership by providing alternatives to home charging. It is expected that public EV charging will have the biggest impact on residents of multifamily buildings, many of whom will have limited access to EV charging equipment, or on low-income households, who may be unable to afford home EV charging equipment. We note that public charging access may lift EV ownership through both channels and that there may be positive interactive effects between the channels that lift the overall impact of public charging networks. The Evaluation Team focused on analyzing the second channel. We will analyze the impacts for the first channel separately when data become available.

164 For the stage one analysis, the team focused on general public charging, not Utility-specific charging; however, for the stage two analysis we will consider both Utility- and program-specific charging.

Table 129. EV Adoption Data Collection

Data Element	Description	Source	Reporting Unit
California CBG shapefiles	Polygon shapefile representing CBGs for the state of California from 2010 Census	U.S. Census Bureau: https://www.census.gov/cgi-bin/geo/shapefiles/index.php?year=2010&layergroup=Block+Groups	CBG
California census block shapefiles	Polygon shapefile representing census blocks for the state of California from the 2010 Census	U.S. Census Bureau: https://www.census.gov/geographies/mapping-files/time-series/geo/tiger-line-file.2010.html	Census block
California vehicle registration data	Data on EV ownership for California CBGs by vehicle category, fuel type, fuel technology, and number of vehicles registered at the same address for 2015 through 2020	California Air Resources Board: https://arb.ca.gov/emfac/fleet-db	CBG
EV charging stations	EV station attributes and location	National Renewable Energy Laboratory Alternative Fuels Data Center: https://developer.nrel.gov/docs/transportation/alt-fuel-stations-v1/	Fueling station
Population demographics and socioeconomic data	Decennial Census or American Community Survey data (five years) on population, housing, income, race, and ethnicity	U.S. Census Bureau: https://data.census.gov/cedsci/	Zip code tabulation area, census block, or CBG
California DACs	Data on CalEnviroScreen 4.0 scores in census tracts that could be used to identify DACs	California Environmental Protection Agency Office of Environmental Health Hazard Assessment: https://oehha.ca.gov/calenviroscreen/maps-data	Census track
California cities land zoning shapefiles	Polygon shapefile representing land use for the top 20 largest cities in California where land zoning data are publicly available	Anaheim: https://main-anaheim.opendata.arcgis.com/datasets/f40f6f69179a4bccb5d4359a0e054b04_3/about Bakersfield: https://bakersfielddatalibrary-cob.opendata.arcgis.com/ Fresno: https://www.co.fresno.ca.us/departments/public-works-planning/divisions-of-public-works-and-planning/cds/gis-shapefiles Long Beach: https://datalb.longbeach.gov/search?q=zoning Los Angeles: https://geohub.lacity.org/datasets/lahub::zoning/about Oakland: https://data.oaklandca.gov/dataset/Zoning/q8sz-29u5 Sacramento: https://data.cityofsacramento.org/search?q=zoning San Diego: https://data.sandiego.gov/datasets/zoning/ San Francisco: https://data.sfgov.org/Geographic-Locations-and-Boundaries/Zoning-Map-Zoning-Districts/3i4a-hu95	Land zone

Data Element	Description	Source	Reporting Unit
		San Jose: https://gisdata-csj.opendata.arcgis.com/datasets/CSJ::zoning-districts/about Santa Ana: https://gis-santa-ana.opendata.arcgis.com/datasets/Santa-Ana::zoning-classifications/explore?location=33.737642%2C-117.887350%2C13.14 Riverside: https://geodata-cityofriverside.opendata.arcgis.com/datasets/edd9eb97a1dd446cb30336d91bc40e8a_2/explore?location=33.945918%2C-117.401342%2C12.00 Stockton: http://www.stocktongov.com/services/gis/mapdatdat.html Chula Vista: https://chulavista-cvgis.opendata.arcgis.com/datasets/a0591cdb609548a182f35bd70a431a20/explore?location=32.631384%2C-117.021350%2C12.73 Fremont: https://fremont-ca-open-data-cofgis.hub.arcgis.com/datasets/25db2e74c6254091a6f340cf01f8f092_0/explore?location=37.529560%2C-122.012239%2C12.00 Fontana: https://data-fontanaca.opendata.arcgis.com/datasets/FontanaCA::zoning-2/explore?location=34.104611%2C-117.459495%2C11.66&showTable=true Oxnard: https://data-oxnard.opendata.arcgis.com/datasets/Oxnard::zoning/explore?location=34.173578%2C-119.184614%2C13.63 Rancho Cucamonga: https://rcdata-regis.opendata.arcgis.com/datasets/zoning/explore?location=34.106902%2C-117.563238%2C15.16&showTable=true Elk Grove: https://gisdata.elkgrovecity.org/datasets/elkmap::city-of-elk-grove-zoning/explore?location=38.407478%2C-121.378550%2C12.52 Garden Grove: https://ggcity.org/maps/data-portal/#/osm/planning/zoning	
California utility investments in EV charging stations	EV station attributes and location	California Utilities	Fuel station

The team then reviewed all data for completeness and accuracy and documented any significant gaps or other issues that would affect the analysis results.

Our analysis sample includes all California CBGs except those meeting one or more exclusion criteria:

- The CBGs was in a rural area;[165]
- The CBG did not have any households;
- The CBG was new since the 2010 census; or
- The CBG has outlier EV registration numbers (those greater than the 99th percentile in EY2020).

After applying these sample exclusion criteria, there were 131,105 CBG-year observations remaining in the analysis sample.

Modeling of EV Ownership

The goal of the stage one analysis was to estimate the impact of public EV charging access on EV ownership. During this stage, we first constructed a composite measure of CBG access to public charging as a function of the number of neighboring public EV charging stations, the geographic distance from homes to the stations, and the number of chargers (ports) at each station. Next, we performed the EV adoption analysis using annual panel data on California EV registrations at the finest spatial resolution possible (the CBG level) from 2015 through 2020. We then estimated the impacts of public charging on EV ownership using two approaches. We first conducted an OLS estimation of a panel annual regression or long differences regression of normalized EV registrations (annual registrations per 1,000 households), which assumes that the siting of public charging infrastructure was exogenous to EV registrations. The panel model included year fixed effects, CBG fixed effects, and county time trends. The CBG fixed-effects and county-time trends are intended to control for, respectively, time-invariant CBG and time-varying county characteristics that could be correlated with the location decisions of public charging and subsequent EV adoption. The long differences model of the change in annual EV registrations between 2015 and 2020 includes controls for income, building type, and annual EV registrations in 2015.

However, the estimates from this OLS analysis may be biased if public EV charging location decisions were based on unobservable trends in EV registrations, such as locating public charging infrastructure in areas with higher EV demand (we refer to this as the endogeneity of the charging location decisions). Therefore, in the second approach, the Evaluation Team estimated the public EV charging impacts by using an instrumental variables, two-stage least squares regression (IV-2SLS). The IV-2SLS models use the percentage of the neighboring land area zoned for public EV charging facilities (that is, land zoned for commercial use, parking, or public use, such as schools, government lands, and parks) as the

---

[165] We adopted the U.S. Census Bureau's urban-rural classification, which is based on 2010 Census population and housing unit: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html. Previous literature has found that the inclusion of rural areas could lead to overestimating the effect of chargers on these non-urban residents, and that limiting the study to an urban population could reduce variation in population density. See Hsu, Chih-Wei, and Kevin Fingerman. 2021. "Public Electric Vehicle Charger Access Disparities across Race and Income in California." *Transport Policy* (100): 59–67.

instrumental variable while controlling for the income and percentage of multifamily housing units in CBGs.[166]

In stage two, the team estimated the impact of California utility investments in public charging on EV adoption in the study period.[167] To estimate the impact of the Utility public charging stations on EV adoption, we followed three steps:

- **Step 1**: Using the public charging access framework above, we estimated the effect of the Utility charging stations on access for California households. We calculated the change in access for each CBG.[168]
- **Step 2:** We used the regression model estimates to determine, for each affected CBG, the change in EV ownership from the change in public charging access for households.
- **Step 3:** We summed the changes in ownership across CBGs to determine the total impact on EVs and to estimate the standard error.

A notable benefit of this two-stage approach to assessing EV and EVSE market acceleration is that it can be applied to evaluations of other programs that also increase EV charging access, ensuring methodological consistency.

Grid Impacts

The team calculated the associated grid impacts for the Public Charging programs based on the consumed energy from charging stations installed through the programs and charging session data from the EVSPs. As part of this analysis, the team examined impacts at the program and bundle levels. This section describes the approach, data sources, and analyses we performed to estimate Public Charging grid impacts.

---

[166] A valid instrumental variable will be strongly correlated with the location of public charging but uncorrelated with EV adoption conditional on other exogenous explanatory variables. Our approach uses the availability of nearby land zoned for public charging as a source of exogenous variation in the availability of public charging among CBGs with similar income levels and housing types. Specifically, the analysis uses the percentage of CBG land area zoned for commercial use, public use (such as schools or government buildings), or parks and beaches. As public charging infrastructure may only be located on suitably zoned land and land zoning remains mostly unchanged over time, proximity to space zoned for commercial, public uses, or parking should be correlated with the change in access to public charging between 2015 and 2020 but uncorrelated with EV adoption over this period.

[167] The team developed the current methodology to study the impact of public EV charging on existing EV adoption. To forecast the impact in a future period, a separate approach and additional data on the utility investments in public charging are required.

[168] A full accounting of the impact of utility investments would require considering whether EV charging station developers would build more (or fewer) charging stations if the Utilities had not built charging stations. Incorporating this supply response would diminish (or increase) the effect of the Utility charging network on EV adoption.

The team collected, cleaned, and analyzed Utility AMI data, provided at 15-minute increments, to calculate total kilowatt-hour usage, on-peak and off-peak usage, and maximum demand, which we then used to calculate load factors. The team took a three-step approach to the analysis:

- **Step 1:** Accounted for total consumption (kilowatt-hours), the proportion of consumption during the on-peak time period, and new load on the grid (kilowatts).
- **Step 2:** Targeted issues such as stability versus growth of charging load, charging load by time of day, and charging session flexibility.
- **Step 3:** Projected the extent to which transportation energy use can be integrated with the grid at a least cost to retail consumers and ratepayers.

These data are reported by site, in aggregate, and on a daily and monthly basis.[169]

The team used the essential primary and secondary data summarized in Table 130 for the Public Charging grid impacts analysis.

Table 130. Public Charging Grid Impacts Data Inputs

Category	Source
Primary Data	Utility AMI data, historical CAISO data (demand, supply sources, renewable curtailments), charging session data from EVSP networks
Secondary Data	Time varying Utility rates in effect at sites, EVSE (interval and charging session) data, site management details (charger capacities), site visits

We uploaded AMI and EVSP data to the data warehouse and calculated results using the internal Power BI dashboard. Foundational program analysis included total electricity consumption (kilowatt-hours) and new demand (kilowatts) added to the grid. The team established trends based on the proportion of electricity usage during the highest cost period (defined as 4 p.m. to 9 p.m. daily) versus non-highest cost periods. We calculated load factors based on usage and utilization rates, which we based on the installed capacity for each site.

The team then assessed daily and weekly charging behaviors and captured patterns that account for load growth. We also examined CAISO data on fuel mix at different times of the day to estimate the extent to which EV loads contribute to system demand.

The 24-hour load curves provided key insights into how the grid is impacted by the program. Charging in which EVs consume power during off-peak periods such as when solar output is high (mid-day) and/or demand is low (night) will become increasingly important as more EV loads are added to the grid and have a different role in each public charging program. Charging flexibility in response to price signals offers a potentially valuable tool to safeguard the grid with new EV loads coming online and to support the growth of renewable energy to provide this power.

169 The actual reported results for each Utility are reflected in a way that preserves and masks personally identifiable information.

While the grid impact analysis was applied to the actual AMI data for the activated sites in EY2022, the team annualized AMI data to support analyses with forecasts including the petroleum displacement and GHG and criteria pollutant emissions reductions. Through the annualization of AMI data the team identified the region of stable operation, then leveraged this data to generate a statistically representative full year of operation.

The emissions calculations require the date and time of AMI data to be matched with the electric generation mix at the time of use. This approach necessitates normalizing emissions calculations across the whole year due to daily, monthly, and seasonal variations in electric generation mix. Therefore, we did not annualize data from sites with two months of data or less (as we were unable to determine seasonable variability). For sites with more than two but less than four months of data, we visually inspected the datasets and used expert judgement to evaluate whether the operation was consistent enough to be annualized.

Of the activated Public Charging sites in EY2022, the team annualized AMI data through a four-step process:

- **Step 1: Find the maximum monthly site usage.** The team identified the month with the maximum total usage in kilowatt-hours for the site by examining the EY2022 AMI data.
- **Step 2: Identify the start month.** The starting month for the actual data used in developing the annualized data was the one where total usage exceeded 75% of the maximum month's usage.
- **Step 3: Create a representative weekly load curve.** Using the AMI data from the start month to the end of the year, we created an average daily load curve for each day of the week and for each 15-minute interval throughout the day.
- **Step 4: Extrapolate weekly load curve.** Using the representative weekly load curve, we extrapolated AMI data that is outside the operational period. We then matched weekday load curves for each day of the week (such as matching Monday to Monday).

Counterfactual Development

The team conducted secondary research to inform the development of the electric LDV and conventional counterfactual for the public charging sites:

- **The electric LDV counterfactual** establishes an average EV efficiency (kilowatt-hours per mile) to convert energy dispensed at charging stations to resulting EV miles.
- **The conventional LDV counterfactual** is the average fuel economy (miles per gallon) for a representative ICE LDV on the road that the electric LDV counterfactual replaces to convert displaced counterfactual vehicle miles to gallons of petroleum displaced.

These counterfactuals are foundational to the public charging evaluation, impacting the EV adoption analysis as well as petroleum displacement, GHG and criteria pollutant emissions reductions, and grid impacts. The subsections below describe the approach, data sources, and analyses performed to develop the counterfactuals for Public Charging.

The team calculated the electric LDV counterfactual for EY2022 as average EV efficiency (kilowatt-hours per mile) using a weighted averaged for the most popular new EVs in each Utility territory. Next, the team calculated the conventional LDV counterfactual for EY2022 as the average fuel economy (miles per gallon) for a representative LDV on the road that the electric LDV counterfactual replaces based on the comparable mix to the EVs available (currently this mix is sedans along with small and mid-size SUVs [some Rivian and Ford light-duty trucks have reached the market but these currently represent less than 2% of the total EVs on the road], but that mix is expected to change over time). We determined that the counterfactual is a composite of all equivalent new vehicles that could have been purchased instead of an EV over the past five years.

The team used the secondary data summarized Table 131 to develop the electric and conventional LDV counterfactuals.

Table 131. Counterfactual Data Inputs by Category

Category	Data Inputs
Electric LDV Counterfactual	New EV sales by county: https://www.energy.ca.gov/files/zev-and-infrastructure-stats-data
	EV efficiency: www.fueleconomy.gov
Conventional LDV Counterfactual	Battery EV and plug-in hybrid EV registrations by county: https://www.energy.ca.gov/files/zev-and-infrastructure-stats-data
	Popular counterfactual vehicles sold and percentage of their sales: https://www.cncda.org/news/?category=auto-outlook
	Fuel economy: www.fueleconomy.gov

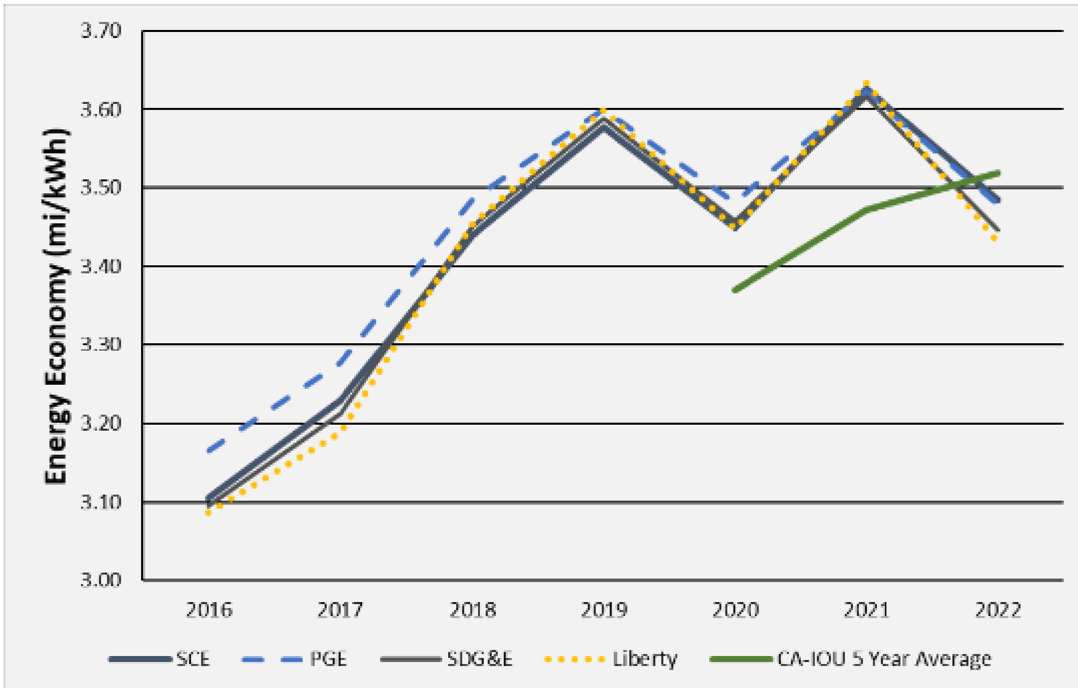
The counterfactual results from 2016 through 2022 are shown in Table 132.

Table 132. Electrical Vehicle Efficiency by Year and Utility

Year	Liberty	PG&E	SCE	SDG&E	CA Utility Average (kWh/mile)	Largest Difference	CA Utility 5-Year Average (kWh/mile)	5-Year Efficiency (kWh/mile) Average
2016	3.09	3.17	3.10	3.09	3.11	2.6%	-	-
2017	3.19	3.28	3.23	3.21	3.23	2.8%	-	-
2018	3.45	3.48	3.44	3.45	3.46	1.3%	-	-
2019	3.60	3.60	3.58	3.59	3.59	0.7%	-	-
2020	3.45	3.48	3.45	3.46	3.46	0.9%	3.37	**0.297**
2021	3.63	3.62	3.62	3.61	3.62	0.5%	3.47	**0.288**
2022	3.43	3.48	3.48	3.45	3.46	1.6%	3.52	**0.284**

The team used the single most recent five-year average (accounting for the most likely mix of EVs using these stations) for all participating Utilities because the difference between Utilities (due to the different EV make up) is not significant, as shown in Figure 210.

Figure 210. EV Efficiency Per Utility Per Year



The team then identified the comparable vehicle type mix, shown in Figure 211, which resulted in California-wide counterfactual weighted averages for 2017 through 2022, as well as the prior five-year average (as shown in Figure 211 and Table 133).

Figure 211. EV Market Share Penetration Rates to Reach 100% BEV Sales by 2035

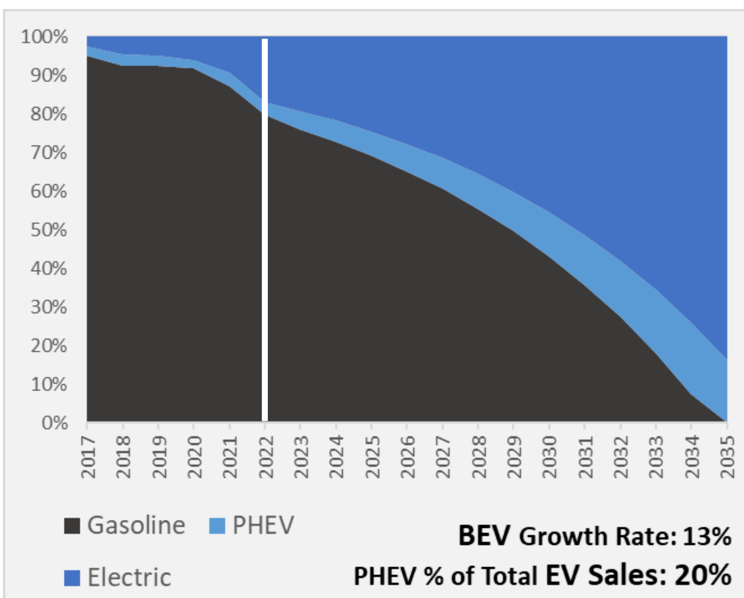


Table 133. Counterfactual Vehicle Fuel Economy by Year

Year	Gasoline	PHEV	Electric	Weighted Average	Last 5-Year Average
2017	27.00	71.83	109.38	30.21	-
2018	27.06	72.98	111.82	32.33	-
2019	26.90	72.69	117.07	32.64	-
2020	27.46	70.65	115.95	33.76	-
2021	28.13	63.06	121.75	38.18	**33.43**
2022	28.36	58.14	120.10	44.94	**36.37**

Petroleum Displacement

One goal of the Public Charging programs was to reduce the amount of petroleum fuels used by conventional vehicles as they are replaced by EVs. As part of this analysis, the team examined these reductions at the program and bundle levels. This section describes the approach, data sources, and analyses we performed to estimate the Public Charging–related petroleum fuel reductions.

The team determined the reduction in gasoline equivalent gallons of petroleum compared to electric usage as a result of the Public Charging programs. To complete this analysis, we calculated annual energy consumption, EV annual miles traveled, and annual counterfactual vehicle fuel consumption, as described in the *Counterfactual Development* section above. In addition, the team examined the petroleum fuel reduction for Public Charging programs overall, by Utility, and for impact on DACs. We explain our analysis in more depth in the *Health Impacts* section below.

The team developed a petroleum displacement tool to estimate EV miles traveled by converting electrical energy use from the EV Public Charging programs in kilowatt-hours from Utility AMI data to petroleum displaced by the use of electricity. We assumed that the same number of miles for conventional vehicles would have been driven in absence of the program (the counterfactual). We then calculated the petroleum displacement in terms of gasoline gallons equivalent using the petroleum displacement equation:

Equation 2. Petroleum Displacement Calculation

For all vehicles at *Site y* that are *Electric Vehicle Type x* and have *Counterfactual Vehicle Category z*, the displaced gallons of gasoline-equivalent or diesel-equivalent fuel are calculated as:

$$Gallons\_Displaced_{x,y} = \frac{Annual\ kWh_{x,y} * (1 - Charger\_Losses) * Counterfactual\_Efficency_z}{EV\_Efficiency_{x,y}}$$

The team used the primary and secondary data summarized in Table 134 for the Public Charging petroleum analysis.

Table 134. Public Charging Petroleum Displacement Data Inputs

Category	Source
Primary (critical) Data	Utility AMI data, EMFAC database, and counterfactual tables to assign linkages between sites and EMFAC Vehicle Classification Codes
Secondary Data	EVSE (interval and charging session) data

The team conducted a range of categorical analyses (shown in Table 135) using tools that include Azure Studio (SQL statements for the resulting calculations), the counterfactual lookup table (populated by the EMFAC and other sources), and outputs from analysis described above. As noted above, Utility AMI data were the basis for much of this analysis.

Table 135. Analysis of Petroleum Displacement

Category	Analysis
Reference Counterfactuals and Secondary Data	For each vehicle type, referenced gallons per mile and kilowatt-hours per mile efficiency from: - Vehicle counterfactuals - Five-year weighted average based on California Department of Motor Vehicles vehicle registrations from CEC [a] and individual vehicle fuel economies for both EV and conventional vehicles from the U.S. EPA [b]
Determine EV Energy Consumption	Referenced annual kilowatt-hours consumed by EVSE at each site (as described in the *Grid Impacts* analysis)
Account for Charging Losses	Compared AMI data to EVSP session data
Calculate Vehicle Miles	Determined miles based on kilowatt-hours consumed using reference counterfactual
Estimate Petroleum Displacement	Estimated petroleum displacement based on conventional miles and fuel consumption factor of conventional vehicles

[a] California Energy Commission. 2023. "Light-Duty Vehicle Population in California." https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics/light-duty-vehicle

[b] U.S. Department of Energy. 2023. "Fuel Economy." https://www.fueleconomy.gov/

Greenhouse Gas and Criteria Pollutant Impact

This section describes the methods and sources for calculating GHG emission reduction and criteria pollutant emission reductions. The Public Charging programs are expected to reduce the amount of GHG and criteria pollutants emitted into the environment as EVs replace conventional ICE vehicles.

The team calculated reduced emissions from displaced fossil fuel use from ICE vehicles that were not in service because of the Public Charging programs. We first developed an ICE counterfactual, then calculated the emissions associated with these vehicles under conditions that otherwise matched the EVs to create a baseline.

The criteria pollutants emission reduction calculations account for NO_x, $PM_{2.5}$ and PM_{10}, carbon monoxide (CO), and SO_x. This team additionally estimated emission reductions of ROGs, which are not criteria pollutants.

Since the electric grid emissions profile varies substantially by time of day and season, the Evaluation Team estimated reductions using actual 8760-hour load curves based on Utility meter data. Next, we calculated the annual avoided emissions implied by the gallons of fossil fuels that were displaced.

The total program and pilot emissions impact presented for key pollutants in Table 136 are net of annual emissions from the displaced counterfactual fossil fuel equipment and the electricity consumed annually by the adopted electric equipment. Local emissions reductions are presented for the remaining pollutants. We developed GHG and criteria pollutants reduction for the overall program, as well as for each Utility and for the DACs individually.

Table 136. GHG and Criteria Pollutant Data Inputs

Description	Unit	Source
Site-Level AMI Electric Data in 15-Minute Intervals	kWh	Utility AMI (~1 month delay between measurement and reporting)
Overall Electricity Demand by 5-Minute Interval	MWh	CAISO Demand (Real time)
CO_2 Grid Emission by 5-Minute Interval	Metric tons	CAISO Emissions (Real time)
Resource Mix by Interval	% by generator fuel	CAISO Supply (Real time)
California Utility Integrated Resource Planning Clean Power System Tool	% by generator fuel	CPUC Developed Clean Power System Tool (25 MMT GHG, July 2022)
Electricity Emission Factors by Resource (details below)	Lb/MWh [a]	EPA eGRID (2021)
• NO_x Emissions Rate	grams/kWh	
• SO_2 Emissions Rate	grams/kWh	
• CO_2 Emissions Rate	kg/kWh	
• CH_4 Emissions Rate	grams/kWh	
• N_2O Emissions Rate	grams/kWh	
• CO_2 Equivalent Emissions Rate	kg/kWh	
Vehicle Emissions (ROG, CO, NO_x, CO_2, PM_{10}, $PM_{2.5}$, SO_X) by Vehicle and Fuel	g/mi	CARB EMFAC (2021)
Vehicle Type (Vehicle Classification Codes or linkage to emission tables)	Standard category	Petroleum reduction methodology
Petroleum Use by Month	Unit measure	Petroleum reduction methodology
Petroleum Fuel Type	name	Petroleum reduction methodology

[a] Units provided by eGRID are in pounds per megawatt-hour and converted to grams per kilowatt-hour (and kilograms per kilowatt-hour for CO_2) for the purposes of this work.

These are multi-year programs, and several input sources are updated periodically. The team uses newly published resources as they become available.

The team completed the analysis in four steps, using the CAISO application programming interface, the CPUC IRP RESOLVE model, EPA's eGRID, and EMFAC:

1. **Electricity emissions:** We used CAISO five-minute demand and resource mix data reported by zone to establish an emission record for each pollutant. We averaged five-minute interval emissions data and applied this to each 15-minute AMI interval, then applied the CAISO-specific emissions factors for that resource provided by the U.S. EPA's eGRID dataset.
2. **Counterfactual emissions.** The team determined baseline emissions for counterfactual vehicles using EMFAC for specific displaced fuel use. We determined this value based on the application, using a standard source for lower heating value energy content available within that fuel on a per unit energy (Btu) basis. This is most often measured in Btus per gallon to derive the grams per gallon, and ultimately the tons per year. The factor provided by EMFAC encompasses the estimated number of cold starts and idling operation.
3. **GHG calculation.** We used the United Nations IPCC GWPs for CO2 equivalence (CO2e) on a 100-year timeframe based on the IPCC AR5. For EY2022, we used GWP-100 factors of 28 for

methane (CH4) and 265 for N2O. The following equation presents the GHG calculation based on CO2e:

Equation 3. GHG Calculation

$$CO_2e = CO_2 + 28 * CH_4 + 265 * N_2O$$

4. **GHG and criteria emissions reductions.** The overall reduction in GHGs, NO_x, and SO_x was net of annual emissions from the displaced counterfactual fossil fuel equipment and the electricity consumed by the adopted electric equipment. The overall reduction in $PM_{2.5}$, PM_{10}, CO, and ROG was represented by the annual emissions from the counterfactual vehicle, as these pollutants present localized effects on populations rather than the more globalized effects of the other pollutants. The team calculated these emission reductions for sites both in and outside DACs.

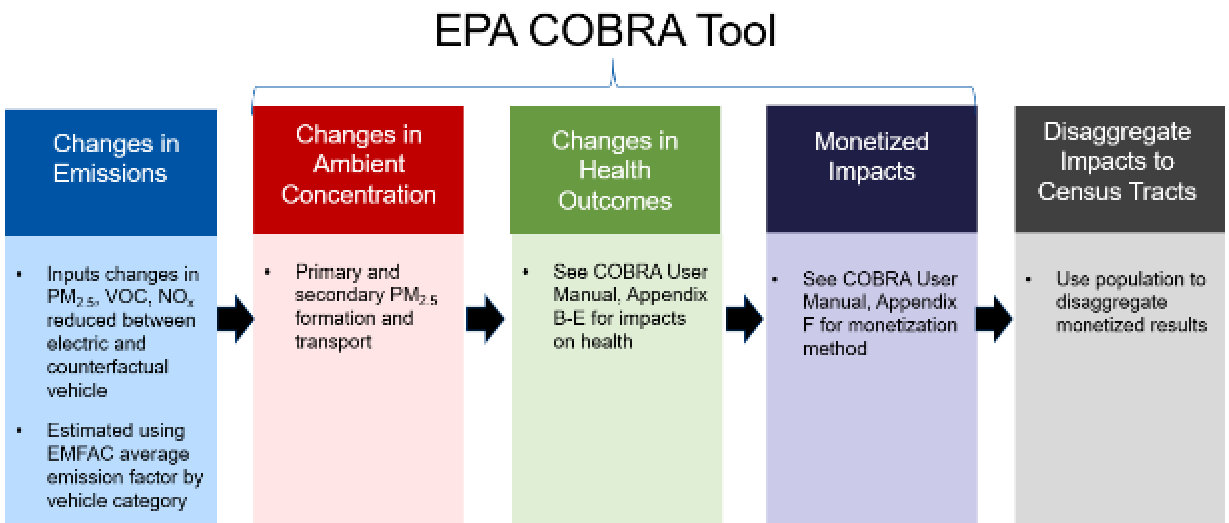
Health Impacts

As EVs replace traditional ICE vehicles, petroleum-based fuels are displaced. These displacements reduce GHG and air pollutant emissions, which may lead to health benefits in regions where EVs are being adopted. To understand the effects of the public charging programs on air pollution and related health benefits, the team estimated the monetized value of health benefits for each individual Utility-funded site by running the emission reductions through the U.S. EPA's COBRA. As part of this analysis, we also examined the impact on DACs. For Liberty, PG&E, and SCE, DACs are identified in the California Communities Environmental Health Screening Tool, CalEnviroScreen, developed by California's Office of Environmental Health Hazard Assessment. SDG&E uses a service territory definition of DAC.[170] This section describes the approach, data sources, and analyses performed to estimate health impacts associated with the public charging programs.

The Evaluation Team used a five-stage methodology to estimate health impacts, shown in Figure 212 and described below the figure.

[170] As per Advice Letter 2876-E, SDG&E found that only 27 census tracts in its territory were considered DACs using the top quartile in the CalEnviroScreen statewide definition. However, the service territory definition is broader and produced a calculated 180 DAC census tracts in SDG&E service territory.

Figure 212. Five-Step Process for Estimating Health Impacts by Census Tract



Step 1: Changes in Emissions. These estimates are annualized emission reductions by project site for EY2022 in tons for $PM_{2.5}$, VOCs, and NO_x. The Evaluation Team aggregated emission reductions by county and used those as inputs into the U.S. EPA COBRA tool, which uses several fields:

- **Sector** – Highway vehicles or off-highway sector
- **Subsector #1** – Diesel for most vehicle applications
- **Subsector #2** – Subsector of highway or non-road
- **Discount rate** – 3% assumed, which reflects the interest rate consumers might earn on government-backed securities

Steps 2 through 4 are run using the COBRA desktop tool. The Evaluation Team uploaded the annual reductions in emissions for $PM_{2.5}$, VOCs, and NO_x and the tool outputs estimates as shown in Table 137. In this analysis VOCs are assumed to be the same as ROGs, which are the output from EMFAC.

Table 137. Mapping of Vehicle Types to Sector, Subsector #1, Subsector #2

Vehicle Type	Sector	Subsector #1 (Counterfactual Fuel Type)	Subsector #2 (Counterfactual Fuel Type)	Discount Rate
LDVs (at public charging sites)	Highway vehicle	Gasoline fuel	Light-duty	3%

Step 2: Changes in Ambient Concentration. The U.S. EPA COBRA tool has a feature that uses the reductions in emissions to estimate the change in ambient concentration. The tool also accounts for transport and the transformation of pollutants (for example, into ozone).

Step 3: Changes in Health Outcomes. The U.S. EPA COBRA tool uses epidemiological models to estimate the health impacts of these emission changes at the county level. COBRA's estimates reflect the current scientific thinking on the relationship between particulate matter and human health, as well as the economic valuation of these health effects. In particular, the U.S. EPA draws from the PM Integrated

Science Assessment.[171] Additionally, the U.S. EPA's methodology for characterizing health impacts has been reviewed by two National Academy of Sciences panels and multiple U.S. EPA Science Advisory Boards. Because the health impacts of air pollution and approaches to value these impacts are areas of active research, the selection of studies used in COBRA may evolve over time, as new evidence and studies emerge. More information is available in the online COBRA documentation.[172] Note that COBRA estimates health impacts for all 3,033 counties in the United States (because of the transport of the pollutants).

Step 4: Monetized Impacts. The U.S. EPA COBRA tool estimates the economic value (in 2017 USD) of the change in health impacts from the emission changes at the county level. These values are converted to 2023 USD using the multiplier of 1.23 (that is, $1.00 in 2017 is the same as $1.23 in 2023).[173] Economic value is estimated differently depending on the health impacts (such as by estimating avoided lost wages, avoided medical costs, the amount people are willing to pay to avoid a negative health impact [such as a respiratory symptoms], or the value of statistical lives [VSL] approach, which uses value-of-life studies to determine a monetary value of preventing premature mortality). COBRA reports both a low impact and a high impact, representing uncertainties in the estimates. The low estimate represents results based on an evaluation of mortality impacts of $PM_{2.5}$ by the American Cancer Society.[174] The high estimate represents results based on the Harvard Six Cities mortality study.[175] Rather than average the results of these studies, the U.S. EPA's standard practice has been to report the estimated change in mortality separately as low and high values.

Step 5: Disaggregate Impacts to Census Tract. The Evaluation Team disaggregated the county-level monetized health impacts by census tract using the relative population from the most recent American Community Survey (where we allocated 10% of the monetized health impacts to a census tract with 10% of the county's population). From there, the team estimated DAC versus non-DAC impacts.

---

171 U.S. Environmental Protection Agency. Last updated June 27, 2022. "Integrated Science Assessment (ISA) for Particulate Matter." https://www.epa.gov/isa/integrated-science-assessment-isa-particulate-matter

172 U.S. Environmental Protection Agency. Last updated November 1, 2022. "CO-Benefits Risk Assessment Health Impacts Screening and Mapping Tool COBRA." https://www.epa.gov/cobra/users-manual-co-benefits-risk-assessment-cobra-screening-model

173 U.S. Bureau of Labor Statistics. 2023. "CPI Inflation Calculator." https://www.bls.gov/data/inflation_calculator.htm

174 Krewski, Daniel et al. May 2009. "Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality." *Res Rep Health Effects Institute* (140): 5–114. https://pubmed.ncbi.nlm.nih.gov/19627030/

175 Lepeule, Johanna, Francine Laden, Douglas Dockery, and Joel Schwartz. March 28, 2012. "Chronic Exposure to Fine Particles and Mortality: An Extended Follow-Up of the Harvard Six Cities Study from 1974 to 2009." *Environmental Health Perspective* 120(7): 965–970. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3404667/

Total Cost of Ownership

For the public charging TCO analysis, the team evaluated the total costs and revenues that are associated with owning and maintaining EVSE over a 10-year period. We calculated average total lifetime ownership costs and revenues *per port* across all public charging sites by pilot or program and, where possible, by charger type. Unlike its MDHD bundle counterpart, for this analysis we excluded vehicles and any counterfactual scenario.

The Evaluation Team first determined upfront costs of the EV charging infrastructure by estimating the initial (first-year) infrastructure costs ($) for the entire project, including TTM, BTM, and EVSE costs using available site-level cost data. This included upfront grants, Utility infrastructure cost coverage, and incentives. We sourced the Utility incentive values from either Utility program materials or program cost data. The team estimated lifetime LCFS credits based on the 2022 average LCFC credit price, the LCFS formula, and assumed decreases in grid electricity carbon intensity.

As utilization affects costs and revenues, estimating utilization prefaces the determination of annual variable costs, revenues, and credits. The Evaluation Team modeled a constant annual rate of growth in kilowatt-hour throughput, up to a maximum increase over the Year 1 kilowatt-hour throughput.

The Evaluation Team estimated annual gross revenue per port based on the researched rates (dollars per kilowatt-hour) charged by public charging stations to drivers. These may vary by network and by year. This established an annual gross revenue (dollar per year) on a per-port basis.

The Evaluation Team estimated annual operating costs for site hosts including EVSE maintenance cost and EVSE networking cost (based on external secondary data) as well as EVSE energy costs based on AMI and EVSP data.

By combining the upfront costs and incentives, gross revenue, operating costs, and discount rates, the Evaluation Team forecasted in NPV the annual cost and revenue associated with operating and maintaining EVSE over 10-year period.

Site Visits

The team conducted visual site visits for the Public Charging programs during EY2022 to provide qualitative insights on activated EV infrastructure sites. This section describes the approach, data sources, and analyses performed for the EY2022 Public Charging site visits.

The team took a census approach in EY2022, visiting all active sites. The team collaborated with the Utilities and site hosts, as appropriate, to access each site location and complete the EY2022 site visits.

For the analysis, the team used detailed notes and photos taken during each site visit as well as data provided by the Utilities. After each site visit, the team compiled the notes, photos, and completed data into the Arkenstone data collection platform.

The team then analyzed the data to document qualitative insights such as critical design elements including number of dedicated parking spots and other parking spots within reach of charging ports, charger signages, distance from surrounding buildings to charging, whether the design optimizes the number of vehicles that can charge at one time, competition for parking (such as at convenience stores), and any upgrades made by the Utilities to comply with ADA rules that require additional space for parking and charging. The team also compared retailed rates for charging by station patrons and determined if TOU charges were in place. Finally, the team quantitatively compared counts of chargers/ports and installed electrical capacity to the Utility-provided information.

Interviews

The team conducted Utility staff interviews to provide insight into program design and implementation and context to analysis outputs and findings. For the Public Charging programs, the team interviewed each Utility program manager to cover a variety of topics about their respective programs. Then we integrated those findings throughout the report, informing many sections including program overviews, materials reviews, and Utility interview analysis findings. This section describes the approach, data sources, and analyses performed for the EY2022 Utility interviews.

The team developed interview guides outlining key topic areas and questions for discussion to ensure that we covered each topic area during the phone interview:

- Status updates and changes from EY2021 (and before)
- Program design
- Key milestones
- Key barriers to implementation and solutions
- Preliminary areas of success and lessons learned

The team relied on program materials as the foundation for developing the initial interview guide. By the time we conducted close-out interviews in March 2023, the team was also able to review additional program materials received from Utilities up through that point, such as interim status updates.

The team reviewed verbatim notes taken during each interview as the basis of our analysis.

Vehicle-to-Grid (SDG&E) Evaluation Methodology

This section outlines the data collection and analysis for the V2G Pilot evaluation.

Data Collection Methodology

The following sections discuss data collection for the V2G Pilot evaluation, including Pilot data and materials and in-depth interviews.

Pilot Data and Materials

Pilot data provides essential insights into Pilot performance. The Evaluation Team reviewed all SDG&E Advice Letters and PAC presentations since 2020 and attended project team meetings during spring and summer 2022 on an as-needed basis.

Interviews

In-depth interviews provided critical insight on the original intent, actual implementation, and success of the Pilot, as well as the potential to scale up. For EY2022, the team conducted phone interviews with Utility staff, key vendors overseeing the Pilot, and vehicle battery experts, for a total of five interviews. We developed interview guides outlining key topic areas and questions for discussion to ensure that we covered each topic area during the phone interview. Topics included staff roles and responsibilities, Pilot design and implementation, and areas of challenges and successes. The Evaluation Team's evaluation lead conducted the interviews and recorded notes to reference during our analysis.

Analytical Methodology

The following section provides an overview of the EY2022 analysis for the V2G Pilot.

Interviews

The team conducted phone interviews with Utility staff, key vendors (Nuvve and Lion Electric), and vehicle battery experts to provide insight into Pilot implementation and context to analysis outputs and findings. Then the team integrated these findings in the report, informing the Pilot overview and status, interview analyses findings, and lessons learned. This section describes the approach, data sources, and analyses performed for the EY2022 interviews.

The team developed interview guides outlining key topic areas and questions for discussion to ensure that we covered each topic area during the phone interviews:

- Staff roles and responsibilities
- Pilot status
- Technology challenges
- Key barriers to implementation and solutions
- EY2022 areas of success and lessons learned
- Vehicle battery degradation impacts from V2G operation

The team relied on Pilot materials and V2G site team meeting notes as the foundation for developing the interview guides. The team reviewed notes taken during each interview, then summarized findings and developed insights and lessons learned from the individual interviews.

Appendix B. Deep Dives

To maintain customer confidentiality, deep dives are anonymized. Appendix B includes the following Deep Dives:

School Bus District: Central Valley, CA

Deep Dive Site

Focus: Reliability and Management

Site Type: School bus service
Electric Vehicles: Type C and D buses
Charging Stations: 70-amp, 16.9 kW L2 stations
Non-EV Vehicles: Type A and D (rear-engine) school buses

Project Completion Date: Summer 2021
Site Visit Date: March 2022
Utility: Southern California Edison
ICE Fuels: Diesel, CNG, gasoline

Blue Bird RE electric buses (green birds, digital route signage) parked at the site

Charging installation at the site depot showing several buses, L2 charging stations (in white), and switchgear (in grey)

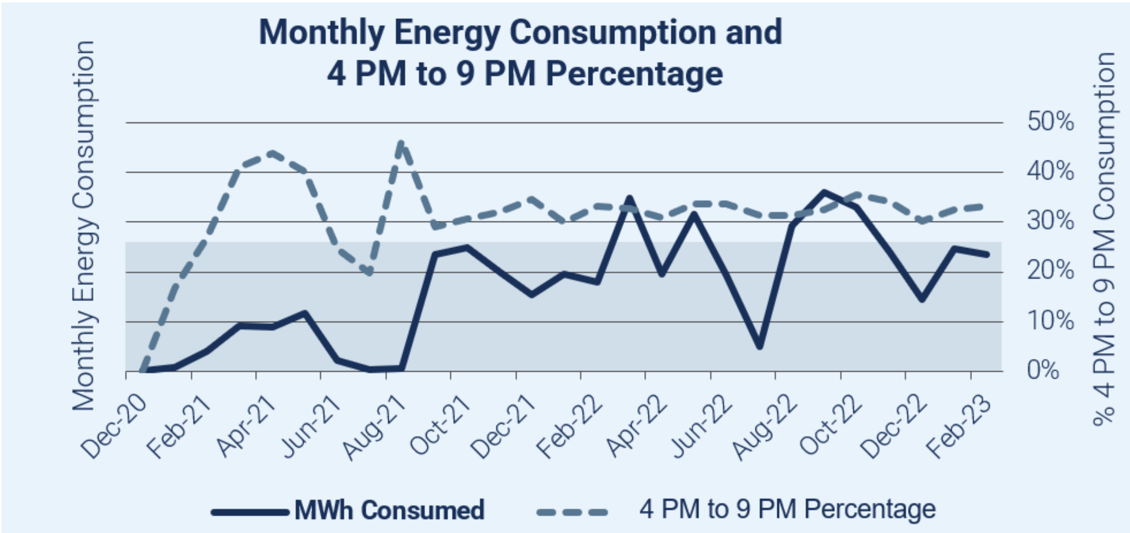
Vehicle Deployment and Operational Data

The site operates nearly a dozen Type C Blue Bird battery-electric school buses, which are equipped with approximately 125 kWh batteries. The Type C buses are a combination of Vision electric and All-American rear-engine (RE) models from Blue Bird, rated for an 80-mile range. Currently, the Type C buses operate on two daily shifts of approximately 50 miles to 70 miles each.

Operator satisfaction with the buses is moderate, with bus reliability and range emerging as key issues for the vehicles' ability to successfully fulfill required duty cycles. Drivers were trained on the bus operation and charging process by district staff, including on how to troubleshoot charging and operational issues.

Charger Usage Patterns

More than two dozen L2 chargers were installed and operational at the bus depot at the time of the site visit. Energy consumption data indicates that the chargers began operation in early 2021.



As expected, energy draw fluctuates over the course of a calendar year, with significant declines in energy consumption during holidays and summer breaks when buses are not in use. The site appeared more consistent in operations starting in September 2021, with increased consumption in 2022.

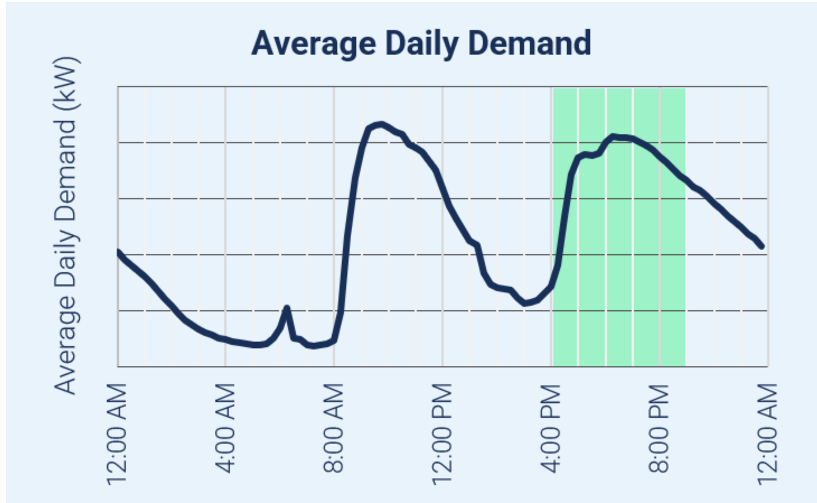
The site operator is incurring significant peak rate energy costs. On average, over 30% of monthly energy use occurs during the peak rate period, as shown in the figure above. Generally, sites should aim for 25% or less of their energy to be consumed during peak rate periods. The site achieved this only when first ramping up EV operations. The site operator believes that load management functionality is included in their EVSP subscription and plans to engage the EVSP to determine how to ensure that their energy consumption is optimized, even as rates and fleet compositions change over time.

The chargers at this site have had some ongoing reliability issues, including overheating and failure of internal electronics during the hot summer months. Early in the deployment, chargers frequently had difficulty initiating charging, with problems occurring roughly onceevery two weeks. Charger-bus authentication (interoperability) is suspected to have been the culprit, and the chargers have been placed in free-vend mode to avoid needing to go through the authentication process. After an additional software update, the initial issues have been reduced in frequency.

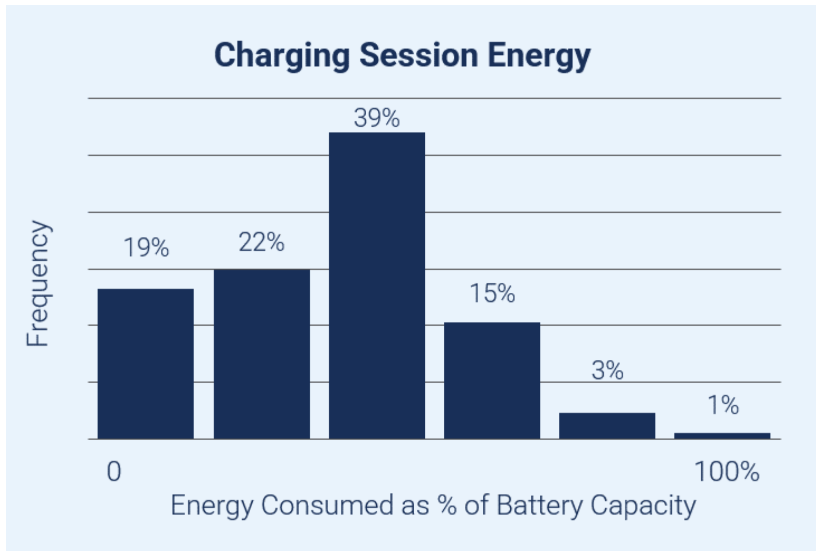
Due to reliability issues with both the chargers and the vehicles, the site does not have imminent plans for electric bus fleet expansion, though the site is planning to expand its white vehicle fleet (administrative vehicles) with potential additional EVs in the near term that would be using the chargers.

The site is subscribed to SCE's time-dependent TOU-EV-8 rate. Under the TOU-EV-8 rate, the winter (October through May) 9 AM to 4 PM time period is designated as super off-peak and offers the cheapest electricity rates. During the summer months (June through September), all hours outside of 4 PM to 9 PM are considered off peak. As Average Daily Demand chart shows, charging after the school bus morning shifts align well with the off-peak rate period and relatively high-power L2 charging. However, the second charge shift (starting at approximately 4:30 PM) coincides with the peak pricing period, increasing the ultimate cost of charging.

Charging Session Energy figure shows that for 80% of the time, chargers are used to replenish about a half of the Type C buses' total battery capacity. At the site's full 16.9 kW L2 rate, this would mean that in 80% of sessions the vehicle is fully charged in about four hours. However, there are several sessions that approach the outer edge of the buses' battery capacity, perhaps due to charging issues earlier in the day. The site host indicated concern that the vehicle range is too short and that they may benefit from reviewing these data trends.

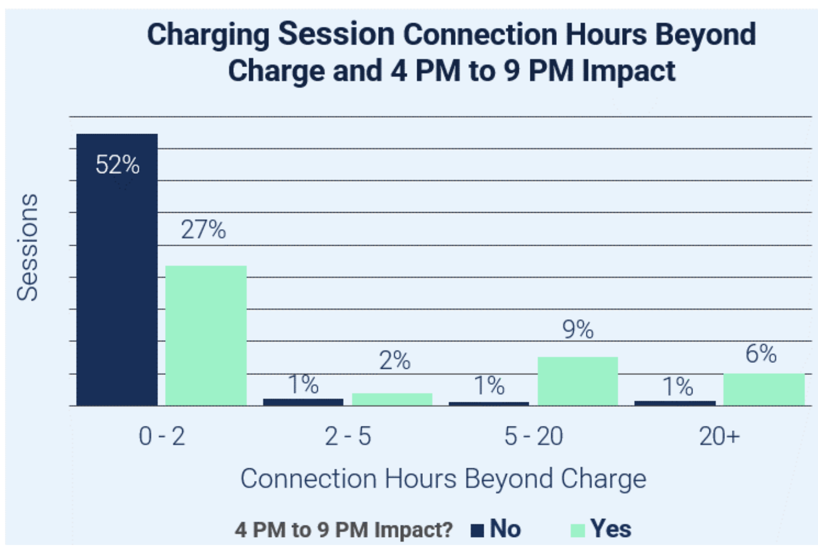


Charging Session Connection figure highlights the duration a vehicle is connected versus drawing power. It shows that buses are commonly left on chargers for only short periods of time beyond when fully charge. In less than 20% of sessions, buses are connected to the charging port for longer than 2 hours after charge is completed; given overnight charging availability at the site this could be an indication that the buses might be moved from the chargers after they are fully charged. More than 40% of the sessions have some charging activity inside of the peak rate period when the buses have completed charging. This excess time at the charger, coupled with typically short observed charging sessions (under four hours), indicates some opportunity to delay charging with used of load management to avoid energy consumption during peak rate periods.



Lessons Learned and Next Steps

This project highlights three key electric school bus fleet characteristics and corresponding lessons learned.



1. **Implementing smart or managed charging will leverage charging flexibility.**
   Currently, vehicle charging is not optimized to avoid peak pricing. Leveraging the charger and network's load management functionality will allow the site operator to automatically initiate and stop charging sessions without manual intervention. Careful and consistent management of charging to shift consumption away from peak pricing times may reduce 30% of each afternoon charging session and improve the long-term cost-effectiveness of fleet electrification.

2. **Additional buses and chargers will require monitoring to maximize efficiencies.**
   While the operator is expected to eventually increase the number of electric vehicles and electric bus utilization, phase in of demand charges in the future may significantly impact the economics of vehicle charging. Periodic reviews of charging data allow operators to make any necessary adjustments for operational and cost efficiency. Therefore, careful observation of bus charging behavior (duration of connection versus power draw) will be essential to understanding how and when charging should be shifted to minimize cost without impinging on operations.

3. **Future upgrades may improve service capabilities of existing electric buses.**
   The site operator hopes for drop-in vehicle replacement so that the electric bus can do everything that a conventional bus can do. Some conventional buses are frequently running 150-mile routes. The current electric buses are only able to reliably travel 60 miles on a full charge, which has limited operations. An upgrade pathway to replace the bus batteries with higher-capacity packs will improve the overall usability of the vehicles. Alternatively, installing low-power DCFC with approximately25 kW output may reduce charging time and allow for additional charging flexibility and load shifting at the expense of slightly increased demand charges after the expected implementation in 2027.

Intermodal Freight Facility: Bay Area, CA

Deep Dive Site

Focus: High Load Factor and Reliable Opportunity Charging

Site Type: Freight handling
Electric Vehicles: battery-powered yard tractors
Charging Stations: 80 kW AC & 60-180 kW DC

Project Completion Date: Summer 2021
Site Visit Date: October 2021
Utility: PG&E

Charging installation at the site showing transformer (left), one three-port DCFC (center), switchgear (right), and several yard tractors (rear).

Left: Three-port DCFC dispenser; center: DCFC power cabinet (180 kW); right: electric yard tractor

Vehicle Deployment and Operational Data

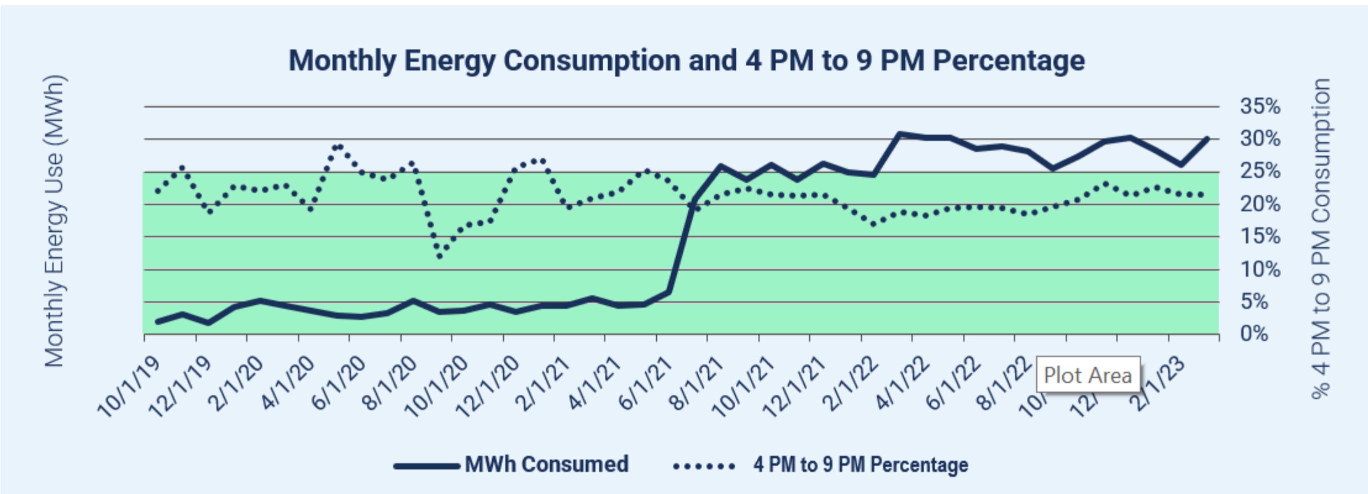
The site began operation in late 2019 with initial batch of battery-electric yard tractors from one manufacturer and then added additional battery-electric yard tractors from another manufacturer in mid-2021. All vehicles were partially funded by California Air Resources Board Clean Off-Road Equipment program grants.

The tractors operate on a flat, approximately one-mile-long property. One EV model has experienced issues reaching an ideal top speed on the long route, was underpowered for intermodal duties, and demonstrated slow acceleration to top speed. Operator satisfaction with the other tractors is good, though some problems with durability were noted, as was the difficulty of obtaining parts from a local supplier.

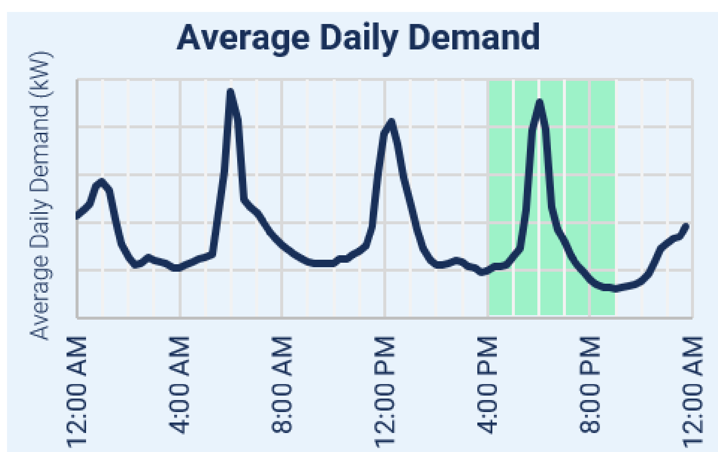
Charger Usage Patterns

The 180-kW charging stations, each paired with a three-port dispenser able to share or prioritize load, were installed and operational at the yard by mid-2021. The dispensers are capable of dynamic power-sharing; when all 3 ports connected to a single 180 kW power cabinet are in use, each port receives 60 kW, but a single active port can receive up to 180 kW. These chargers were installed in addition to 25-kW chargers initially installed at the site to support deployment of the initial batch of tractors. Data indicates that the lower-powered chargers began operation at the site in mid-2020. The fleet of nearly two dozen electric tractors is one of the highest consuming MDHD fleets across the Utilities Standard Review MDHD projects.

The first year and a half of deployment the consumption was significantly lower with the initial batch of tractors in operation but has increased more than five-fold when the second batch of tractors was added to the fleet. The operations of the first batch of vehicles appeared to stabilize within the first few months, by January 2020. The second batch of vehicles again took only a few months to stabilize in fall 2021.

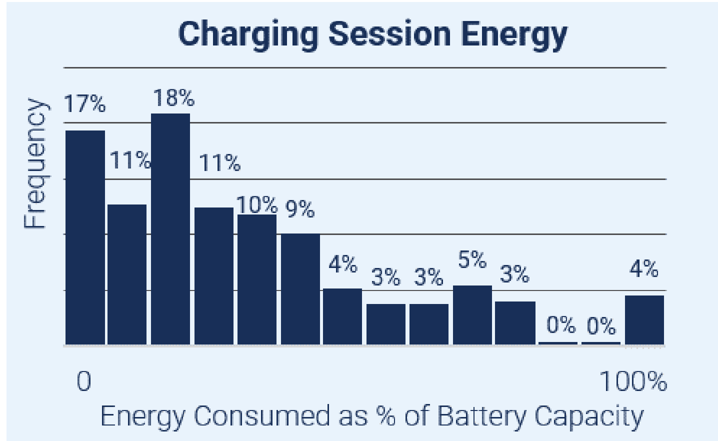


Ideally, sites should aim to consume at most 25% of their energy during the hours of 4 PM to 9 PM, which is generally when utilities charge the most for electricity (shaded in green in the figure above); this should be minimized to the extent that reliable operation allows. On average, approximately 20% of the site's monthly energy use occurs during the 4 PM to 9 PM period, as shown in the figure above. While this is a relatively small percentage of energy consumed, the site operator is not necessarily avoiding significant energy costs so much as consuming heavily throughout the day. Their three-shift charging is apparent in the average daily demand figure below, where one of the charging sessions is during the 4 PM to 9 PM period. Due to the high overall consumption and round-the-clock operations, there may not be much energy savings available, but it would be beneficial to review charging data and load mangement plans to see whether the third charging session could be postponed until 9 PM.



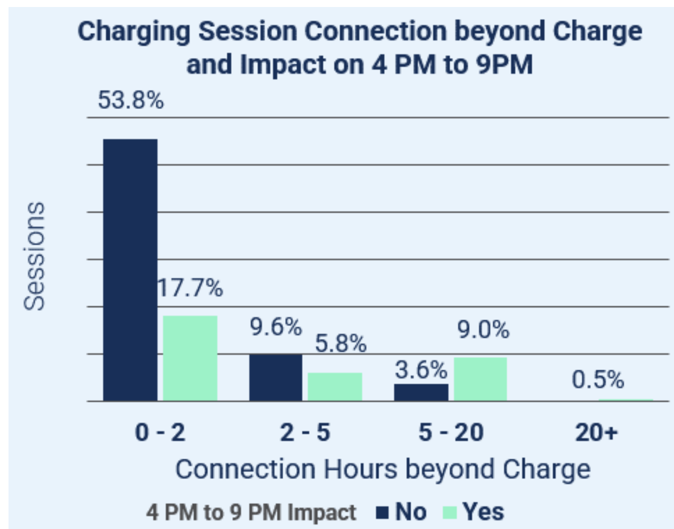
The number of daily charging sessions and amount of energy consumed may increase further as the operator deploys additional vehicles, as the site operator anticipates achieving full vehicle electrification by the end of 2023 or early 2024 with a few additional yard tractors and several forklifts. This operator has been involved in electrification at their other facilities around the country prior to this project – the operator plans to electrify all trucks at one of their Southern California facilities by the end of 2023.

The site is subscribed to PG&E's time-dependent high-use BEV rate (BEV2). Under these tariffs, it is significantly more expensive for the operator to charge their vehicles during the designated peak-rate period of 4 PM to 9 PM. As of the end of 2022, charging was not managed and did not adhere to any schedule to reduce costs for the operator. Under the BEV2 rate, the 9 AM to 2 PM period is designated as "super off-peak" and offers the cheapest electricity rates. Shift work generally avoids the highest costs but also misses some of the lowest cost opportunities. Vehicles are also charged during breaks and generally stay above 30% state of charge overall. The 24-hour, opportunity-charging nature of the site does not lend itself well to traditional load management.



Based on charging session trends illustrated in the figure at right, about 75% of the time chargers are used to replenish fewer than 50% of the tractor's battery capacity. While the lower power chargers take several hours to fully charge the tractors, higher power chargers reduce the charging time to under an hour, which is ideal for the short turnaround nature of opportunity charging at 24-hour freight handling facilities.

Vehicles at the depot site are commonly left connected to the chargers for short periods of time beyond when they are fully charged. As illustrated in the figure to the right, in most sessions (~72%), tractors are connected to the charging port for under two hours, showing little flexibility for substantially slowing or shifting charging to further reduce costs. This is expected for heavy usage multi-shift operations and an indicator of EVs successfully leveraging opportunity charging to match diesel duty cycles. Given the relatively low charging flexibility and the overarching need for opportunity charging, there is limited ability to leverage demand management as a solution to reduce costs. There may be some opportunity for "coasting" on the stored charge until the peak-pricing period ends, or for acquiring EV tractors with larger storage to reduce the amount of charge used between charging opportunities. This site has a relatively high load factor, meaning that demand-related costs are spread out over significant energy consumption. On average, the site's cost-per-kWh was on the low end of the PG&E EV Fleet program's active sites – the high volume of energy consumed outside the 4 PM to 9 PM period offsets the increased costs of the energy consumed between 4 PM and 9 PM.



Lessons Learned and Next Steps

This project highlights two key freight handling fleet characteristics and corresponding lessons learned:

1. Charger power output and reliability can be improved, while vehicle upgrades are mostly for operator comfort.

The site operator is concerned about the power output and reliability of the chargers. It took several months to enable the chargers to supply the full 180 kW to single dispensers (up to that point, the chargers would only supply up to 60 kW to a dispenser, regardless of the number of vehicles connected). The site operator has identified a style of charging station that is expected to behave in the way they desire: high-power dispensers that can prioritize current to multiple charging ports based on the order of vehicle connection. This manufacturer also offers chargers that have fewer failure points, with no screen or ancillary options—simply a start/stop button—which offers potentially improved reliability and a significantly streamlined user interface.

On the vehicle side, the site operator identified the necessary vehicle improvements for their next procurement (including specific component upgrades and locally available replacement parts) and the manufacturer of vehicles that is best able to meet their acceleration and performance requirements.

2. Opportunity charging at a 24-hour site significantly limits the load management opportunity.

   The site adheres to a round-the-clock operational schedule, with equally spaced charging periods throughout the day. As three of those charging periods are solidly within off-peak or super-off-peak pricing periods on the BEV rate, most of the energy dispensed is billed during low-cost times. The operational needs of the site dictate that charging must occur at specific times and power levels, removing most of the ability for load management and requiring more creative solutions for cost reduction.

Port Cargo Handling Facility: Bay Area, CA

Deep Dive Site

Focus: Opportunity Charging and Charging Session Data Harvesting

Site Type: Freight handling
Electric Vehicles: small (<10,000-lb capacity) and large (>19,000-lb capacity) forklifts
Charging Stations: 15-kW and 11-kW L2 chargers

Project Completion Date: Summer 2021
Site Visit Date: December 2021
Utility: PG&E

Vehicles illustrative of the site's operational fleet. Left: 36,000-lb-capacity battery-electric forklifts; right: 8,000-lb-capacity battery-electric forklifts

Charging installation at the site depot, showing 11-kW L2 chargers and 15-kW XLerator chargers

Vehicle Deployment and Operational Data

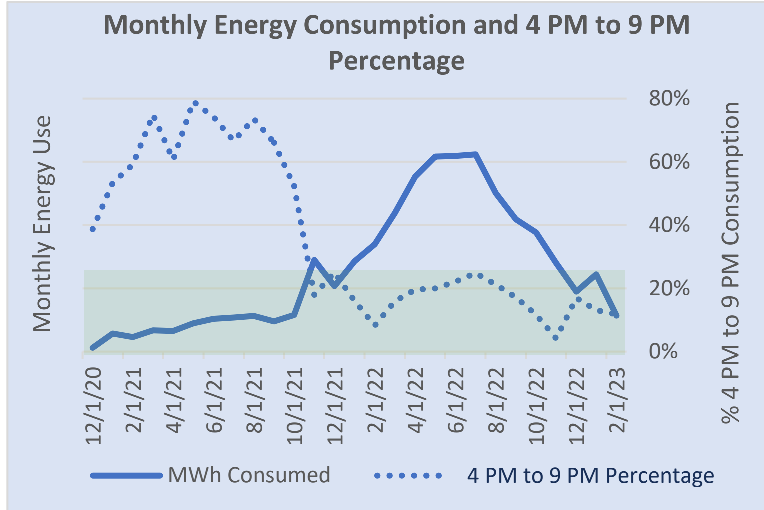
The site operates more than a dozen small, 8,000-lb-capacity battery-electric forklifts, which are equipped with electric powertrains and approximately 44 kWh batteries. Additionally, the site operates nearly as many large, 36,000-lb-capacity battery-electric forklifts with roughly 125-kWh batteries. The electric forklifts were funded by California Air Resources Board (CARB) Zero- and Near-Zero Emission Freight Facilities grant. The forklifts operate on sporadic, unpredictable schedules based on freight deliveries to the port.

Operator satisfaction with the forklifts is good, though some ongoing problems with battery sizing can limit equipment functionality and reduce the lifts' ability to meet duty cycles under heavy usage.

Charger Usage Patterns

As of late 2021, the L2 chargers were installed and operational at the forklift bay. Data indicates that the chargers began operation in early 2021. Forklift energy consumption is directly and closely tied to freight deliveries and varies significantly over time based on the level of activity at the port facility. Two distinct types of operation have been observed at the facility: low-use periods (from May through October 2021) and high-use periods (November 2021 through December 2022).

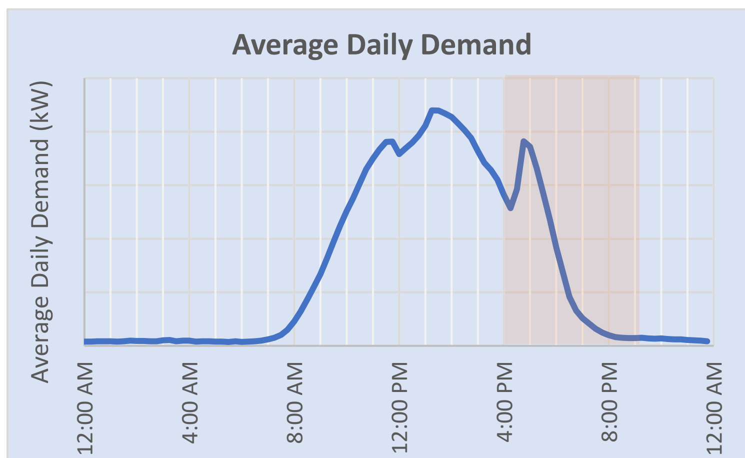
At the peak of the high-use period in summer 2022, the forklifts were consuming six times the observed steady-state consumption during the low-use period. The site operator confirmed that the energy draw was directly tied to a dramatic increase in cargo shipment arrival at the port. The operator could run two shifts daily as needed and was able to avoid significant on-peak energy costs in 2022 year, as shown in the figure to the right. With no load management, this may be based on significant charging midday before 4 PM in addition to a photovoltaic solar array installed at the site. Despite this, it may be beneficial for the site to converse with their EV charger network service provider to ensure that their energy consumption remains optimized even as rates and fleet composition change over time.



An important consideration in the analysis of this data is feedback from the operator on the charger power level. All chargers installed as part of the PG&E EV Fleet project have similar power (11 kW and 15 kW), and the operator reported that these power levels are unable to reliably meet the needs of the heavy-duty forklifts. The heavy-duty forklifts generally charge at other locations on the port site with faster (DCFC) charging, which was funded outside of the PG&E EV Fleet program (DCFC operation is not captured in the data collected as part of this project).

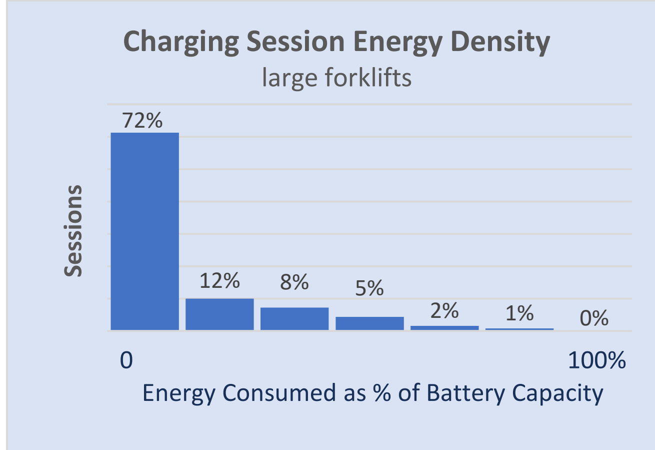
The number of daily charging sessions and amount of energy consumed may increase further as the operator deploys additional vehicles or upgrades charging capacity, though there are no imminent plans for expansion.

The site is subscribed to PG&E's time-dependent BEV rate. Under this tariff, it is significantly more expensive for the operator to charge during the designated peak-rate period of 4 PM to 9 PM. Through the end of 2022 charging was unmanaged, and thus does not adhere to a strict schedule to limit charging during the high cost 4 PM to 9 PM period. This specific BEV rate designated from 9 a.m. to 2 p.m. is super off-peak and offers the cheapest electricity rates. Anecdotally, due to the duty cycles of the port, charging activity is heavily biased toward operating hours (8 AM to 5 PM) and the operator cannot restrict charging but needs to ensure that the forklifts are replenishing as much charge as possible. The average daily load curve shown to the right suggests that charging is often completed by 8 PM, leaving minimal demand from then until the morning shift 10 hours later. This insight suggests that it is possible to delay charging past the end of the final shift. The L2 and Xlerator charging stations are capable of delaying charging.

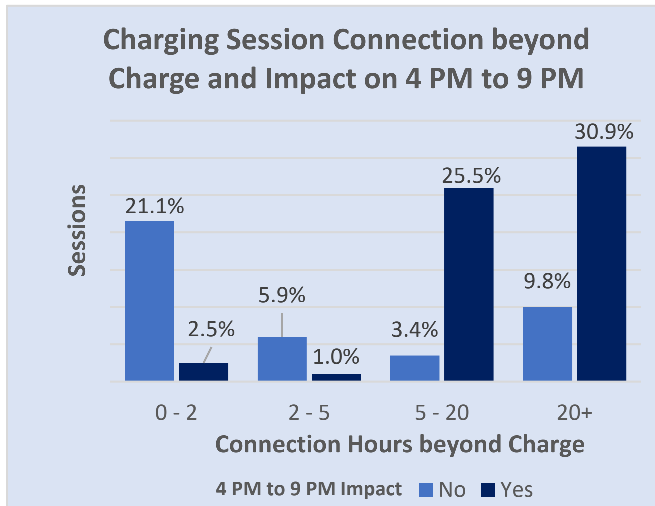


The site is subject to CARB's goal of operating completely zero-emission cargo handlers by 2030; as more vehicles are acquired and more chargers are installed, managing vehicle charging load will have significant impacts on the overall costs of fueling vehicles. There may be an opportunity to learn more from charging session data.

The site operator would ideally like to move to DCFC for their heavy-duty forklifts to reduce the amount of time their vehicles spend charging. The heavy forklifts currently use 11-kW chargers, which take longer than desired to charge their 100 kWh and larger batteries. Moving to the 50-kW DCFCs reduces the charging time to under two hours; thus, the heavy forklifts almost exclusively charge away from the chargers installed as part of the PG&E EV Fleet project. The XLerator chargers (which charge the small forklifts) do not currently report data into the project database, and a significant difference between the consumption reported by the ChargePoint EVSP and the site's meter suggests that greater than 90% of the charging at the site is done by the smaller forklifts, which may indicate just how much they are used.



Charging session data is limited to the heavy forklifts, which primarily charge elsewhere. Those trends indicate that more than 70% of sessions consume fewer than one-sixth of the heavy forklifts' total battery capacity and approximately two hours of charging (see the figure to the right). This is expected behavior for forklifts that leverage opportunity charging as a primary method of fueling such as between shifts and during breaks. Examining the charging session behavior from the XLerator units (smaller forklifts) will provide a more thorough insight into their operations, representing most of the charging at this site.



Heavy forklifts charging on the ChargePoint units follow a bimodal distribution on post-charge connection time. While 26% of sessions are disconnected relatively promptly after charge completion, as illustrated in the figure to the right, in approximately 70% of sessions forklifts are connected to the charging port for five hours or longer after the end of their main charging activity, the vast majority of which have some charging activity during the peak-rate period. This suggests that less charging could take place during high-cost times by delaying charging.

Lessons Learned and Next Steps

This project highlights three key freight handling fleet characteristics and corresponding lessons learned.

1. Charging must match the anticipated use case.

   In applications such as freight loading and unloading at a port or other transfer facility, equipment uptime and runtime is paramount to ensuring uninterrupted work. Minimizing the amount of time that equipment is offline for charging and maintenance is crucial in ensuring that electrified vehicles can easily and effectively serve in the same role as the conventional baseline vehicles. In this case, the L2 charging is inadequate for the rapid fueling times required to sustain the heavy forklifts' constant operation.

2. Load management can have a significant impact on the charging energy cost.

   As of the end of 2022, the peak-pricing rate for electricity on the site's utility plan is over twice that of the off-peak rate. The site's operations naturally place the bulk of its charging during the super-off-peak period and into the beginning of the peak-rate period. In future rounds of electrification, it may be beneficial to pair DCFC with forklifts with larger batteries to maximize the amount of charging conducted during the super-off-peak periods, then place the vehicles on a timed schedule to initiate overnight charging once the peak-rate period ends.

3. Data should be collected from all chargers.

   The chargers used for the small forklifts can share similar statistics as the chargers for the large forklifts, such as duration connected versus duration drawing power. This data can help triangulate the extent to which least-cost energy could be used, knowing that little consumption takes place between 8 PM and 8 AM.

Transit Bus Facility: Central Region, CA

Deep Dive Site

Focus: Flexibility and Reliability

Site Type: Transit Operator

Electric Vehicles: 35-foot buses (440-kWh) and shuttle vans (120-kWh) Long-term plans for additional vehicles.

Charging Stations: 12 depot 50-kW chargers and two en route DCFC with a split 360-kW system.

Project Completion Date: Summer 2021

Site Visit Date: March 2022

Utility: Southern California Edison

Charging installation at the site depot, showing chargers and multiple shuttle vans charging

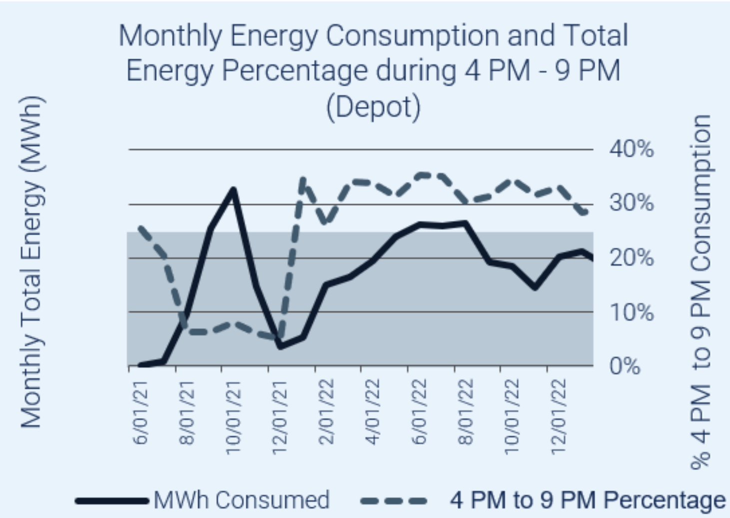
Left to right: Depot fast charger; en route charger dispensers; en route electrical switchgear and transformer

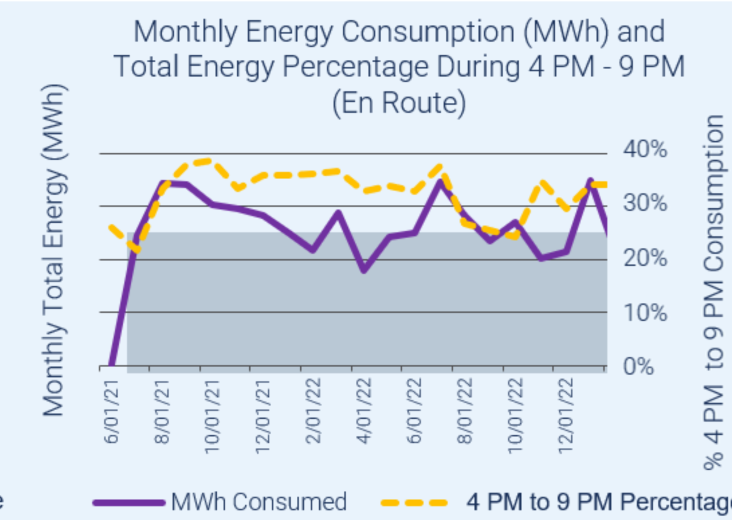
Vehicle Deployment and Operational Data

The site operates a few 35-foot, New Flyer–manufactured battery-electric transit buses equipped with 440 kWh batteries. Additionally, the site operates nearly a dozen battery-electric Ford Transit shuttle vans manufactured by Lightning eMotors. These shuttle buses replaced other electric shuttle buses that were consistently experiencing issues with unexpected battery depletion halfway through their daily shifts.

Charger Usage Patterns

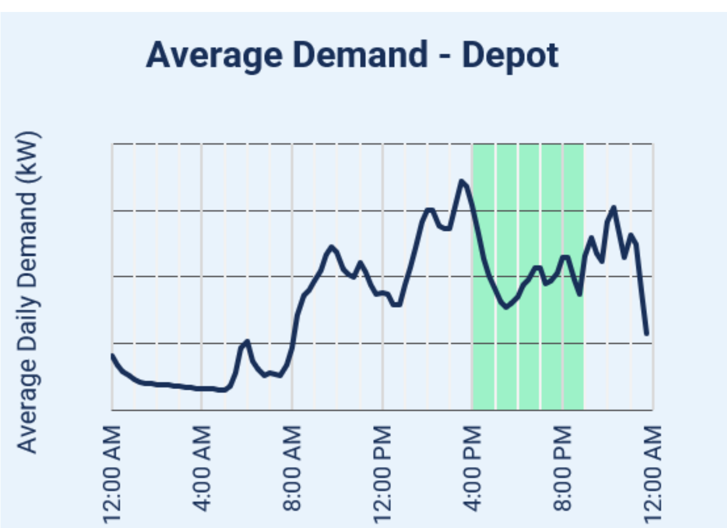
As of late EY2022, 50-kW DCFCs were installed and operational at the bus depot and a 360-kW charger serving two dispensers was installed at the transit station for en route fueling. Based on charging data, these chargers began operation at both sites in mid-2021. As shown in the figures below, after a dip in usage due to vehicle issues, the depot appears to have achieved stable usage in early 2022, while the en route chargers have operated steadily since they were installed in mid- 2021.

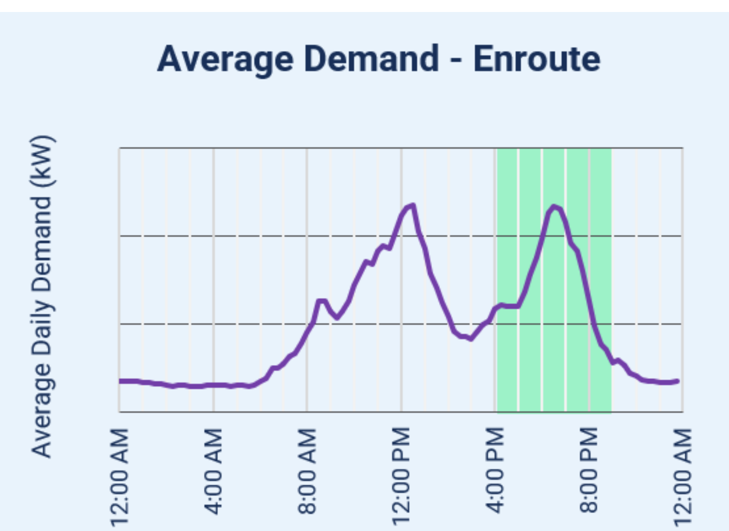




The fleet currently consists of a few operational buses with 440-kWh batteries and nearly a dozen shuttle vans with 120-kWh batteries, totaling of more than 2 MWh of energy capacity. The buses and vans monthly consume between two to three times the energy at the depot chargers compared to the en route chargers. Energy consumption has stabilized following a ramp up in the first half of 2022. The site operator is incurring significant on-peak energy costs, as 35% to 40% of monthly energy use occurs during the peak-rate at both sites, as shown in the figures above. En route opportunity charging is necessary to maintain operations, which ensures that vehicles are able to maximize the amount of power transfer when only short dwell times are available for charging.

Both sites are subscribed to SCE's time-dependent TOU-EV-8 rate. Under this tariff, it is significantly more expensive for the operator to charge buses during the designated peak-rate period of 4 PM to 9 PM. As of late 2022, the site has managed depot charging manually, with transit employees manually plugging in vehicles outside of the 4 PM to 9 PM peak-rate period. This is reflected in the dip in average power demand during the peak-rate period (left figure below). The en route charging (right figure below) demonstrates a two-peak opportunity charging schedule where the bulk of charging occurs around noon and 6 PM; due to the nature of en route charging, these chargers should not be limited to ensure that vehicles reliably receive the maximum amount of energy possible.

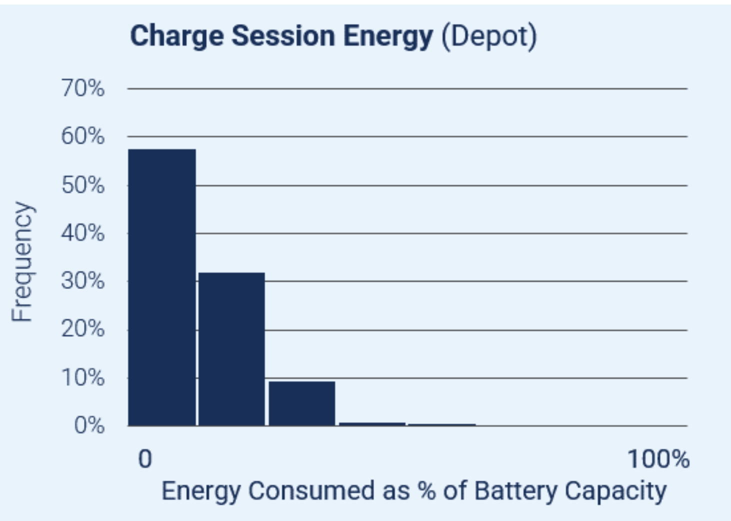


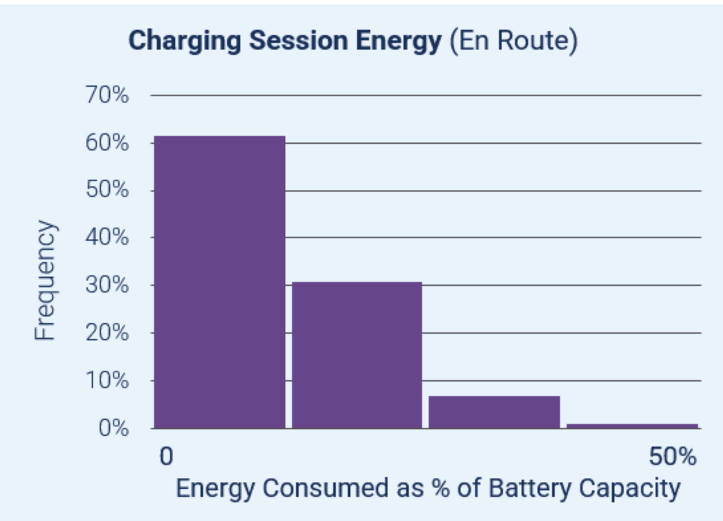


Though additional vehicles are not anticipated for several years, when more electric buses are eventually acquired and more chargers are installed, it will be valuable to continue to manage load or adopt automatic load management to reflect the changing charging loadcycles.

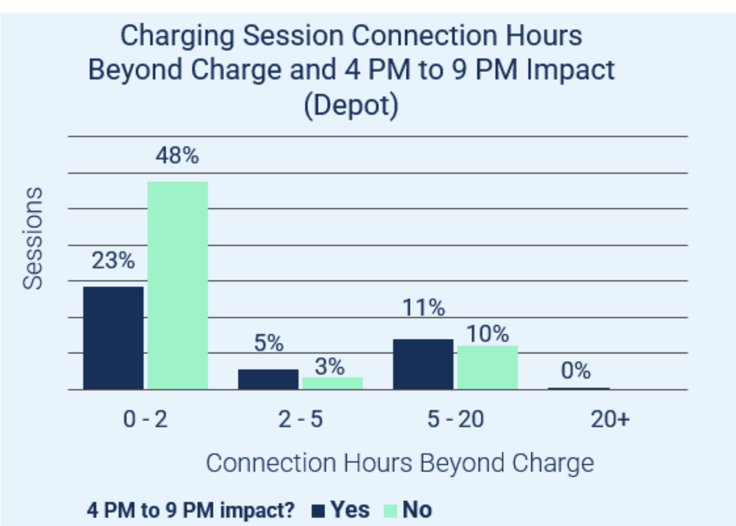
Charging session trends at the depot and at the en route charger indicate that about 90% of the time, chargers are used to replenish fewer than one-third of the shuttle vans' effective battery capacity and one-tenth of the transit buses' capacity (figures below). At therated charger power levels at the depot, the vehicles could be fully charged in less than two hours. Given this short charge time, the implementation of automatic load management/charge delay could further reduce the amount of energy required during the 4 PM to 9 PM peak rate period, as it would be less intrusive than manual load management. Further analysis may indicate that buses could be run to lower states of charge to avoid high-cost charging.

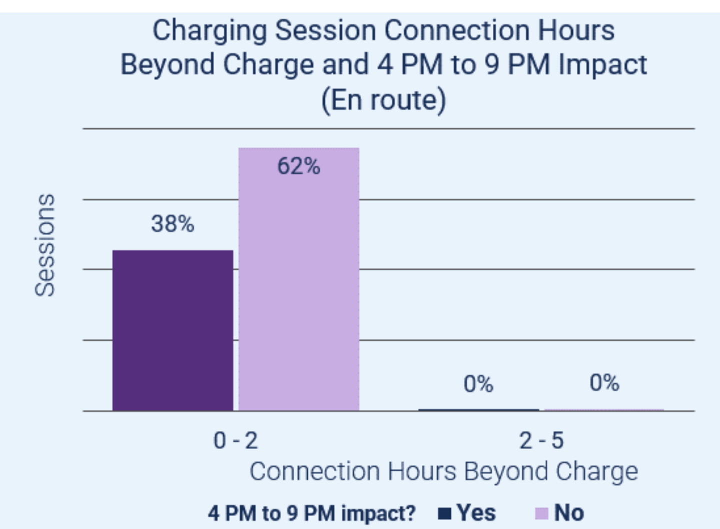
Charging session trends at the en route charger indicate that most sessions at the transit station are very short, anywhere between a few minutes to two hours, depending on charger power and the required amount of energy needed. The buses likely top off throughout the day to extend their service range. Sessions dispensing more than one-third of the shuttle vans' effective battery capacity are more common at the depot chargers, reinforcing the opportunity-charging role of the en route chargers.





Vehicles at the depot site are commonly left on chargers for short periods of time beyond when they are fully charged. As illustratedin the figure to the left below, in approximately 22% of sessions, buses are connected to the charging port for more than five hours. The buses are not actively charging during these hours, but rather maintaining their fully charged state. This excess time at the charger, coupled with typically short observed charging sessions (under three hours), indicates further opportunity to delay chargingto avoid energy consumption during peak rate periods.





As expected, the en route charging station setup has extremely low rates of vehicles plugged in for long periods of time after charging is complete, with less than 1% of sessions having buses staying plugged in for longer than two hours after charge cessation.

Lessons Learned and Next Steps

This project reveals some interesting transit fleet characteristics and corresponding lessons learned. The site operator will want to prepare for the phase-in of demand charges from the new TOU-EV-8 rate, scheduled to start in 2027. While staff at the depot site manually reduce load during peak-pricing hours as best they are able, the number of vehicles charging simultaneously outside of the peak-pricing period can result in significant demand charges. To mitigate unnecessary demand charges, it could be beneficial for the operator to rotate charging between vehicles over a longer period outside of the peak-pricing period.

1. **Implementing smart or managed charging will improve charger flexibility and reliability.**
   Currently, vehicle charging is managed manually to avoid charges incurred during peak-pricing periods. Leveraging the chargers' built-in intelligent load management functionality will allow the chargers to automatically initiate and stop charging sessions without manual intervention. Careful and consistent charge management to shift consumption away from peak pricing times will sharply reduce electricity costs and improve the long-term cost-effectiveness of fleet electrification.
2. **Additional buses and chargers will require monitoring to maximize efficiencies.**
   While the operator is expected to eventually increase the number of electric buses and electric bus utilization, changes to SCE rate tariffs may significantly impact the economics of vehicle charging and should be closely monitored. When the time comes to expand, the site operator should keep in mind that chargers are most effectively utilized when no authentication is required and when space assignments are flexible. Periodic reviews of charging data allow operators to make any necessary adjustments for operational and cost efficiencies. Therefore, careful observation of bus charging behavior will be essential to understanding how and when charging should be shifted to minimize cost without impinging on operations.
3. **Impending demand charges call for load management solutions.**
   Analysis of load data reveals that buses remain plugged into chargers for significantly longer than they are actively charging.While the site operator intends to implement load management with the next phase of bus deployment, the supporting charging hardware for these buses will not be completed at the time of delivery, and new buses will initially use the existing hardware. This requires additional effort to stagger charging times and limit on-peak consumption. In 2027, demand charges are currently scheduled to come into effect. This offers a strong motivation to curb the total amount of power consumed when multiple vehicles are charging simultaneously.

Transit Bus Fleet: Southern California

Deep Dive Site

Focus: Scale and Expandability

Site Type: Transit Bus Operator
Electric Vehicles: 40-foot transit buses (444-kWh battery capacity); additional buses with larger batteries planned for 2024. Plans for more than 100 buses by 2027.
Charging Stations: 62.5 kW DCFCs with plans for additional ones by 2028

Project Completion Date: Summer 2021
Site Visit Date: November 2022
Utility: Southern California Edison
ICE Fuel Types: CNG, LNG, gas-hybrid

Charging installation showing chargers, above-ground conduit run, and a bus charging

Left to right: nose-in charging configuration, site switchgear installation, Gillig bus displaying front-mounted charge port

Vehicle Deployment and Operational Data

The site's battery-electric buses are equipped with Cummins electric powertrains and 444-kWh battery systems. These buses initially experienced issues with their batteries and CANbus communications, which reduced vehicle reliability. Manufacturer support improved vehicle reliability considerably after approximately six months.

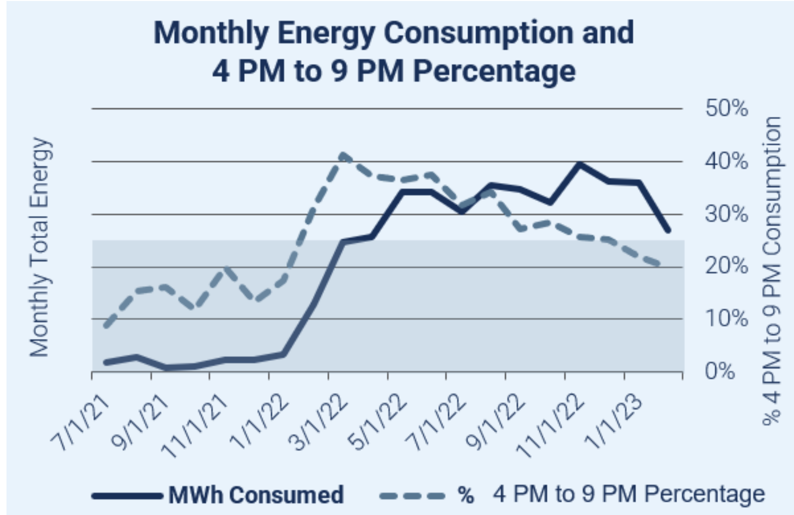
The operator deployed more than a dozen electric buses and plans for at least two phases of additional infrastructure to fully transition to EVs (more than 100 buses in fleet at this site). Notable updates to the future buses will include adding charging ports on the front and rear of each bus to increase adaptability in a large and crowded depot.

Charger Usage Patterns

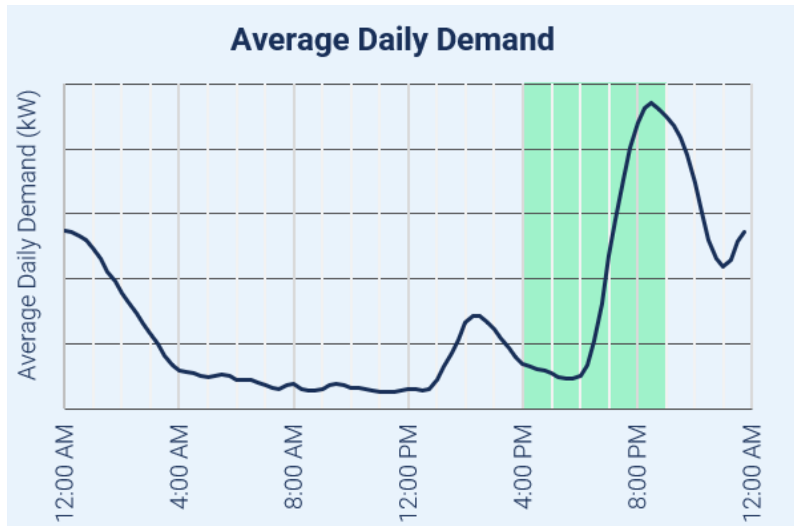
As of late 2022, nearly two dozen DCFCs were installed and operational. To support the electrification of the whole fleet by 2028 the charger count is planned to more than double. The operator is in the process of introducing these vehicles into regular operations.

The operator noted during the Evaluation Team's interview that EVs are mostly used for single shifts on shorter routes of up to 70 miles. Vehicles that are charged midday typically complete two shifts.

The fleet currently consists of nearly two dozen operating buses with approximately 444 kWh batteries, totaling more than 80 MWh of energy capacity. Energy consumption has stabilized following a ramp up in the first half of 2022 and the fleet is now one of the largest consumers of energy in CRT program. More high consumption days were observed in 2022, likely due to the operator's greater confidence in the vehicles' capabilities and increasing bus service.



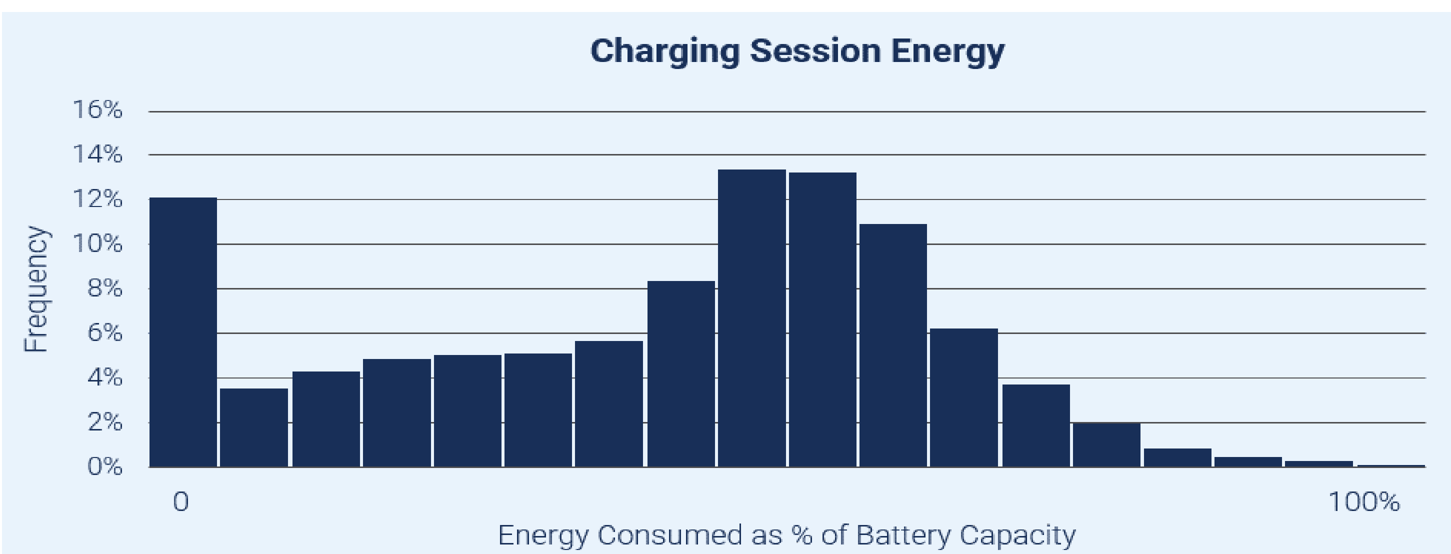
Based fleet manager's input, the transit operator plans to deploy additional electric buses with larger batteries, and as schedulers find more opportunity for midday charging, which allows for second shifts, energy consumption will likely increase.



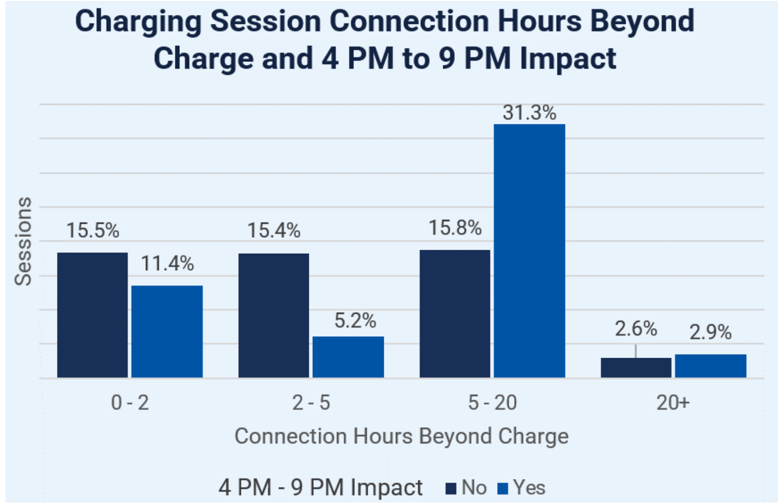
Under SCE's time-dependent TOU-EV-9 rate, it is significantly more expensive for the operator to charge buses during the designated peak-rate period from 4 PM to 9 PM. The operator could reduce overall charging costs by minimizing charging during these hours and has begun to shift load away from this time period. However, the site operator is still incurring significant on-peak energy costs, as 25% of monthly energy use still occurs during the peak-rate period, as shown in the Average Daily Demand figure.

No formal load management plan has been carried out as of the end of 2022, but the operator acknowledged that this will be vital as more electric buses are added and more chargers are installed. Chargers onsite have automated load-management capabilities, though it is uncertain whether that ability will be utilized for future load management.

Charging Session Energy chart indicates that about 85% of sessions, replenish less than 40% of the bus' effective energy capacity. At the rated charger powerlevels, the buses could be fully charged in about three hours.



Vehicles at this site are commonly left connected to the chargers for extended periods of time beyond when buses are fully charged. As illustrated in the figure to the right, in approximately 35% of charging sessions, buses areconnected to the charging port for five hours or more. For much of this time, the buses are not actively charging, but rather maintaining their fully charged state. This excess time at the charger, coupled with typically short observed charging sessions (under three hours), indicates an opportunity to delay charging to avoid energy consumption during peak rate periods.



Lessons Learned and Next Steps

This project highlights a few key characteristics and corresponding lessons. The site operator will want to prepare for the phase-in of demand charges on the TOU-EV-9 rate which have been pushed out to 2027. As the next set of delivered buses will feature larger batteries, it will be particularly important to follow best practices as the total energy consumption of the electric fleet grows along with the number of chargers.

1. **More higher-capacity battery electric buses provide benefits but also increase charging costs.**
   The buses on order have larger batteries that will provide more range. Increasing the number of buses may also further exacerbate demand charges and increase the amount of energy consumed during peak rate periods if charging patterns are not modified. Careful and consistent charge management to shift consumption away from peak pricing times will sharply reduce electricity costs and improve the long-term cost-effectiveness of fleet electrification.
2. **Additional buses and chargers will require monitoring to maximize efficiencies.**
   The operator is expected to increase the number of electric buses and electric bus utilization. Additional chargers will be installed in the second phase of depot electrification and the operator will have the ability to charge the buses at a faster rate than currently. Chargers are most effectively used when no authentication is required and when space assignments are flexible. Reviewing charging data allows operators to make any necessary adjustments for operational and cost efficiencies. Therefore, careful observation of bus charging behavior will be essential to understanding how and when charging should be shifted to minimize costs without impinging on operations.
3. **Impending demand charges call for load management solutions.**
   Analysis of load data reveals that buses remain plugged into chargers for significantly longer than they are actively charging. While the site operator intends to implement load management with the next phase of bus deployment, the supporting charging hardware for these buses will not be completed at the time of delivery, and new buses will initially use the existing hardware. This requires additional effort to stagger charging times and limit 4 PM to 9 PM consumption. While the demand charges have been postponed until 2027, they will impact the charging costs. This offers a strong motivation to curb the total amount of power consumed when multiple vehicles are charging simultaneously.

School Bus Fleet: Bay Area, CA

Deep Dive Site

Focus: Reliability and Management

Site Type: School bus fleet operation
Electric Vehicles: Type C 132-kWh and Type A 88-kWh buses
Charging Stations: L2 16 kW chargers
Non-Electric Vehicles: Diesel Type A bus; gasoline passenger vans

Project Completion Date: Summer 2021
Site Visit Date: March 2022
Utility: PG&E
ICE Fuel Types: diesel, gasoline

Lion Type C electric buses parked at the site.

Charging installation at the site depot showing L2 chargers, above-ground conduit run, and switchgear

Vehicle Deployment and Operational Data

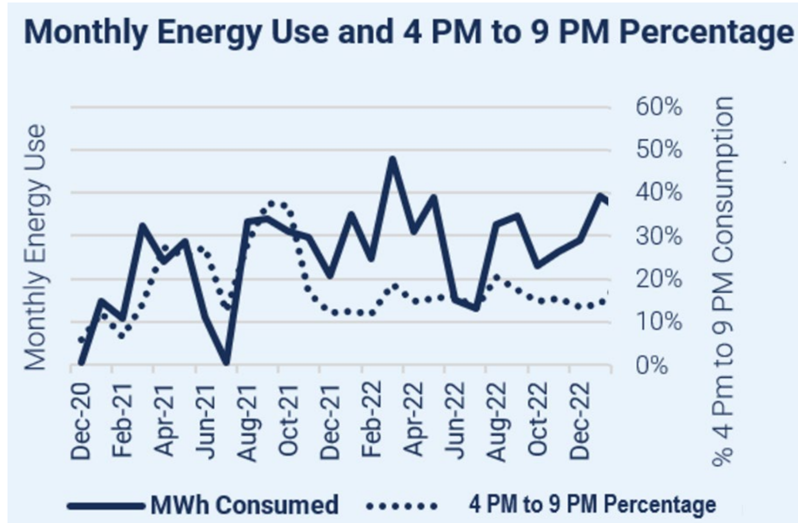
The site operates several Lion Electric Type C school buses equipped with approximately 132 kWh batteries and Blue Bird Type A electric school buses with a 90-kWh battery. All buses were funded by local Air Quality Management District grants.

The first-generation Type C school bus model from Lion Electric is rated at an 80-mile range; the second-generation models are rated at 120-mile range. These buses mostly operate on approximately 60-mile daily flat routes. The buses have occasionally experienced a reduced speed “limp” mode on days with extremely high temperatures.

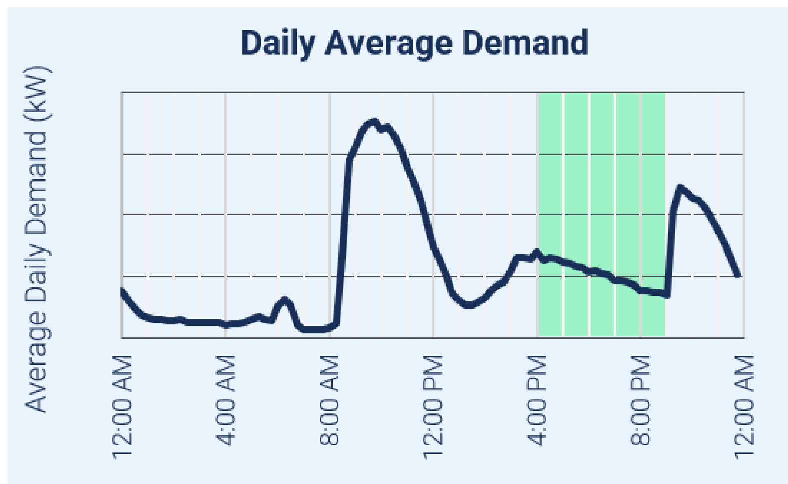
Operator satisfaction with the Type C buses is good, though some initial problems with undersized wiring were encountered and resolved: a loose wire on one of the vehicle doors caused problems with vehicle operation for a brief time after the vehicle was acquired. Additionally, staff is observing that vehicles are not reliably achieving their full rated ranges, potentially due to additional battery load from full buses and climate conditioning. Drivers were trained on the bus operation and charging process by a combination of Lion Electric and school district staff.

Charger Usage Patterns

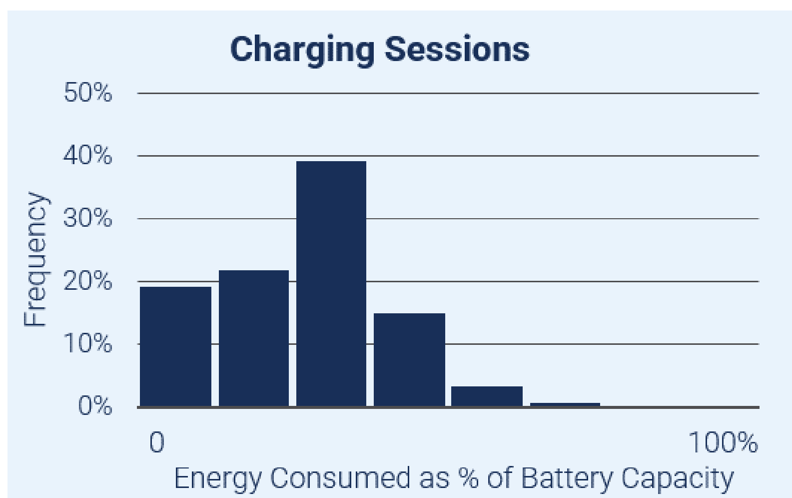
Data indicate that chargers began operation at the site in early 2021. As shown in the Monthly Energy Use chart, the electric bus monthly energy consumption fluctuates over the course of a calendar year. Significant declines in energy consumption are observed during summer breaks and other school holidays.



Load management of vehicle charging has significantly reduced peak rate energy costs since implementation at the end of 2021. Less than 20% of monthly energy use occurs during the peak rate, as shown in the Monthly Energy Use figure, which is exceptional compared to the overall Utilities SRP MDHD programs trend: other sites have not demonstrated this degree of effective load management. As a general guideline, no more than 25% of total energy should be consumed during peak price periods. This site achieved this for 20 of the 25 months (80%) of the site's operation, and for 100% of charging in 2022.



The number of daily charging sessions and amount of energy consumed may increase further as the operator deploys additional vehicles, though there are no current plans to expand the existing fleet.

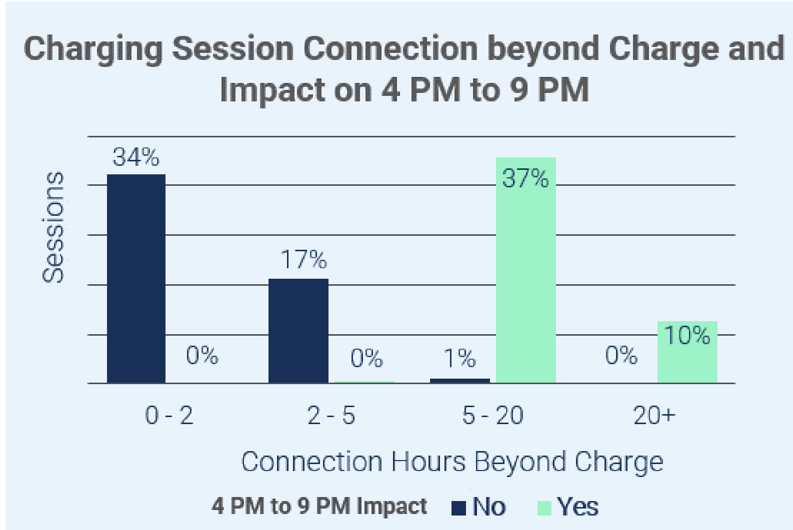


The site is billed on PG&E's time-dependent BEV rate. Under this tariff it is significantly more expensive for the operator to charge buses during the designated peak-rate period of 4 PM to 9 PM daily. As of the end of 2022, charging is managed automatically and adheres to a strict schedule that limits charging during the 4 PM to 9 PM period, thus reducing operator's energy cost. Under the BEV rate, the daily 9 AM to 2 PM time-period is designated as "super off-peak" and offers the cheapest electricity rates (under half the cost of the peak rates).

Analysis of data trends indicates that the site is taking advantage of lower rates by charging the buses right after their morning route at 9 AM (as shown in the Daily Average Demand figure). Notably, the site appears to be maximizing morning charging for the lower cost and potential higher CARB LCFS credits while minimizing evening peak rate charging. Though additional buses are not expected for several years, as more vehicles are acquired and more chargers are installed, conscientious management of vehicle charging loads will have a significant impact on overall cost.

Charging session trends at the depot indicate that about 80% of the time, chargers are used to replenish approximately one-half of the newer Type C buses' total battery capacity (shown in the Charging Session figure). At a typical 16.5 kW L2 rate, this is around four hours of charging. However, there are several sessions that approach the outer edge of the vehicle battery capacity. The site host expressed concern that vehicle range is too short.

Vehicles at the depot site are commonly left connected to the chargers for long periods of time beyond when vehicles are fully charged. As illustrated in the figure to the right, in nearly half of the sessions, buses are connected to the charging port for more than five hours longer than what is necessary to fully charge. Similar to other sites, this excess time at the charger indicates an opportunity to delay charging away from the peak rate periods, and to potentially slow charging down to mitigate demand-oriented costs.



Lessons Learned and Next Steps

This project highlights two key school bus fleet characteristics and corresponding lessons learned.

1. **Future upgrades may be incremental upfits on existing buses.**
   The site operator is focused on drop-in vehicle replacement, in which the electric bus can do everything that a conventional bus can do. The conventional buses that were replaced were frequently running 100-mile daily routes. The current first-generation Type C buses are only able to reliably travel 60 miles on a full charge. A plan to replace the bus batteries with updated, higher-capacity packs could offer an excellent path to improve vehicle functionality.

2. **Load management can significantly reduce the operational energy costs.**
   As of the end of 2022, the peak-pricing rate for electricity on the BEV plan is more than twice that of the off-peak rate. The site is prioritizing charging during the super-off-peak period and the vast remainder of the charging during the off-peak period. As a result of this automated charging management, the total effective cost-per-kilowatt-hour for this site is among the lowest-cost energy observed in the SRP MDHD programs across the Utilities.

Appendix C. Data Collection Instruments

SRP Evaluation: MDHD Fleet Manager Survey (EY2022)

Survey Purpose: This online survey is designed to engage MDHD fleet managers whose fleets participated in one of the SRP-funded transportation electrification programs. The survey will assess their experience in the program, factors that led to successful electrification, the benefits and costs of electrification, and their view on broader market trends. The survey will be conducted via Qualtrics on a yearly basis. Depending on survey participation rates and count of completed sites, the evaluation team may also consider fielding the survey as a phone survey instead of an online survey.

Research Objectives
1. Identify the factors that facilitate successful fleet electrification and lessons learned
What strategies lead to viable sites and successful deployments?
What would fleet partners or managers have done differently, if anything?
2. Explore the benefits of TE for fleets and for fleet drivers
Have fleet partners/managers heard from drivers about their experience? Are there benefits associated with air quality, health, stress, and noise?
How did TCO change after the fleet was electrified, if at all? What were the ongoing costs of fueling and maintenance before/after participating in the program?
3. Asses the experience of fleet partners and managers with the program and infrastructure
How reliable and user-friendly is the electric vehicle charging equipment?
Have fleets experienced any operational tradeoffs or loss of flexibility, and if so, how severe are these impacts?
How satisfied are fleet managers with the program overall? How does overall satisfaction vary by market sector?
4. Gauge market impacts, trends, and identify market barriers
Which vehicle and market sectors are seeing the most uptake? To what degree can we expect that to change as other incentives are scaled up or scaled back, and as technology and costs improve?
What are the barriers to fleet electrification and how do these differ by vehicle or market sector?
How did the program change electrification within fleets, and do the fleets plan to accelerate TE-related procurement because of the experience?
5. Assess program attribution
What type of transportation electrification project would participants have undertaken in absence of the utility program? Have the fleets decided to electrify more of their fleets without incentives from the fleet electrification program or another organization, due to their participation in the fleet electrification program?

Target Audience: Fleet Managers of operational sites

Desired number of completions: Census of all operational sites (sites where AMI and/or EVSP data were received from the Utility or EVSP) per utility. The below are cumulative completion totals across the entire program cycle. We will determine completion targets for each utility during each fielding wave.

- Liberty: 1
- PG&E: 700
- SCE: 870
- SDG&E: 300

Estimated timeline for fielding: The next wave of fleet manager surveys will be conducted in Q1 2023 (note the Liberty/Tahoe Transit District Fleet Manager will be surveyed only once, in Q1 2023).

Variables to be Pulled into Survey:

- Email
- FirstName
- LastName
- UTILITY (SCE/SDGE&E/PG&E/Liberty; read-in)
- PROGRAM_NAME (read-in; do not include "program")
- Organization
- SITE_TYPE (Distribution, Transit, Airport, School Bus, Port, Forklift, etc.)

Sample Fleet Manager Contact Info Collection Email

To: [EMAIL – Site Host]
From: [Cadmus]

CC: [SCE/SDG&E/PG&E/Liberty MDHD PM and Customer Account Manager]
Subject: Survey with fleet managers for the [UTILITY] fleet electrification program

Dear [FIRSTNAME AND LASTNAME],

Thank you for working with [UTILITY] to expand transportation electrification. As part of our evaluation of the [UTILITY PROGRAM NAME] program, we are surveying fleet managers from each activated project about their experience during installation, their fleet operations, and the benefits/costs of transportation electrification. Could you please provide the contact information (name, title, email, phone) for the most appropriate person within your organization so we may reach out to them and invite them to complete the 20-minute online survey? [IF ELIGIBLE FOR INCENTIVE: We are offering respondents a $50 gift card upon survey completion (for non-public agency fleets).]

Survey results are anonymized and the utility will not be able to see respondents' individual responses.

Thank you,

CADMUS PERSON'S FIRST AND LAST NAME
THEIR TITLE
CADMUS GROUP

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Email Invitation

To: [EMAIL]
From: [Cadmus]

CC: [SCE/SDG&E/PG&E/Liberty MDHD PM and Customer Account Manager] Subject: Your experience with the [SCE/SDGE&E/PG&E/Liberty] fleet electrification program

Dear [FIRSTNAME AND LASTNAME],

As part of [SCE/SDG&E/PG&E/Liberty]'s fleet electrification program evaluation, we invite you to share your opinion about your experience electrifying your fleet. Your experience can provide valuable feedback about how to improve the program experience for other fleets. Your input is very important to us and will be anonymized and only used for research purposes – utilities will not be able to see individual responses. **The survey will take about 20 minutes to complete**. [IF ELIGIBLE FOR INCENTIVE: We are offering respondents a $50 gift card upon survey completion (for non-public agency fleets).]

Click the link below to take the survey (or copy and paste into your browser):

[auto-generated link]

If you feel that someone else is better positioned to answer this survey, could you please forward the email to that person and copy the people on this email?

If you have any questions about this research, or any difficulties taking the survey, please contact Athena Dodd at The Cadmus Group, the national research firm conducting this survey for the utilities. You can reach Athena at (303) 389-2539 or athena.dodd@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

CADMUS PERSON'S FIRST AND LAST NAME
THEIR TITLE
CADMUS GROUP

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Reminder Invitation

To: [EMAIL]
From: [SCE/SDG&E/PG&E/Liberty] Feedback
Subject: Will still want to hear about your experience with the SCE/SDG&E/PG&E/Liberty] transportation electrification program!

Dear [FIRSTNAME AND LASTNAME],

We recently invited you to tell us about your experience with the [SCE/SDG&E/PG&E/Liberty] fleet electrification program. Your experience can provide us with valuable feedback that can help improve program experience for participating fleets. Your input is very important to us, will be kept confidential, and only used to improve our programs for customers like you. **Please take 20 minutes today to**

complete the survey. [IF ELIGIBLE FOR INCENTIVE: For your participation in this survey, you are eligible to receive a $50 gift card (or request that we make a donation).] Survey results are anonymized and the utility will not be able to see respondents' individual responses.

Click the link below to take the survey (or copy and paste into your browser):

[auto-generated link]

If you feel that someone else would be better positioned to answer this survey, could you please forward the email to that person and copy the people on this email?

If you have any questions about this research, or any difficulties taking the survey, please contact Athena Dodd at The Cadmus Group, the national research firm conducting this survey on our behalf. You can reach Athena at (303) 389-2539 or athena.dodd@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

CADMUS PERSON'S FIRST AND LAST NAME
THEIR TITLE
CADMUS GROUP

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Survey Introduction and Screener

Welcome! Thank you for sharing your experience with the [PROGRAM NAME] **program**, offered by [UTILITY]. This survey will take about 20 minutes to complete and will ask questions about fleet electrification and the benefits of transportation electrification. Your responses will remain confidential.

To thank you for your participation, you are eligible to receive a $50 gift card upon completion of the survey. Please note that public fleet employees (e.g. transit agencies, school districts, etc.) are not eligible for the incentive.

[SCREEN OUT TERMINATION MESSAGE:] Those are all the questions we have. Thank you.

A. Overview & Background Information

To begin, we'd like to ask you some general background questions.

A1. What types of vehicles/equipment do you have in your fleet? [SELECT ALL THAT APPLY; FORCE RESPONSE]

- School bus
- Transit bus
- Medium-duty vehicles
- Heavy-duty vehicles
- Port cargo trucks
- Airport ground support equipment
- Forklifts
- Truck refrigeration unit
- Truck stop electrification technology
- Other (#1) [PLEASE SPECIFY]
- Other (#2) [PLEASE SPECIFY]
- Other (#3) [PLEASE SPECIFY]

A2. Please specify the number of internal combustion engine and electric vehicles **currently in your fleet**:

	(1) Number of internal combustion engine vehicles	(2) Number of electric vehicles
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
Other vehicle type; please specify: [OPEN END]		
Other vehicle type; please specify: [OPEN END]		
Total Vehicles	[AUTOSUM]	[AUTOSUM]

A3. Please specify the number of electric vehicles/equipment that you plan to acquire in the next 5 years and in the next 10 years.

	(3) Number of electric vehicles you plan to acquire in the next 5 years	(4) Number of electric vehicles you plan to acquire in the next 10 years
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
Other vehicle type; please specify: [OPEN END]		

	(3) Number of electric vehicles you plan to acquire in the next 5 years	(4) Number of electric vehicles you plan to acquire in the next 10 years
Other vehicle type; please specify: [OPEN END]		
Total Vehicles	[AUTOSUM]	[AUTOSUM]

A4. Are there any other types of vehicles/equipment you plan to electrify in the next 10 years? If so, please state the vehicle/equipment type, the number of vehicles, and the rough timeframe.
1. [OPEN END]

A5. Did your participation in the [PROGRAM NAME] program change the number of electric vehicles you acquired or planned to acquire? [FORCE RESPONSE]
1. Yes
2. No

A6. **[ASK IF A5=1]** How did your participation in the [PROGRAM NAME] program change the number of electric vehicles you acquired or planned to acquire? Please specify the vehicle type, the change in number of vehicles, and the timeframe.
1. [OPEN END]

A7. Since site completion, approximately how many medium- and heavy-duty internal combustion vehicles/equipment have been retired?

A8. Roughly what percent of your fleet's routes are within disadvantaged communities? If you are unsure about which communities are designated as disadvantaged, please reference this map from the CA State government and try to give your best guess.
1. [DROPDOWN WITH PERCENTAGE RANGES OF 10% INCREMENTS]

B. Program Experience

Now, we'd like to ask you a few questions about your experience in **[UTILITY] [PROGRAM NAME]** program.

B1. Thinking about your experience with the **[PROGRAM NAME]** program, how satisfied are you with the following? **[SELECT ONE PER ROW]**

	Very satisfied	Somewhat satisfied	Not too satisfied	Not at all satisfied
[SKIP FOR LIBERTY] Application process (through signing of program participation agreement - includes site assessment and conceptual design)				
Design and permitting process (detailed site design, easement, permitting)				
Construction and installation process (infrastructure construction and installation of customer-side, behind-the-meter infrastructure)				

	Very satisfied	Somewhat satisfied	Not too satisfied	Not at all satisfied
Rebate process (documentation processing, rebate receipt)				
Amount of the rebate you received or expect to receive from [UTILITY] for the purchase of EV charging equipment, if eligible				
Amount of the rebate you received or expect to receive from [UTILITY] for the installation of customer-side, behind-the-meter infrastructure, if eligible				
Benefits you received through the program (i.e., provision of utility-side, to-the-meter infrastructure by [UTILITY])				
Experience working with [UTILITY] staff				
[PROGRAM NAME] program overall				

B2. Are there aspects of the **[PROGRAM NAME]** program that you were particularly **satisfied** with? If so, which ones, and why?

1. [OPEN ENDED]

B3. Are there aspects of the **[PROGRAM NAME]** program that you were particularly **dissatisfied** with? If so, which ones, and why?

1. [OPEN ENDED]

B4. On a scale from 0 to 10, with '10' being the most likely, how likely would you be to recommend this program to another company?

1. [RECORD 0-10 RATING; IF STATING "ALREADY DID RECOMMEND", CODE AS 10]

C. Factors Leading to Successful Fleet Electrification and Lessons Learned

Now, we'd like to talk to you about the fleet electrification process.

C1. Why did your fleet decide to transition to EVs? Select all that apply. **[MULTIPLE RESPONSE] [RANDOMIZE 1-10]**

1. Regulatory requirement
2. Corporate/organizational sustainability goals or initiatives
3. Expected fuel cost savings
4. Expected maintenance cost savings
5. Better technology
6. Driver comfort/ preference
7. Environmental benefits
8. Rebates/incentives for EVs
9. Rebates/incentives for EV charging infrastructure
10. Operational benefits
11. Other, please specify: **[OPEN ENDED]**

C2. How did you first learn about the **[PROGRAM NAME]** program? If there were multiple sources, please select the primary source.

1. From [UTILITY]
2. From an EV/EVSE manufacturer
3. From a contractor/engineer
4. From another fleet
5. Another source, please specify: **[OPEN ENDED]**

C3. How would you rate the reliability of the electric vehicles that are part of your fleet?

1. Very reliable
2. Somewhat reliable
3. Not too reliable
4. Not at all reliable

C4. How would you rate the reliability of the electric vehicle charging equipment? [FORCE RESPONSE]

1. Very reliable
2. Somewhat reliable
3. Not too reliable
4. Not at all reliable

C5. [IF C4 = 3 OR 4] What challenges have you had with the reliability of the electric vehicle charging equipment?

1. [OPEN ENDED]

C6. How would you rate the ease of using the electric vehicle charging equipment?

1. Very easy to use
2. Somewhat easy to use
3. Not too easy to use
4. Not at all easy to use

C7. Prior to joining the program, did you know that you needed upgrades to the electrical infrastructure from the utility grid to your meter to charge electric vehicles at your site?

1. Yes
2. No

C8. Did your site design, procure, install, and maintain the make-ready infrastructure on the customer side of the meter, or did the utility do this work?

1. Our site
2. The utility
3. Don't know

C9. Do you regularly receive information on, or know where to find out how much your electric fuel costs?
1. Yes
2. No

C10. How, if at all, do you engage in load management?
1. By training drivers or other staff to plug in vehicles during off-peak times
2. By using load management options of my fleet's EVs or EV charging equipment
3. By using a software program
4. Our fleet does not engage in load management
5. Other, please specify: **[OPEN ENDED]**

C11. **[ASK IF C10=4]** If you don't currently engage in load management, how, if at all, do you plan to ?
1. By training drivers or other staff to plug in vehicles during off-peak times
2. By using load management options of my fleet's EVs or EV charging equipment
3. By using a software program
4. Our fleet does not plan to engage in load management
5. Other, please specify: [OPEN ENDED]

C12. Thinking about the complete process of electrifying your fleet, what would you have done differently if you were to go through it again, if anything?
1. [OPEN ENDED]

D. Additional Benefits of Transportation Electrification

Next, we would like to ask you questions about the benefits of transportation electrification and fleet drivers' experience.

D1. What ancillary benefits do you think will be realized for your community/fleet as a result of electrifying? These could be benefits to any party, such as your company, your drivers, or your community, among others. **[SELECT ONE PER ROW]**

	I think there will be significant benefits	I think there will be some benefits	I think there will be no benefits	Not sure
Improved air quality/health (i.e., breathing in less pollution)				
Improved driver/passenger comfort/convenience (i.e., easier to drive, smoother to ride in)				
Reduction in noise pollution (i.e., quieter when driving, accelerating)				
Increased fleet flexibility				
Encourages other individuals or fleets to convert to EV				

D2. What other benefits, if any, do you think will be realized for your community/fleet as a result of electrifying? These could be benefits to any party, such as your company, your drivers, or your community, among others.

1. [OPEN END]

E. Cost of Transportation Electrification

Next, we will ask about the operational and ownership costs of fleet electrification.

E1. Please think about all the costs associated with operating and maintaining your fleet. For each cost type shown below, please estimate how much the cost has changed since transitioning your fleet to EVs.

Compared to before transitioning to EVs…

	Costs are now lower	Costs are relatively equal	Costs are now higher	Don't know
Vehicle maintenance costs (i.e., purchasing replacement parts, labor to complete repairs, and regular maintenance)				
Vehicle fueling costs (i.e., the cost of fuel)				
Vehicle fueling infrastructure costs (i.e., the costs of the equipment needed to fuel your fleet)				
Training – drivers				
Training – maintenance staff				
Cost of additional support/staff time				
Cost of additional time on warranty or service claims				
Cost of fueling schedule modifications				
Cost of changes to parking lot configuration				
Cost of route modifications to accommodate range limitations of EVs				
Loss of flexibility				

E2. Have these operational and maintenance costs been what you expected?

	Yes	No, lower than expected	No, higher than expected	Don't know
Vehicle maintenance costs (i.e., purchasing replacement parts, labor to complete repairs, and regular maintenance)				
Vehicle fueling costs (i.e., the cost of fuel)				
Vehicle fueling infrastructure costs (i.e., the costs of the equipment needed to fuel your fleet)				
Training - drivers				
Training – maintenance staff				
Cost of additional support/staff time				
Cost of additional time on warranty or service claims				

	Yes	No, lower than expected	No, higher than expected	Don't know
Cost of fueling schedule modifications				
Cost of changes to parking lot configuration				
Cost of route modifications to accommodate range limitations of EVs				
Cost of needing to maintain ICE vehicles for routes or events that cannot be reliably served by EVs				

E3. Have there been any other impacts/costs you've incurred as a result of electrifying? This could include costs for items such as employee labor, equipment purchases, or space utilization, among others.

1. [OPEN END]

F. Market Impacts, Trends, and Market Barriers

Next, we'd like to ask you about the broader market and what may be preventing further electrification.

F1. How well positioned do you think your industry/sector is for electrification?

1. Extremely well-positioned
2. Somewhat well-positioned
3. Neutral
4. Not too well-positioned
5. Not at all well-positioned

F2. Why did you give this rating?

1. [OPEN ENDED]

F3. Which of the following barriers to electrification did your fleet face before participating in the [PROGRAM NAME] program? [MULTIPLE RESPONSE; RANDOMIZE 1 – 6; FORCE RESPONSE]

1. The cost of the EVs was prohibitive
2. The cost of installing EV charging infrastructure was prohibitive
3. It was challenging to find the right types of EVs for our needs
4. Our routes were too long for the EVs available
5. There was insufficient charging equipment on/near our routes
6. Finding qualified drivers or maintenance technicians for EVs
7. Other, please specify: **[OPEN ENDED]**
8. None of the above **[EXCLUSIVE]**

F4. You mentioned that the following were barriers to electrification before participating in the **[PROGRAM NAME]** program. Do any of these barriers **still exist after you participated in the program**? **[INSERT OPTIONS SELECTED IN F3; MULTIPLE RESPONSE; RANDOMIZE 1 - 6]**

1. The cost of the EVs was prohibitive
2. The cost of installing EV charging infrastructure was prohibitive
3. It is challenging to find the right types of EVs for our needs
4. Our routes are too long for the EVs available
5. There is insufficient charging equipment on/near our routes
6. Finding qualified drivers or maintenance technicians for EVs
7. Other, please specify: **[OPEN ENDED]**
8. None of the above

F5. Do you plan to accelerate procurement of EVs and related equipment because of your experience with the program?

1. Yes
2. No change
3. No, we plan to slow procurement

F6. **[IF F5= 1]** What aspect(s) of the program have impacted your decision to accelerate your procurement of EVs?

1. [OPEN ENDED]

F7. Are you satisfied with current EV options on the market for your sector?

1. Yes
2. No

F8. What are the limitations of current EV options for your sector?

1. [OPEN ENDED RESPONSE]

F9. The purchase price and operating costs (fuel and maintenance) of electric trucks may differ from those of diesel trucks. Given what you know or believe about requirements for fleets to purchase zero-emission medium- and heavy-duty trucks, do electric or diesel trucks seem like a riskier purchase in the **next 3 years**? **[RANDOMIZE ORDER]**

1. **Electric trucks** seem like a riskier purchase
2. **Diesel trucks** seem like a riskier purchase

F10. Given what you know or believe about requirements for fleets to purchase zero-emission medium- and heavy-duty trucks, do electric or diesel trucks seem like a riskier purchase in the **next 10 years**? **[RANDOMIZE ORDER]**

1. **Electric trucks** seem like a riskier purchase
2. **Diesel trucks** seem like a riskier purchase

G. Attribution - Freeridership

G1. If the [UTILITY] fleet electrification program had not been available, which of the following alternatives would your organization most likely have done?

1. Proceeded with a smaller, but similar transportation electrification project (Please specify how much smaller in terms of electric vehicles/chargers (e.g. 10% less, 40% less, etc): _____)
2. Installed/procured an internal combustion engine (ICE) transportation project or whatever was required by regulation
3. Done nothing within 20 years
4. Applied for an exemption
5. Done the same thing as completed through the program
6. Something else (Please specify: _____)

G2. [ASK IF G1≠3, 6] You said previously that your organization would have [G1 RESPONSE]. In terms of timing, if the [UTILITY] fleet electrification program had not been available, when would your organization have [G1 RESPONSE]?

1. At the same time
2. Later, but within 5 years
3. Between 5 and 10 years
4. Between 10 years and 15 years
5. Between 15 years and 20 years
6. More than 20 years
7. Something else (Please specify: _____)

G3. Did your organization learn about the [UTILITY] fleet electrification program **BEFORE** or **AFTER** you decided to implement the transportation electrification project that was eventually implemented?

1. Before
2. After

G4. Please allocate 10 points on the overall importance of the following utility **program factors** versus the most important **non-program factors** in your organization's decision to procure the transportation electrification project. Using a 0 to 10 rating scale, where 0 means "not at all important" and 10 means "extremely important". Please ensure that the two ratings total 10.

1. [Record Program Factors Rating]
2. [Record Non-Program Rating]

Program Factors

1. The availability of the utility program incentives, rebates, or discounts
2. Recommendations or suggestions from utility program staff
3. Recommendations or suggestions from your utility account representative
4. Recommendations or suggestions from a program vendor or contractor

Non-Program Factors

5. Funding sources outside of the utility program
6. Internal policy or requirements inside your company or organization
7. [DISPLAY IF SITE_TYPE= Transit] Transit agency requirements to purchase zero emission bus by January 2023 (for large fleets, acquisition must be 25% for 2023-2025, 50% for 2026-2028, 100% in 2029; for small fleets, 25% for 2026-2028, 100% for 2029;)
8. [DISPLAY IF SITE_TYPE= Distribution] Distribution fleets requirements to meet CARB's pending zero-emission operation targets in 2024 and 2025 (acquisition must be 100% ZEV starting in 2024 OR hit fleet levels of 10% by 2025, 25% by 2028, 50% by 2031, 75% by 2033, 100% by 2035)
9. [DISPLAY IF SITE_TYPE= Airport] Airport group support equipment requirements to meet their initial 2027 compliance targets
10. [DISPLAY IF SITE_TYPE=School Bus] School bus requirements in consideration to meet potential future compliance targets
11. [DISPLAY IF SITE_TYPE= Port] Port cargo truck requirements to meet their initial 2024 compliance targets
12. [DISPLAY IF SITE_TYPE= Forklift] Forklift requirements to meet their future compliance targets
13. Concerns about environmental effects or global warming
14. Your organization's desire to save money on transportation energy costs
15. Your interest in the transportation electrification technology
16. Your desire to reduce operations and maintenance costs
17. Your desire to have the latest technology
18. Your desire to procure transportation electrification to attract employees, for your employees or to improve employee morale

G5. If the utility program had not been available, what is the likelihood that you would have procured exactly the same program-qualifying transportation electrification project that you did through the program. Use a likelihood scale from 0 to 10, where 0 is "not at all likely" and 10 is "extremely likely".

1. [Record Likelihood Rating]

H. Attribution – Participant Spillover

H1. Since you started participating in the program, has your organization decided to electrify more of your fleet **without incentives** from the [UTILITY] fleet electrification program?

1. Yes
2. No [SKIP TO CLOSING]

98. Don't know [SKIP TO CLOSING]

H2. [ASK IF H1=1] Please describe the additional electric vehicle types you have decided to pursue without support from the [UTILITY] fleet electrification.

1. [RECORD VERBATIM]

	(H2.1) Describe vehicle type:	(H2.2) Specify the number of vehicles:	(H2.3) Additional notes:
First vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]	[RECORD VERBATIM]
Second vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]	[RECORD VERBATIM]
Third vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]	[RECORD VERBATIM]
Fourth vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]	[RECORD VERBATIM]
Fifth vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]	[RECORD VERBATIM]

H3. [ASK IF H1=1] Did you receive any financial support from any organization for any of the electric vehicle types?

1. Yes
2. No

98. Don't know

H4. [ASK IF H3=1] H4.1. What organizations provided the financial support? H4.2. What type and amount of financial support did you receive from each?

	(H4.1) What organization provided the financial support?	(H4.1) What type and amount of financial support did you receive?
First vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]
Second vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]
Third vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]
Fourth vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]
Fifth vehicle type	[RECORD VERBATIM]	[RECORD VERBATIM]

H5. [ASK IF H1=1] How important was your participation in the [UTILITY] fleet electrification program on your decision to electrify more of your fleet without program support? Using a scale from 0 to 10, where 0 is "not at all important" and 10 is "extremely important".

1. [RECORD RATING]

I. Closing

I1. [ASK ONLY IF ELIGIBLE FOR INCENTIVE] Those are all the questions we have. Thank you for your responses. To receive a $50 gift card for your participation, please enter your email address below. Alternatively, please check the "donation" option to have the $50 donated to the American Red Cross. Please note that public fleet employees (e.g., transit agencies, school districts, etc.) are not eligible for the incentive.

1. Email address: [OPEN ENDED]
2. Please donate the $50 gift card

End of Survey Message

Thank you for your responses! In addition to this survey, we are also conducting interviews with a select number of fleet managers to discuss specific topics. We may reach out to you in the future about an interview. We appreciate your time and assistance.

SRP Evaluation: MDHD Fleet Dropout Online Survey

This survey seeks to learn more from program applicants (site hosts, fleet managers, or other relevant staff) who ended or indefinitely paused their participation in the California SRP to electrify Medium-Duty and/or Heavy-Duty (MDHD) fleet vehicles. Questions in this survey seek to understand applicants' experience with the program, including their initial interest as well as factors that contributed to ending or pausing participation. Additionally, this survey will seek to understand the applicants' perspective on the EV market overall and their fleet readiness for electrification. This survey is designed to take 15 minutes to administer through an online platform.

Research Objectives
1. Identify the factors that facilitate successful fleet electrification and lessons learned
Why did the applicant decide to pursue electrification initially? What benefits did applicants think they might gain from electrifying?
How satisfied were applicants with the program overall? How does overall satisfaction vary by market sector?
Would applicants who withdrew from the program say that the program provides appropriate financial and non-financial support?
Why did applicants decide to drop out of the program?
What factors would have facilitated applicant participation in the program, if any?
What would applicants have done differently, if anything?
What did applicants do instead of pursuing fleet electrification through the program?

Target Audience: Utility customers who submitted an application and subsequently withdrew from the program. This excludes applicants who were deemed ineligible for the program.

Desired number of completions: Census of all sites that withdrew from the program (specific numbers TBD based on program data)

Estimated timeline for fielding: First wave of Fleet Withdrawal survey was conducted in Q1 2022 for PG&E and SCE. Second wave to be conducted in Q1 2023 for PG&E, SCE, and SDG&E. Third and final wave to be conducted in Q1 2024, depending on the length of the programs.

Variables to be Pulled into Survey

- **Email**
- **FirstName**
- **LastName**
- **UTILITY (SCE, SDG&E, PG&E; read-in)**
- **PROGRAM_NAME (read-in; does not include "program" i.e., "EV Fleet" for PG&E)**
- **Organization**

Email Invitation

To: [EMAIL]
From: [Cadmus]
CC: [SCE/SDG&E/PG&E MDHD PM and Customer Account Manager]
Subject: Survey regarding your experience with the [SCE/SDGE&E/PG&E] [PROGRAM NAME] program

Dear [FIRSTNAME AND LASTNAME],

Thank you for applying for the [SCE/SDG&E/PG&E] [PROGRAM NAME] program. Our records indicate you did not complete an EV charging project as a part of [PROGRAM NAME] program. Through the following survey, you can provide valuable feedback about how to improve the program experience for fleets in the future. Your input is very important to us and will be kept confidential and only used for research purposes. **The survey will take no more than 15 minutes to complete**. [IF ELIGIBLE FOR INCENTIVE: For your participation in this survey, you are eligible to receive a $50 gift card.]

Click the link below to take the survey:

[auto-generated link]

Or you may copy and paste the URL below into your internet browser: [auto-generated url]

If you have any questions about this research, or any difficulties taking the survey, please contact Athena Dodd at The Cadmus Group, the national research firm conducting this survey on the utility's behalf. You can reach Athena at (303) 389-2539 or athena.dodd@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

CADMUS PERSON'S FIRST AND LAST NAME
THEIR TITLE
CADMUS GROUP

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Reminder Invitation

To: [EMAIL]
From: [Cadmus]
CC: [SCE/SDG&E/PG&E MDHD PM and Customer Account Manager]
Subject: Still interested in your experience with the [SCE/SDG&E/PG&E] [PROGRAM NAME] program!

Dear [FIRSTNAME AND LASTNAME],

We recently invited you to tell us about your experience with the [Utility] [PROGRAM NAME] program. Your experience can provide us with valuable feedback that can help improve program experience for participating fleets. Your input is very important to us, will be kept confidential, and only used to improve our programs for customers like you. **Please take 15 minutes today to complete the survey**. Please note that public fleet employees (e.g., transit agencies, school districts, etc.) are not eligible for the $50 gift certificate.

Click the link below to take the survey:

[auto-generated link]

Or you may copy and paste the URL below into your internet browser: [auto-generated url]

If you have any questions about this research, or any difficulties taking the survey, please contact Athena Dodd at The Cadmus Group, the national research firm conducting this survey on the utility's behalf. You can reach Athena at (303) 389- 2539 or athena.dodd@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

CADMUS PERSON'S FIRST AND LAST NAME
THEIR TITLE
CADMUS GROUP

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Survey Introduction and Screener

Welcome! Thank you for sharing your experience with the [PROGRAM NAME] program, offered by [UTILITY]. This survey will take 15 minutes to complete and will ask questions about factors that facilitate fleet electrification, barriers to fleet electrification, and your experience with the program. [IF ELIGIBLE FOR INCENTIVE: To thank you for your participation, you are eligible to receive a $50 gift card upon completion of the survey.]

Your responses will remain confidential.

[SCREEN OUT TERMINATION MESSAGE:] Those are all the questions we have. Thank you for taking the time to complete this survey.

A. Overview & Background Information

To begin, we'd like to ask you some general background questions on your fleet.

A1. What types of vehicles/equipment do you have in your fleet? [SELECT ALL THAT APPLY] [REQUIRE QUESTION]

1. School bus
2. Transit bus
3. Medium-duty vehicles
4. Heavy-duty vehicles
5. Port cargo trucks
6. Airport ground support equipment
7. Forklifts
8. Truck refrigeration unit
9. Truck stop electrification technology
10. Other (#1) [PLEASE SPECIFY]
11. Other (#2) [PLEASE SPECIFY]
12. Other (#3) [PLEASE SPECIFY]

A2. For each type of vehicle/equipment in your fleet, please specify the number of internal combustion engine vehicles in your fleet, and the number of electric vehicles in your fleet.

	(1) Number of internal combustion engine vehicles/equipment currently in your fleet	(2) Number of electric vehicles/equipment currently in your fleet
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
Other vehicle/equipment type; please specify: [OPEN END]		
Other vehicle/equipment type; please specify: [OPEN END]		
Total Vehicles	[AUTOSUM]	[AUTOSUM]

A3. Of the internal combustion engine vehicles in your fleet, please specify the number of vehicles you **considered electrifying through the [PROGRAM NAME] program**, and the number you **considered electrifying outside of the [PROGRAM NAME] program**.

	(3) Vehicles/equipment you originally planned to electrify through the program	(4) Vehicles/equipment you originally planned to electrify outside of the program
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
[VEHICLE SELECTED IN A1]		
Other vehicle/equipment type; please specify: [OPEN END]		
Other vehicle/equipment type; please specify: [OPEN END]		
Total Vehicles	[AUTOSUM]	[AUTOSUM]

A4. Of all the vehicles in your fleet that you originally planned to electrify when you applied to the [PROGRAM NAME] program, **how many have you electrified**? Please specify the number of each type of vehicle.

	(1) Number you said you planned to electrify in the prior question	(2) Number of vehicles/equipment actually electrified
[INSERT VEHICLE TYPES LISTED IN A2		
[INSERT VEHICLE TYPES LISTED IN A2]		

A5. Are there any other vehicles not listed in the prior questions that you planned to electrify? If so, please state the vehicle/equipment type, the number of vehicles, and the rough timeframe.

- [OPEN END]

B. *Program Experience*

The following questions seek to understand your interest and experience in the **[PROGRAM NAME]** program.

B1. Why did your fleet initially intend to transition to EVs? Select all that apply. **[RANDOMIZE 1-9; MULTIPLE RESPONSE]**

- Regulatory requirement
- Corporate/organizational sustainability goals or initiatives
- Expected fuel cost savings
- Expected maintenance cost savings
- Better technology
- Driver comfort/preference
- Environmental benefits
- Rebates/incentives for EVs
- Rebates/incentives for EV charging infrastructure
- Other, please specify: **[WITH WRITE IN OPTION]**

B2. How satisfied were you with the **[PROGRAM NAME]** program overall?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

B3. How satisfied were you with the application process for the **[PROGRAM NAME]** program?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

B4. How satisfied were you with the application timeline for the **[PROGRAM NAME]** program?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

B5. How satisfied were you with the level of program services (e.g., site planning, provision of to-the-meter infrastructure) from **[UTILITY]** offered as a part of the **[PROGRAM NAME]** program?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
5. I wasn't aware of the program services offered as part of the program

B6. How satisfied were you with the amount of the rebates offered from **[UTILITY]** as a part of the **[PROGRAM NAME]** program if eligible?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied
5. I wasn't aware of the amount of the rebates offered as part of the program

B7. How satisfied were you with your experience working with **[UTILITY]** staff?

1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not at all satisfied

B8. Did you install any EV charging equipment without the rebates offered from **[UTILITY]** as a part of the **[PROGRAM NAME]** program?

1. Yes [ASK B9]
2. No

B9. [ASK IF B8=1] Did you receive any rebates or incentives to cover some of the cost of the EV charging equipment? If so, please specify where the rebates or incentives came from.

1. Yes, please specify: [OPEN END]
2. No

B10. In your opinion, what kinds or levels of services should the [**PROGRAM NAME]** program be offering? **[RANDOMIZE 1-4; MULTIPLE RESPONSE]**

1. Increased technical support on electric vehicles
2. Increased technical support on EV charging equipment
3. Increased utility-side make-ready infrastructure support
4. Increased customer-side make-ready infrastructure support
5. Other, please specify: **[OPEN ENDED]**

B11. In your opinion, what types of costs should the [**PROGRAM NAME]** program rebates apply to? **[RANDOMIZE 1-3; MULTIPLE RESPONSE]**

1. Construction costs
2. EVSE costs
3. Vehicle costs
4. Other, please specify: **[OPEN ENDED]**

B12. Did your organization proceed with any of the intended EV charging outside of this program?

1. Built project as intended
2. Built project scaled down from intended plan:
3. What would have been different from the intended plan? [OPEN ENDED]
4. Decided not to incorporate EVs into the fleet
5. Put project on temporary hold **[ASK B14B14]**
6. Built project through utility's general distribution service planning program (Rule 28/29/45)
7. Other, please specify: **[OPEN ENDED]**

B13. **[ASK IF** B12=1, 2, OR 6**]** How important was your experience with the [PROGRAM NAME] program on your decision to build EV charging infrastructure outside of the [PROGRAM NAME] program?

1. Very important
2. Somewhat important
3. Not too important
4. Not at all important

[ASK IF **B12=5**]

B14. If project is on temporary hold, which of the following best represents its current status?

1. Pending funding from a specific source (or sources), please specify: **[OPEN ENDED]**
2. Pending further action from the utility, please specify: **[OPEN ENDED]**
3. Pending procurement or delivery of electric vehicles or equipment, please specify: **[OPEN ENDED]**
4. Pending procurement or delivery of EV charging equipment, please specify: **[OPEN ENDED]**
5. Pending for some other reason, please specify: **[OPEN ENDED]**

C. Reasons for Dropping Out of the Program

Next, we would like to ask you questions about why you decided to end your participation in the program.

C1. What were the main reasons why your organization decided to stop participating in the program? Select all that apply. **[SELECT ALL THAT APPLY] [RANDOMIZE 1-16]**

1. Vehicle costs
2. Charging equipment costs
3. Behind-the-meter make-ready costs
4. Inability to obtain easements
5. Difficulty hiring contractors to install the behind-the-meter infrastructure or EV chargers
6. Labor costs
7. Lack of availability of electric vehicles/equipment that met my fleet's needs
8. Inadequate incentives
9. Lack of utility support for behind-the-meter make-ready process
10. Required too much time

11. Training requirements
12. Driver hesitancy
13. Reliability concerns with EVs or EV chargers
14. Return-on-investment was too long
15. Timeline to receive vehicles is too long
16. Other organizational priorities for funds/other stakeholder input
17. Other, please specify: **[WITH WRITE IN OPTION]**

C2. What factors would have enabled your continued participation in the program, if any? Select all that apply. **[RANDOMIZE 1-5; SELECT ALL THAT APPLY]**

1. Lower costs of or higher rebates for charging infrastructure
2. More utility support for behind-the-meter make-ready process
3. More knowledge sharing with other fleet managers electrifying their fleets
4. Ability to obtain easement
5. Lower costs of or more funding for the electric vehicles/equipment
6. More availability of electric vehicles/equipment that meet my fleet's needs
7. Greater interest from drivers
8. Greater interest from other organizational stakeholders or decisionmakers
9. Other, please specify: **[WITH WRITE IN OPTION]**

C3. Based on your experience with fleet electrification so far, what would you recommend to other utility customers who may be going through this process or considering it?

1. [OPEN ENDED]

C4. What, if anything, would you recommend **[UTILITY]** change about the program to improve it?

1. [OPEN ENDED]

End of Survey Message

Those are all the questions we have. Thank you for your responses.

[IF ELIGIBLE FOR INCENTIVE] To receive a $50 gift card for your participation, please enter your email address below. Alternatively, please check the "donation" option to have the $50 donated to the American Red Cross. Please note that public fleet employees (e.g. transit agencies, school districts, etc.) are not eligible for the incentive.

1. Email address: **[OPEN ENDED]**
2. **Please donate the $50 gift card**

SRP Evaluation: Fleet Driver Online Survey

This survey is designed to assess participating fleet drivers' experience driving a Medium-Duty and/or Heavy-Duty (MDHD) Electric Vehicle (EV) as a part of the California Transportation Electrification Standard Review Projects. Questions in this survey pertain to the user experience, observed benefits, and challenges associated with the EV and related charging infrastructure. This survey should take approximately 15 minutes for the driver to complete.

Research Objectives	Corresponding Question Numbers
1. Assess participating driver experience with EV infrastructure	
Did drivers receive training to operate an EV?	A8 - A11
How satisfied are fleet drivers with their EV, including its range, and its charging station(s)?	B1 - B5
How reliable and user-friendly are the charging stations?	B8 - B9
2. Explore the benefits/operational impacts of TE for fleet drivers	
Have drivers observed any benefits of electrification associated with improved air quality and health outcomes?	C2 - C3
Have drivers observed any benefits of electrification associated with comfort or convenience?	C4 - C5
Have drivers observed any benefits of electrification associated with noise pollution?	C6 - C7
Have drivers experienced challenges driving an EV or using the associated EV charging stations? Have the charging stations been sufficient?	D1 - D4
How has a driver's job changed now that they are driving an EV?	D5

Target Audience: Fleet drivers in California Standard Review Projects

Target Quota = Representative sample of drivers from a subset of fleets (final sampling TBD)

General Instructions

- Interviewer instructions are in green **[LIKE THIS]** (the style is "Survey: Interviewer Instructions").
- CATI programming instructions are in red **[LIKE THIS]** (the style is "Survey: Programming").
- Items that should not be read by the interviewer are in parentheses like this ( ).

Variables to be Pulled into Survey

- Contact name
- Contact email address
- Contact phone number
- Company name
- Utility name
- Program Name

Email Invitation

To: [EMAIL]
From: Cadmus
Subject: Survey on your experience driving an electric vehicle

Dear [FIRSTNAME AND LASTNAME],

As part of your company's participation in the [SCE/SDG&E/PG&E/Liberty] [PROGRAM NAME] program to support transportation electrification, we are conducting surveys with drivers of electric vehicles. Through the following survey, you can provide valuable feedback about how to improve the program for fleets in the future. Your input is very important to us and will be kept confidential and only used for research purposes. **The survey will take 15 minutes to complete**. **[IF NON-PUBLIC SECTOR ENTITY, DISPLAY:** As an appreciation for your time, **we'd like to offer you a $20 gift card** upon completion of the survey.**]**

Click the link below to take the survey:

[auto-generated link]

Or you may copy and paste the URL below into your internet browser: [auto-generated url]

If you have any questions about this research, or any difficulties taking the survey, please contact Athena Dodd at The Cadmus Group, the national research firm conducting this survey on our behalf. You can reach Athena at (303) 389-2539 or athena.dodd@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Reminder Invitation

To: [EMAIL]
From: Cadmus
Subject: We still want to hear about your experience driving an electric vehicle!

Dear [FIRSTNAME AND LASTNAME],

We recently invited you to tell us about your experience driving an electric vehicle. Your experience can provide us with valuable feedback that can help improve utility programs for fleet electrification. Your input is very important to us, will be kept confidential, and only used to improve our programs for customers like you. **Please take 15 minutes today to complete the survey**. **[IF NON-PUBLIC SECTOR ENTITY, DISPLAY:** As an appreciation for your time, **we'd like to offer you a $20 gift card** upon completion of the survey.**]**

Click the link below to take the survey:

[auto-generated link]

Or you may copy and paste the URL below into your internet browser: [auto-generated url]

If you have any questions about this research, or any difficulties taking the survey, please contact Athena Dodd at The Cadmus Group, the national research firm conducting this survey on our behalf. You can reach Athena at (303) 389- 2539 or athena.dodd@cadmusgroup.com.

Thank you in advance for sharing your experiences and your time.

CLIENT CONTACT PERSON'S FIRST AND LAST NAME
THEIR TITLE
COMPANY NAME

Survey Introduction and Screener

[RECOMMENDED: CLIENT-APPROVED LOGO TO APPEAR ON START SCREEN]

Welcome! Thank you for sharing your experience with driving an electric vehicle, whose charging infrastructure was supported through the [PROGRAM NAME] program, offered by [SCE/SDG&E/PG&E/Liberty]. This survey will take 15 minutes to complete and will ask questions about your experience driving an EV and using the associated charging infrastructure. **[IF NON-PUBLIC SECTOR ENTITY, DISPLAY: As an appreciation for your time, we'd like to offer you a $20 gift card** – please enter your information at the end of the survey to receive the gift card.**]**

Your responses will remain confidential and will only be used for research purposes.

[SCREEN OUT TERMINATION MESSAGE:] Those are all the questions we have. Thank you for taking the time to complete this survey.

A. Background

The following questions pertain to background information on your current role, any relevant training you received, and your level of satisfaction with the EV you drive and its associated charging stations.

A1. What type of electric vehicle do you primarily operate? **[SINGLE RESPONSE]**

1. School Bus
2. Transit Bus
3. Medium-duty vehicles
4. Heavy-duty vehicles
5. Port cargo trucks
6. Airport ground support equipment
7. Forklift
8. Vehicle with an electric transport refrigeration unit (eTRU)
9. Other [WITH WRITE IN OPTION]
10. I do not drive an electric vehicle for **[COMPANY NAME]**.

A2. When (month/year) did you begin **operating the EV**/EV equipment for your company's/organization's fleet?

1. [OPEN ENDED RESPONSE]

A3. How often do you charge the EV/EV equipment you operate for **[COMPANY NAME]**?

1. Less than once per day
2. Once per day
3. Twice per day
4. More than twice per day

A4. What time(s) of day do you typically charge the EV/EV equipment? **[ACCEPT MULTIPLE RESPONSES]**

1. Morning
2. Night
3. Middle of the day
4. Other [WITH WRITE IN OPTION]

A5. How much time is needed to charge the EV/EV equipment to be ready for your shift?

1. Less than 30 minutes
2. 30 minutes – 1 hour
3. 1-3 hours
4. 3-5 hours
5. 5-7 hours
6. More than 7 hours
7. Don't know

A6. How much time is needed to fully charge the EV/EV equipment?
1. Less than 30 minutes
2. 30 minutes – 1 hour
3. 1-3 hours
4. 3-5 hours
5. 5-7 hours
6. More than 7 hours
7. Don't know

A7. How many miles do you typically drive the EV/EV equipment on your shift for **[COMPANY NAME]**? Would you say:
1. Less than 25 miles
2. 25-74 miles
3. 75-124 miles
4. 125-174 miles
5. 175-224 miles
6. 225 miles or more
7. Don't know

A8. Did you receive any training to operate your EV/EV equipment?
1. Yes **[ASK A9-A11]**
2. No

[ASK A9-A11 IF A8 = Yes]

A9. What did the training to operate the EV/EV equipment consist of? **[MULTI-SELECT]**
1. Received a training manual to operate the vehicle/equipment
2. Received a training manual to charge the vehicle/equipment at the charging station
3. Received onsite training to operate the vehicle/equipment
4. Received onsite training to charge the vehicle/equipment at the charging station
5. Other [WITH WRITE IN OPTION]

A10. Who provided the training? Was it:
1. Your company
2. The vehicle/equipment original equipment manufacturer
3. The vehicle/equipment distributor/supplier
4. The charging station provider
5. Other [WITH WRITE IN OPTION]
6. Don't know

A11. How helpful was the training?
1. Very helpful
2. Somewhat helpful
3. Not too helpful
4. Not helpful at all

B. User Experience and Satisfaction

The following questions are designed to gain a better sense of your experience driving an EV and using the related charging equipment.

B1. How satisfied are you with the experience of operating the EV/EV equipment?
1. Very satisfied
2. Somewhat satisfied [ASK B2]
3. Not too satisfied [ASK B2]
4. Not satisfied at all [ASK B2]

[ASK IF B1= 2, 3, or 4]

B2. Why do you say you are **[INSERT SELECTED OPTION]** with your experience operating the EV/EV equipment?
1. [OPEN ENDED RESPONSE]

B3. How satisfied are you with the range of your EV/EV equipment?
1. Very satisfied
2. Somewhat satisfied
3. Not too satisfied
4. Not satisfied at all

B4. How satisfied are you with your experience using the charging stations at your company's site?
1. Very satisfied
2. Somewhat satisfied [ASK B5]
3. Not too satisfied [ASK B5]
4. Not satisfied at all [ASK B5]

[ASK IF B4 = 2, 3, or 4]

B5. Why do you say you are **[INSERT SELECTED OPTION]** with using the charging stations?
1. [OPEN ENDED RESPONSE]

B6. How reliable would you say the EV/EV equipment you operate is?
1. Very reliable
2. Somewhat reliable [ASK B7]
3. Not too reliable [ASK B7]
4. Not at all reliable [ASK B7]

[ASK IF B6 = 2, 3, or 4]

B7. Why do you say the EV/EV equipment is **[INSERT SELECTED OPTION]**?
1. [OPEN ENDED RESPONSE]

B8. Compared to operating a vehicle with an internal combustion engine, would you say **operating the EV/EV equipment** is overall:
1. Easier to drive
2. About the same driving experience
3. Not as easy to drive

B9. Compared to refueling a vehicle with an internal combustion engine, would you say **using the charging stations for the EV/EV equipment** is overall:
1. Easier to use
2. About the same user experience
3. Less easy to use

C. Benefits of Operating an EV/EV equipment

The following questions pertain to your experience operating the EV/EV equipment compared to an internal combustion engine vehicle/equipment.

C1. Since you began operating the EV/EV equipment for **[COMPANY NAME]**, what benefits, if any, have you noticed compared to operating an internal combustion engine vehicle or equipment?
1. [OPEN ENDED]
2. I have not noticed any benefits

C2. Based on your experience operating the EV/EV equipment, have you noticed an **improvement in air quality or health**, such as reduced exposure to exhaust, compared to operating internal combustion engine vehicles or equipment?
1. Yes, I've definitely noticed this [ASK C3]
2. Yes, I've somewhat noticed this [ASK C3]
3. No, I have not noticed this

[ASK IF C2 = 1 or 2]

C3. Which air quality or health improvements have you observed?
1. [OPEN ENDED RESPONSE]

C4. Based on your experience operating the EV/EV equipment, have you noticed an **improvement to your comfort or convenience**, such as better ride or vehicle/equipment performance compared to operating internal combustion engine vehicles or equipment?
1. Yes, I've definitely noticed this [ASK C5]
2. Yes, I've somewhat noticed this [ASK C5]
3. No, I have not noticed this

[ASK IF C4 = 1 or 2]

C5. What comfort or convenience improvements have you observed?
1. [OPEN ENDED RESPONSE]

C6. Based on your experience operating the EV/EV equipment have you noticed a **reduction in noise** compared to operating internal combustion engine vehicles/equipment?
1. Yes, I've definitely noticed this [ASK C7]
2. Yes, I've somewhat noticed this [ASK C7]
3. No, I have not noticed this

[ASK IF C6 = 1 or 2]

C7. Which noise reduction(s) have you observed?
1. [OPEN ENDED RESPONSE]

D. Challenges of Operating the EV/EV Equipment

The following questions pertain to any challenges you have experienced operating the EV/EV equipment compared to internal combustion engine vehicle/equipment and using the associated charging stations.

D1. Have you experienced any challenges operating the EV/EV equipment?
1. Yes [ASK D2]
2. No

[ASK IF D1 = Yes]

D2. What kind of challenges have you experienced?
1. Difficult to find charging stations
2. Insufficient vehicle/equipment range
3. Requires charging more frequently than I expected
4. Is more challenging to drive/operate
5. Is unreliable or requires more maintenance than I expected
6. Other [OPEN ENDED]

D3. Are the current charging stations sufficient for the EV/EV equipment you operate?
1. Yes
2. No [ASK D4]

[ASK IF D3 = NO]

D4. In what ways are the EV charging stations lacking?

1. Difficult to find
2. Not enough charging stations
3. Difficult to use/operate the charging stations
4. Charging stations are located out of my way
5. Charging stations take longer to charge the EV/EV equipment than I expected
6. Charging stations are unreliable or require more maintenance than I expected
7. Other [WITH WRITE IN OPTION]

D5. How has your job changed now that you are driving an EV? Select all that apply. [RANDOMIZE 1-8]

1. More training requirements
2. More concern over range
3. Quieter ride/operation
4. Better driving experience
5. Less air pollution
6. Better towing capability
7. Improved job satisfaction/enjoyment, please specify how: ________ [WITH WRITE IN OPTION]
8. Nothing; my job has remained the same
9. Other [WITH WRITE IN OPTION]

E. Closing

E1. Do you have any other comments or questions for **[UTILITY NAME]** at this time? Please feel free to share any feedback you have about operating or charging the EVs/EV equipment, whether positive or negative.

1. [OPEN ENDED RESPONSE]

E2. **[ONLY DISPLAY IF NON-PUBLIC SECTOR ENTITY]** As an appreciation for taking the time to complete the survey, we'd like to offer you a $20 gift card. Please enter your information below to receive the gift card. You can expect to receive this gift card via email within 6-8 weeks.

1. Name: ____________________
2. Email address: _________________

Those are all the questions we have. Thank you for your time.

SRP Evaluation: EVSP Interview Guide

Research Objective Map

Objective Sources	Research Questions	Corresponding Guide Questions
Objective 1: Acceleration of TE	What barrier(s) did the TE investment overcome, and what barriers remain?	E1,E2,G1
	How, if at all, did the program contribute to a more mature market supply chain (e.g., by spurring product improvements, supply chain improvements, cost improvements, or service improvements)?	E4
Objective 2: Maximize Benefits	Did the project go according to plan? What caused delays, and what could help reduce delays?	B1,B2,B3,B5,B6,B7
	How could program efficiencies lead to lower costs for the same impact?	B8,E4,E5
	What other support do you need from utilities? What can utilities do to reduce barriers? Can utilities help to scale up electrification over time?	C2,E3
	How can load management be employed to reduce impacts on the electricity grid?	D4,D5,D6
Objective 3: Maximize Learnings	How could the fleet manager, site host, and driver experience be improved?	C1,C1.1,C1.2,C3,C3.2
	Which fleet types, vehicles, applications, or routes are best suited for electrification and how can the Utility develop more partnerships for these best matches?	F1,F2,F3
	Is the market maturing enough to spur rapid naturally occurring uptake?	F4
	How can the data collection process be improved?	D1,D2,D3, D7

Recruitment

Hello,

I am reaching out because your company is an EV Service Provider for fleets in **[UTILITY NAME]'s [PROGRAM NAME]**. The goal of **[PROGRAM NAME]** is to help accelerate the electrification of vehicle fleets across the state of California, and as an EVSP your company is a key partner. We're very interested in learning about your company's experience with this utility program, and would appreciate the opportunity to discuss your experience and **[PROGRAM NAME]**. This interview will help us better understand your products and services, and also help improve the program.

We anticipate this interview will take approximately one hour, and we are currently scheduling for **[INSERT TWO-DAY TIME PERIOD UP TO ONE WEEK IN ADVANCE]**. Please let me know if those days work for you, and any time restrictions. From there, I would be happy to send you some options for a good time for a call.

Thank you in advance for your time and looking forward to hearing from you!

[NAME]

A. Introduction and Background

Hello, my name is [**NAME**] calling on behalf of **[UTILITY/FLEET]**. Thank you for taking the time to speak with us today. We are here to talk the impacts of fleet electrification from **[UTILITY]**'s **[PROGRAM]**. The overarching purpose of this interview is to learn about the early stages of the **[PROGRAM]** and learn more about your company's experience with it as an EVSP. You may not have answers to some of the questions yet, and we completely understand. Before we get started, do you have any questions for me?

A1. Please note that all your individual responses will remain anonymous, so we encourage your candid feedback. Is it ok if I record this call? [y/n]__________First, I have a few basic questions about your company and your role(s). Could you briefly introduce yourself(ves), and describe your role with [**COMPANY**]?
   1. [IF INFORMATION AVAILABLE, USE A2 TO CONFIRM]

A2. We understand that your company is in the [SECTOR/INDUSTRY]. Is this correct? [Electric Vehicle Service Provider (EVSP); Software integrator; Charge controller vendors; Electrical contractors; other entity. Near-term focus is EVSP.]

A3. [IF INFORMATION UNAVAILABLE FROM PROGRAM DATA, ASK 1-2 AS NEEDED]
   1. How aware of [SCE/PG&E/SDG&E]'s [Charge Ready Transport/EV Fleet/Power Your Drive for Fleets] program are you?
   2. Approximately how many Level 2 and DCFC EVSE do you operate or have you sold in [**UTILITY**] territory?

B. Infrastructure Installation and Interoperability

[ASK ONLY IF EVSP IS INVOLVED IN INSTALLATIONS AND HAS COMPLETED INSTALLATIONS THROUGH THE PROGRAM] Now, let's talk about the installation of chargers.

B1. [TIE BACK TO (ROLES AND RESPONSIBILITIES)] What went well about the installation process?

B2. What challenges did you face during the installation process?

B3. What, if anything, would you change about the process going forward?

B4. **[IF SUGGESTED CHANGES]** Have any steps been taken to make these types of changes?

B5. **[IF SUGGESTED CHANGES]** What, if any, barriers are there to making these changes?

B6. What factors could speed up the installation process? [PROBE: design (customer's design engineer), supply chain, incentives]

B7. Would you recommend that we speak with the installation contractors that you worked with, or any other vendors who were involved in the project? [**Probe: contact information**]

B8. We understand it's still early in the program, but do you have ideas on what might drive the differences in costs between projects installing comparable EVSE?

B9. What issues, if any, have there been regarding interoperability between the EVSE and the EVs?

C. Fleet Owner, Site Host, and Driver Experience

Now let's talk a little about the fleet owners. These are the entities who own (or lease) the medium- and heavy-duty vehicles supported through this program.

C1. Have you had fleet owner interaction?

1. **[If YES to C1]**, What aspects of the program, if any, do you think are particularly helpful to fleet owners?
2. **[If YES to C1]**, What aspects of the program, if any, do you think are particularly challenging for fleet owners?

C2. **[If YES to C1]**, Do you think there is enough interest from fleet owners to warrant the utility expanding the program such as with increased technical assistance and incentive funds?

1. [IF YES] In what ways? [PROBE FOR OPPORTUNITIES FOR DESIGN CHANGES, IN TERMS OF ELIGIBILITY CRITERIA, TECHNICAL ASSISTANCE, INCENTIVE LEVELS, ETC.]
2. [IF NO] What do you think could increase fleet owner interest? [PROBE FOR OPPORTUNITIES TO MAKE DESIGN CHANGES]

C3. **[If YES to C1]**, Was the site host (the owner of the property on which the EVSE was installed) a different entity from the fleet owner (the one responsible for the vehicles)?

1. **[IF YES]** Did this present any challenges to project execution? If so, how could such challenges be addressed?
2. **[If YES to C1]**, At this point in the program, have you been able to gain any insights from the drivers of the fleet vehicles about the EVSE or the EVs? If so, what feedback have you received so far?

D. Data Collection and Load Management

D1. How has the data collection process gone so far?

D2. Are there any data that are difficult to collect or report on?

D3. [EVSP only] How do your staff measure equipment reliability? Is equipment regularly tested?

D4. To what extent are customers using your portal or other online tool to track electricity usage, bills, and costs?

D5. To what extent are customers employing the load management features of your EVSE systems? What type of load management technologies are being coupled with the EVSE systems? What do you see as the barriers to implementing load management?

D6. How are you helping customers implement load management?

D7. Are there additional data parameters that you feel should be collected by your company, by [UTILITY], or by other entities??

E. Barriers to Electrification

E1. What barriers does your company see, broadly speaking, that inhibit fleet electrification?

E2. Has [UTILITY PROGRAM] helped in overcoming any of these barriers? Which ones specifically did it help most with?

E3. What other support do you need from utilities to increase electrification?

E4. Has [Vendor] been able to introduce any improvements in supply chain, cost efficiency, or other factors of product production and delivery as a result of the program? [Probe: with supply chain issues, possibly shifting limited product supply to CA due to program?]

E5. What features of [UTILITY PROGRAM] or fleet customers impact the cost-effectiveness of fleet electrification?

F. Technology Fit with Fleet Electrification

F1. How is your company working to meet the charging needs of different types of fleets?

F2. What technological advancements do you expect in vehicle-charger communication in the next five years?

F3. What improvements are you prioritizing that might impact electrification or the grid?

F4. Do you think more or different programs or policies are needed to help the market reach sufficient maturity for rapid and naturally occurring uptake? If so, what types of programs or policies?

G. *Closing*

G1. Is there anything else you'd like to mention that we haven't already covered?

Those are all our questions for today. Thank you so much for your time, we really appreciate it. Have a great rest of your day.