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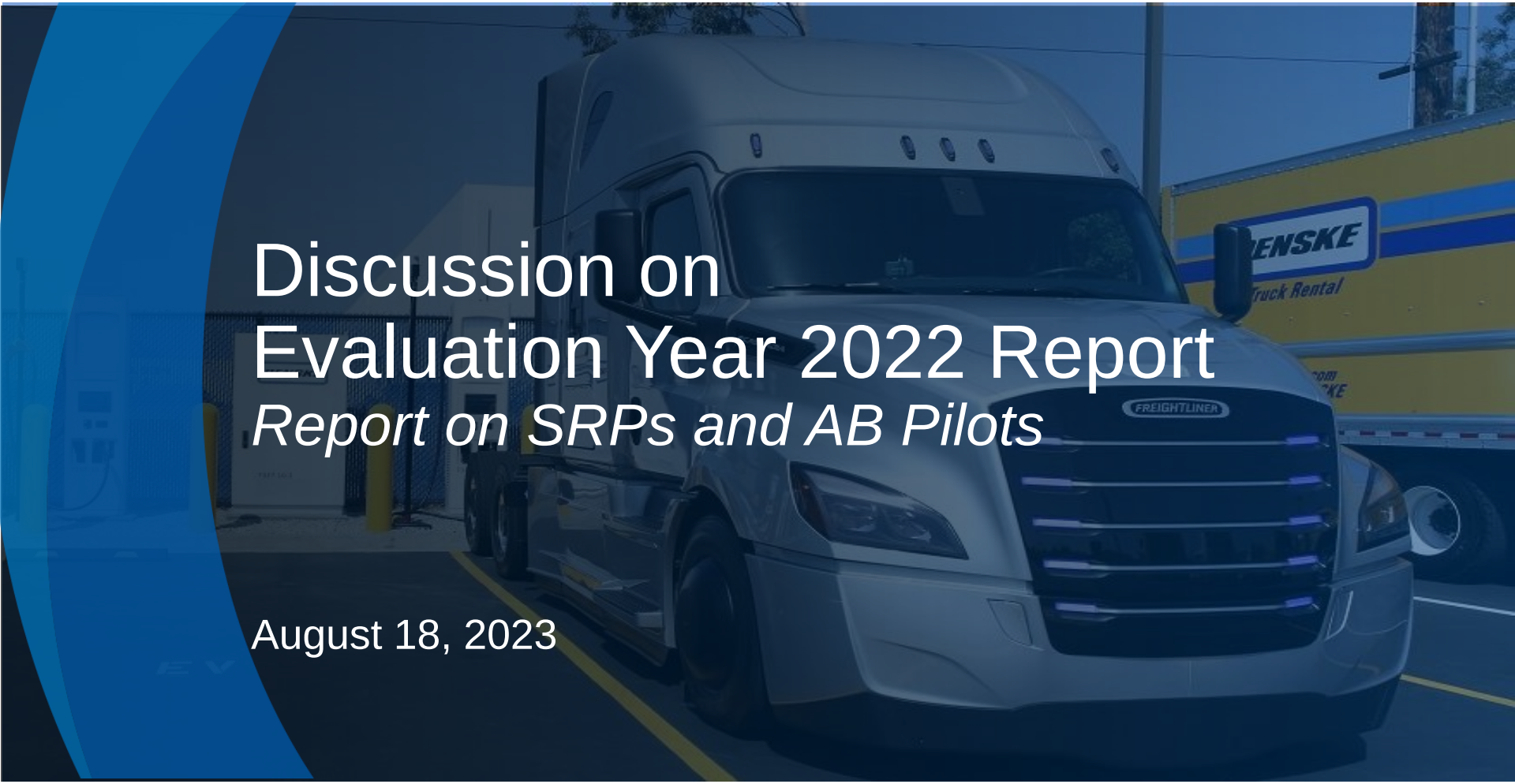

Discussion on Evaluation Year 2022 Report

Report on SRPs and AB Pilots

August 18, 2023

ZM ASSOCIATES Environmental Consultants

DAVENERGY solutions
DEDICATION ALIGNMENT VALUE

NREL
NATIONAL RENEWABLE ENERGY LABORATORY

ITS UCDAVIS
INSTITUTE OF TRANSPORTATION STUDIES

Agenda

- Introduction
- Medium-Duty and Heavy-Duty Fleets
- Schools, Parks and Beaches, and EV Fast Charge
- Vehicle-to-Grid
- Q&A

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Motivation

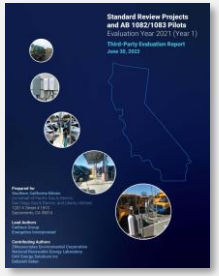
CPUC decision documents from 2018 and 2019 outline Utility programs and goals

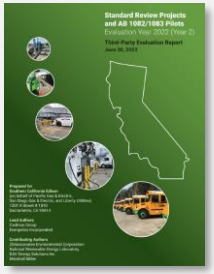
CPUC Decision Documents

See Evaluation Report for Links to decision documents

https://docs.cpuc.ca.gov/DecisionsSearchForm.aspx

Evaluation Reports





Liberty MDHD Final Report

EY2024 Eval Report

V2G Final Report

Final Schools & Parks Eval Report

EY2025 Eval Report

EY2026 Eval Report

Final MDHD Eval Report

Link to EY21 Evaluation Report: Standard Review Projects and AB 1082/1083 Pilots: Evaluation Year 2021

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Introduction | Programs and Budgets

Total Utility investment: **$765M over four to six years**

	Program	Budget ($Millions)
Liberty	EV Bus Infrastructure Program	$0.2
	Schools Pilot	$3.9
	Parks Pilot	$0.8
Pacific Gas & Electric (PG&E)	EV Fleet (Fleet) Program	$236.3
	EV Fast Charge Program	$22.4
	Schools Pilot	$5.8
	Parks Pilot	$5.5
Southern California Edison (SCE)	Charge Ready Transport (CRT) Program	$342.6
	Schools Pilot	$9.9
	Parks Pilot	$9.9
San Diego Gas & Electric (SDG&E)	Power Your Drive for Fleets (PYDFF) Program	$107.4
	Vehicle-to-Grid (V2G) Pilot	$1.7
	Schools Pilot	$9.9
	Parks Pilot	$8.8
	TOTAL	**$765**

Introduction | Evaluation Organization

EVALUATION RESEARCH OBJECTIVES

1. Investigate whether the TE investments accelerated the TE market
2. Determine whether the TE investments maximized benefits and minimized costs
3. Integrate learnings from analysis of key market, program, and impact data into program activities

RESEARCH QUESTIONS

THREE BUNDLES OF PROGRAMS

BUNDLE 1
Medium-Duty and Heavy-Duty Fleet Evaluations

BUNDLE 2
Public Charging Infrastructure Evaluations

BUNDLE 3
Vehicle-to-Grid Evaluation

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Introduction | Program Activity

Summary of completed sites as of December 31, 2022

	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

- **Utility Construction Complete:** Utility has completed their scope
- **Activated:** Charging stations are installed and available for use
- **Operational:** Energy usage data has been received from the Utility or EVSP
- **Closed Out:** All financial documentation has been finalized by Utility and rebates have been paid

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Introduction | Evaluation Activities

		MDHD Bundle	Public Charging Bundle		V2G Bundle
			Schools and Parks	*EV Fast Charge*	
Data Collection	Program Data and Materials	x	x	x	x
	AMI/EVSP Data	x	x	x	x
	Site Visits	x	x	x	x
	Interviews	x	x	x	x
	Surveys	x			
	Delphi Panel	x			
Analysis	EV Adoption Regression		x	x	
	Grid Impacts	x	x	x	
	Counterfactual Development	x	x	x	
	Petroleum Displacement	x	x	x	
	GHG and Criteria Pollutant	x	x	x	
	Health Impacts	x	x	x	
	Total Cost of Ownership	x	x	x	
	Site Visit Findings	x	x	x	
	Co-Benefits and Co-Costs	x			
	Interviews and/or Survey Findings	x	x	x	x
	Market Effects	x			

Cadmus Team Organization

PROJECT MGT

CPUC Coordination; IOU Coordination; Report Leads, PPT Templates; Data and Analysis Strategy; Gitlab Memos; Invoices; Monthly Reports

Project Manager
Geoff Morrison

Technical Director
Ziga Ivanic

Evaluation Director
Priya Sathe

DATA & ADMIN LEADS

Provide project support to all others

- Data Pipeline & QC (**Shreekar Pradhan**)
- Dashboard Development (**Dave Molner**)
- MDHD/PC IOU Calls (**Kaitlyn Teppert**)
- PPR, Monthly Reports (**Ally Dugan**)
- Sub Invoices (**Grant Bennett**)
- Arkenstone Dev (**Jake Ciolek**)

PROJECT LEADS

Coordination of Cadmus and Energetics Task Leads

Operations Lead
Allie Marshall

Technical Lead
Rex Hazelton

TASK LEADS

Lead methodology, writing, and implementation of analysis tasks

Cadmus Tasks

- Surveys (**Mark Janett**)
- Program Performance (**Xander Zuczek**)
- ME&O (**Kaitlyn Teppert**)
- Interviews (**Kaitlyn Teppert**)
- Total Cost of Ownership (**Geoff Morrison**)
- Health Impacts (**Geoff Morrison**)
- Delphi Panels (**Andrew Carollo**)
- NTG (**Andrew Carollo**)
- Truck Choice Model (**Xander Zuczek**)
- LDV Regression Model (**Yu Wu**)
- V2G (**Christie Amero**)

Energetics Tasks

- Site Visits (**Jason Greenblatt**)
- Grid Impacts (**Jason Greenblatt**)
  - AMI (**Ewan Pritchard**)
  - EVSP analysis (**Jason Greenblatt**)
  - Billing Data (**Jason Greenblatt**)
- Deep Dives (**Derek Ichien**)
- GHG, Criteria Pollutant (**Ewan Pritchard**)
- Petroleum (**Kevin Wood**)
- LDV Counterfactual (**Bryan Roy**)
- MDHD Counterfactual (**Kevin Wood/Ziga**)

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Bundle 1:
Medium-Duty and Heavy-Duty Fleets

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MDHD | Preliminary Findings

Modest impacts in second year of evaluation; 906 MDHD EVs toward goal of 17,993

Impact Parameter	MDHD Bundle
Population of Activated Sites in EY2022 (#)	41
Ports Installed in Analyzed Sites (#)	745
EVs Supported (#) [a]	906
Electric Energy Consumption (MWh)	5,536
Petroleum Displacement (diesel gallons equivalent [DGE])	525,711
GHG Emission Reduction (metric ton [MT] GHG) [b]	4,346
Oxides of Nitrogen (NO_x) Reduction (kg)	3,975
Particulate Matter (PM_{10}) Reduction (kg)	27
Particulate Matter ($PM_{2.5}$) Reduction (kg)	25
Reactive Organic Gases (ROG) Reduction (kg)	761
Carbon Monoxide (CO) Reduction (kg)	59,176

[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).

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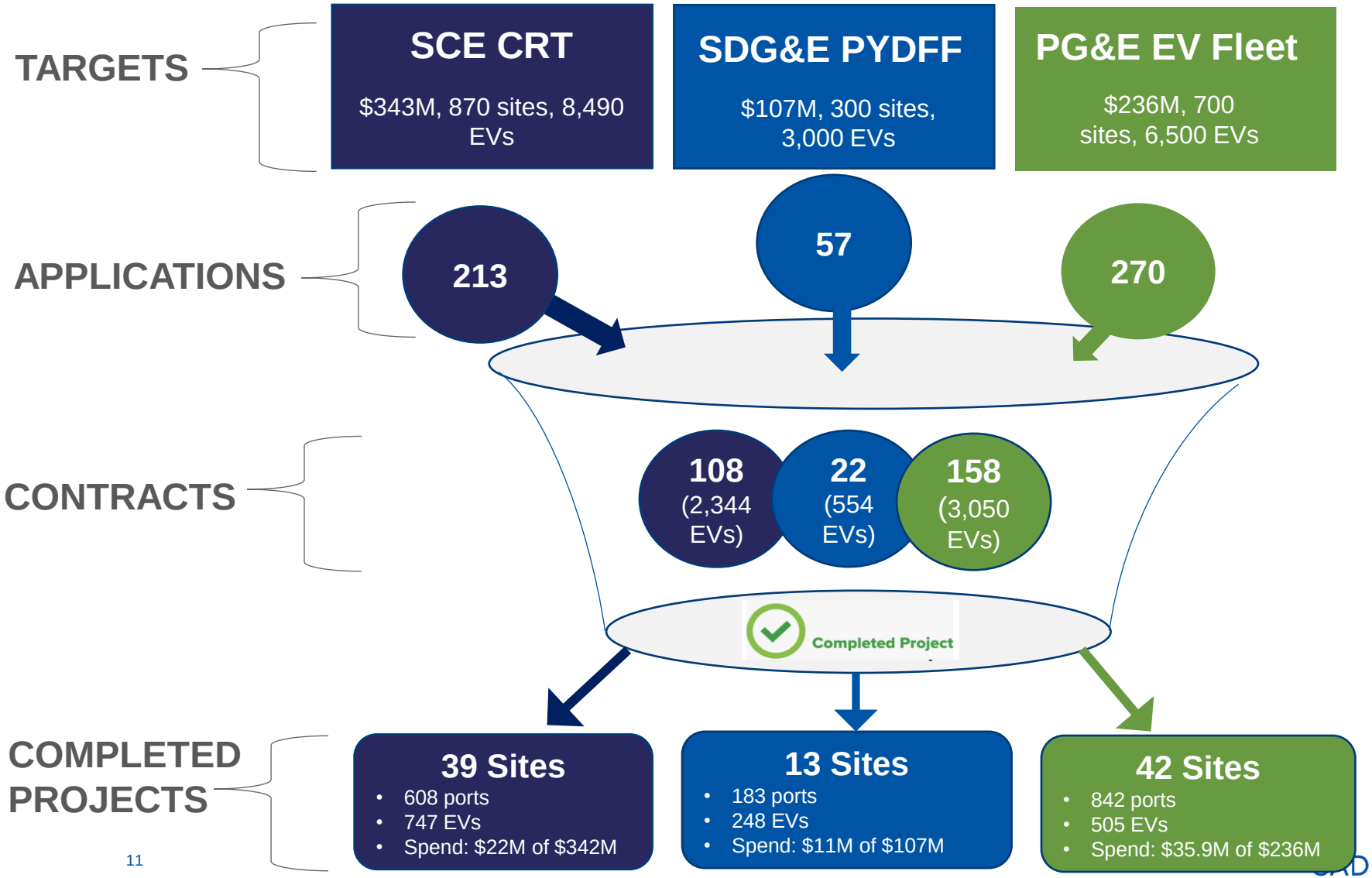
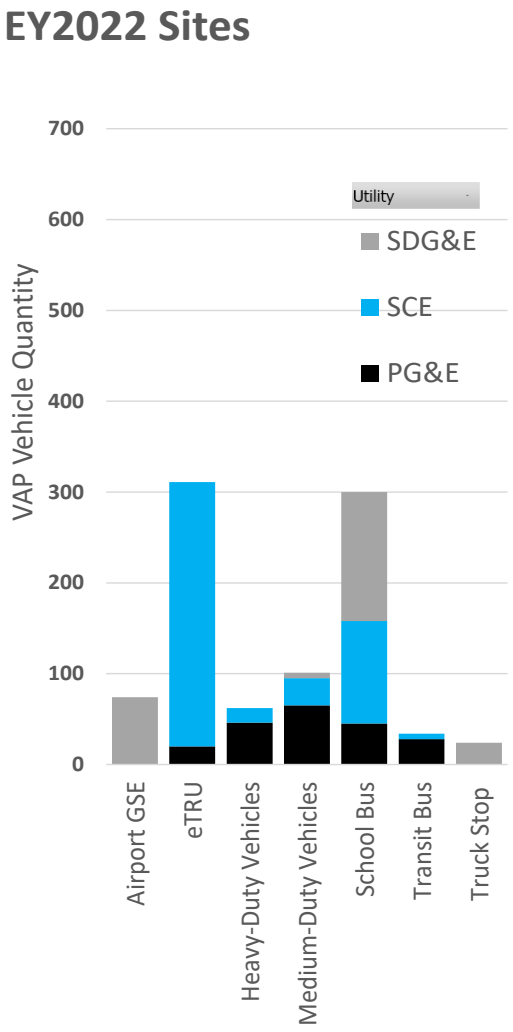
Progress Toward Program Targets

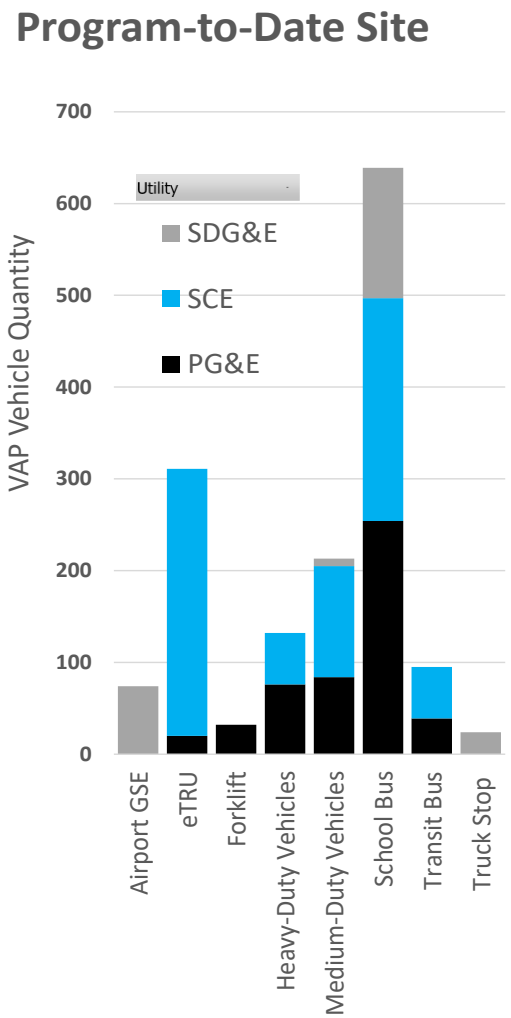
Program Targets (Sites & EVs) / Received Applications / Signed Contracts / Completed Sites



MDHD | Market Sector Mix

Market Sector Diversity Continues





- School Bus sector continues to grow
  - EPA and CEC grants
- Transit Bus sector is maintaining presence
  - CARB ICT regulation
- Medium- and Heavy-Duty Vehicles are increasing presence
  - Large fleet adoption
- New market sectors:
  - Electric Trailer Refrigeration Units
  - Truck Stop Electrification
  - Airport Ground Support Equipment appear

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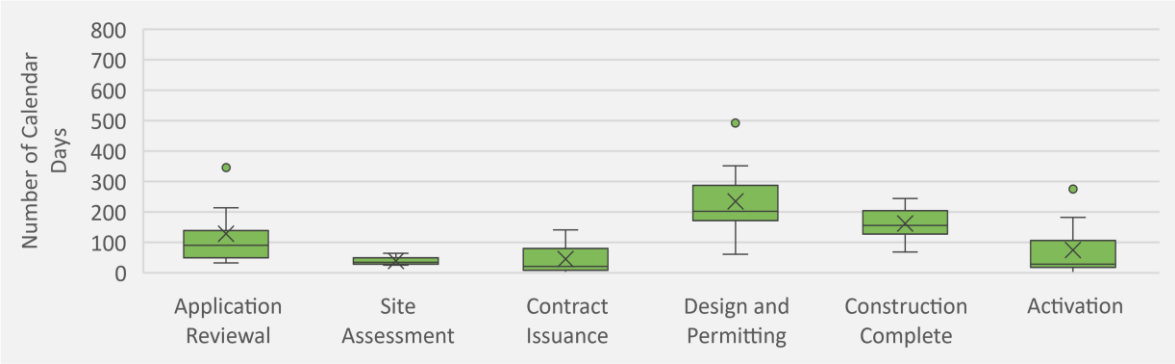
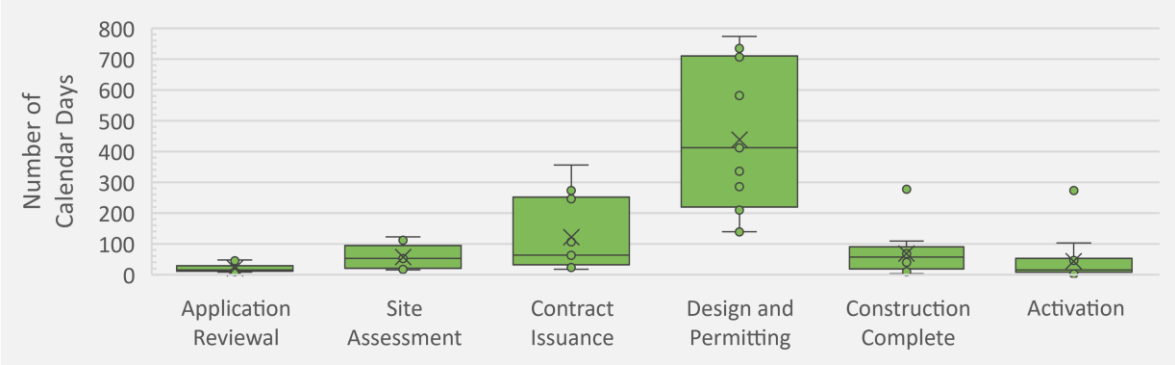
MDHD | Site Timelines

Timelines were generally longer than expected and varied widely by phase

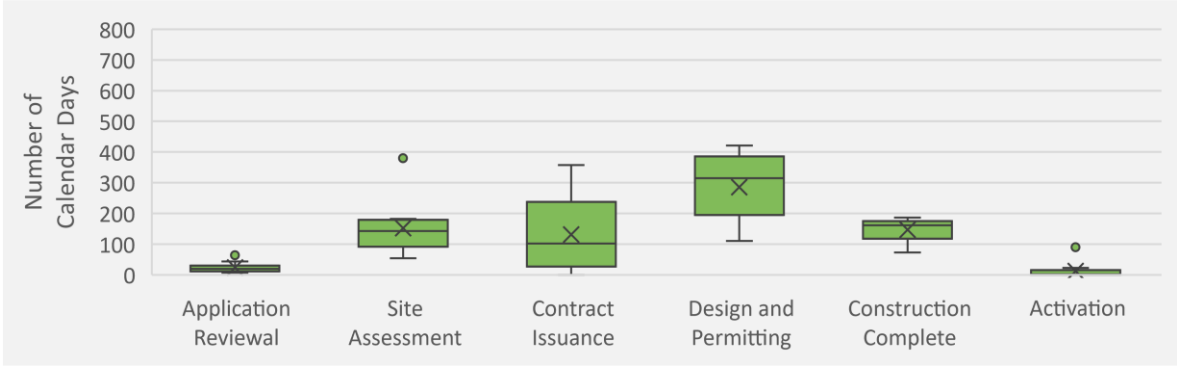
SCE



PG&E



SDG&E



- Original Utility estimates ranged between 11 and 19 months while program medians are between 19 and 24 months.
- The median start-to-finish duration for all 41 EY2022 activated sites is 715 days (649 days for all 94 activated sites program to date).
- Design and Permitting is longest phase with a median of 231 days in PTD sites, followed by Construction Complete with a median of 97 days.
- Acquisition of switchgear is a primary driver for delays, with timelines extending to 50 to 70 weeks.
- Design and Permitting delays are often driven by the customer design schedule.

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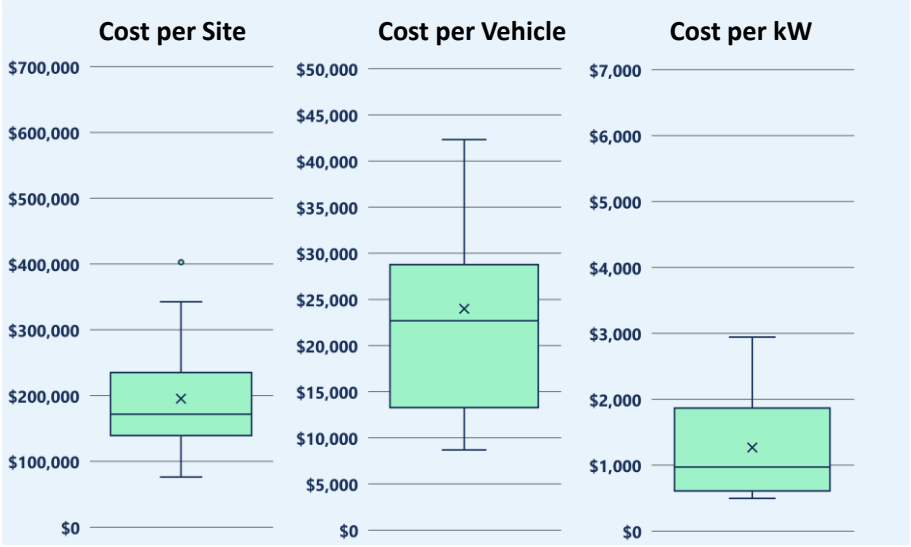
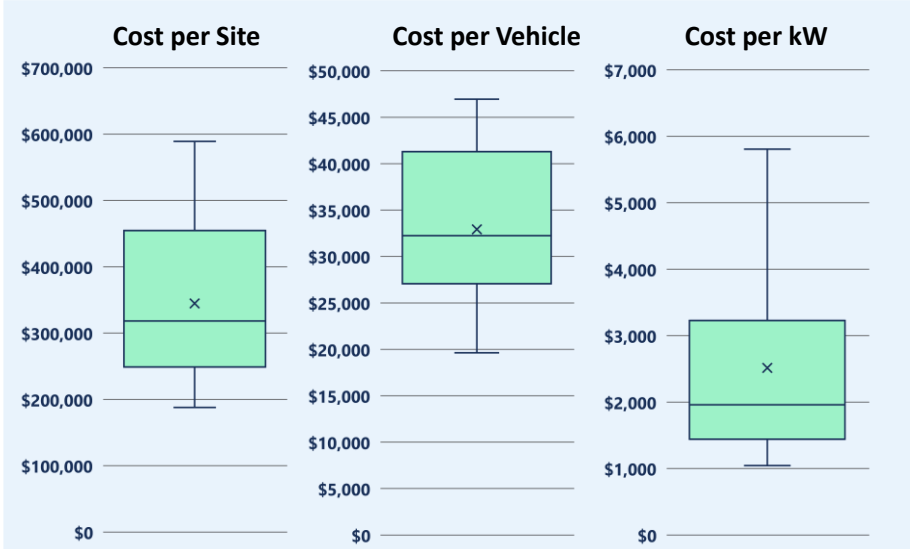
MDHD | Site Costs

SCE CRT (n=16)



PG&E Fleet (n=32)



- Costs include utility-funded TTM plus BTM for financially closed out sites
- Mix of L2 and DCFC for school, transit, medium-duty, and forklifts
- Every additional plug adds (on average) $14K to the TTM+BTM cost
- Larger sites have lower costs per vehicle and per kW than smaller sites, although the scale effect is relatively modest.

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MDHD | Grid Impacts – Energy Use Trends

Overall consumption and demand continues to grow for each utility

Figure 24. SCE CRT Program Daily Maximum Demand and Consumption, Program-to-Date Sites

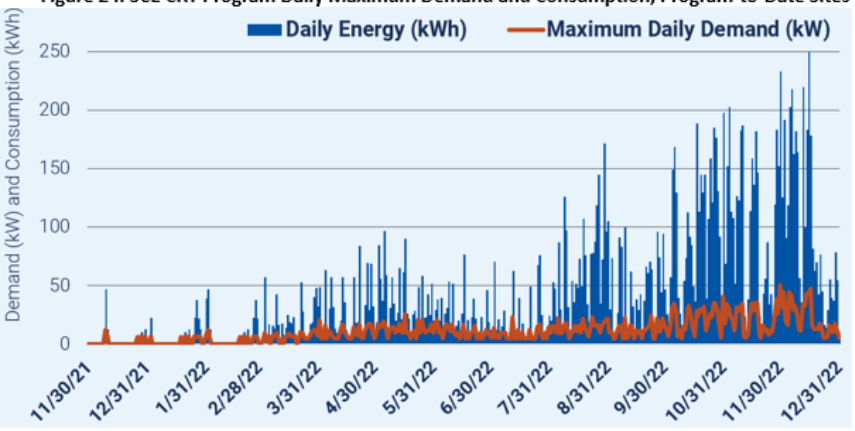
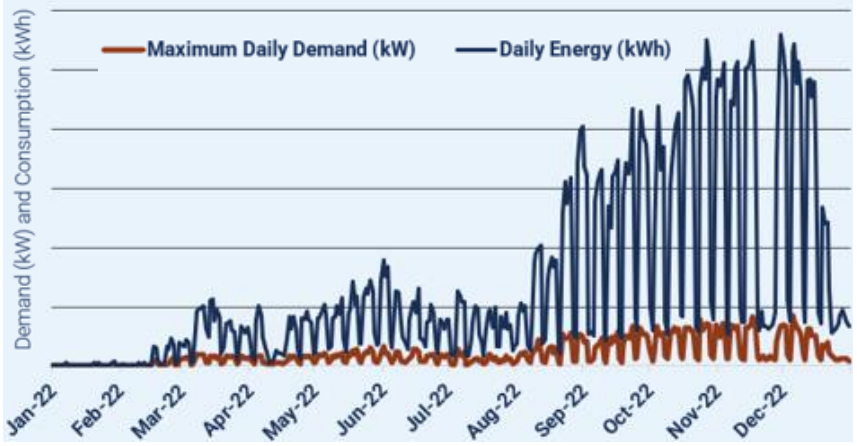
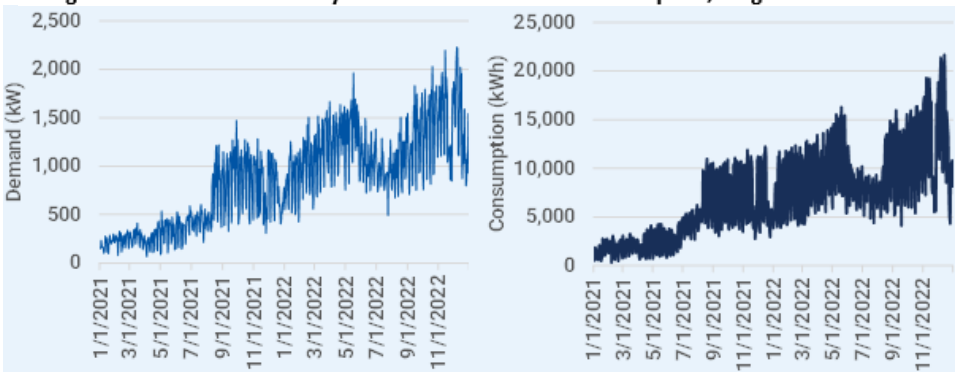


Figure 28. SDG&E PYDFF Program Maximum Daily Demand and Consumption, Program-to-Date Sites



- Significant load growth is expected during all time periods
- 92% of fleets are not employing load management
  - PG&E: four of 41 observed sites manage their load
  - SCE: three of 39 observed sites manage their load
- In 2022, a few Heavy Duty and Transit sites have impacted the load shape that was previously dominated by Level 2 school bus charging
  - Multi-shift operations may have less charging flexibility
- Many operators do not access their charging trends or cost data

Figure 31. PG&E EV Fleet Daily Maximum Demand and Consumption, Program-to-Date Sites



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MDHD | Grid Impacts – Load Management

Figure 25. SCE CRT Program Average Weekday Load September 2022, Program-to-Date Sites

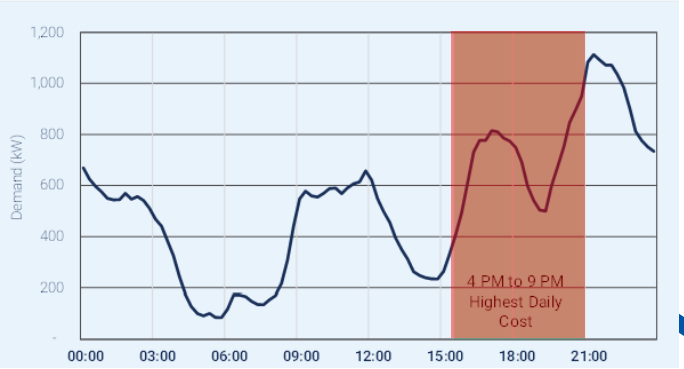


Figure 32. PG&E EV Fleet Program Load Curve on December 8, 2022, Program-to-Date Sites

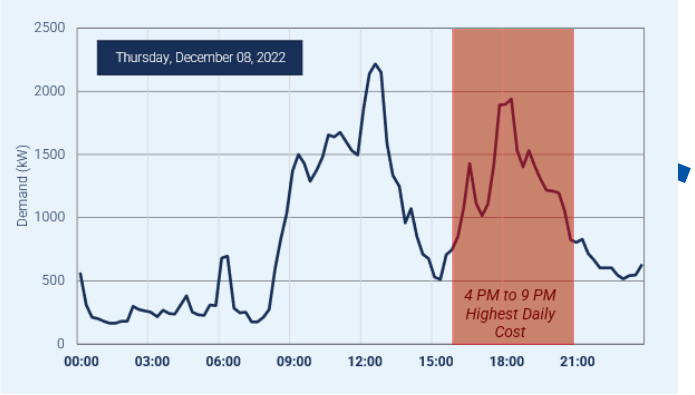


Figure 29. SCE, Figure 37. PG&E EV Fleet Program School Bus Charging Flexibility

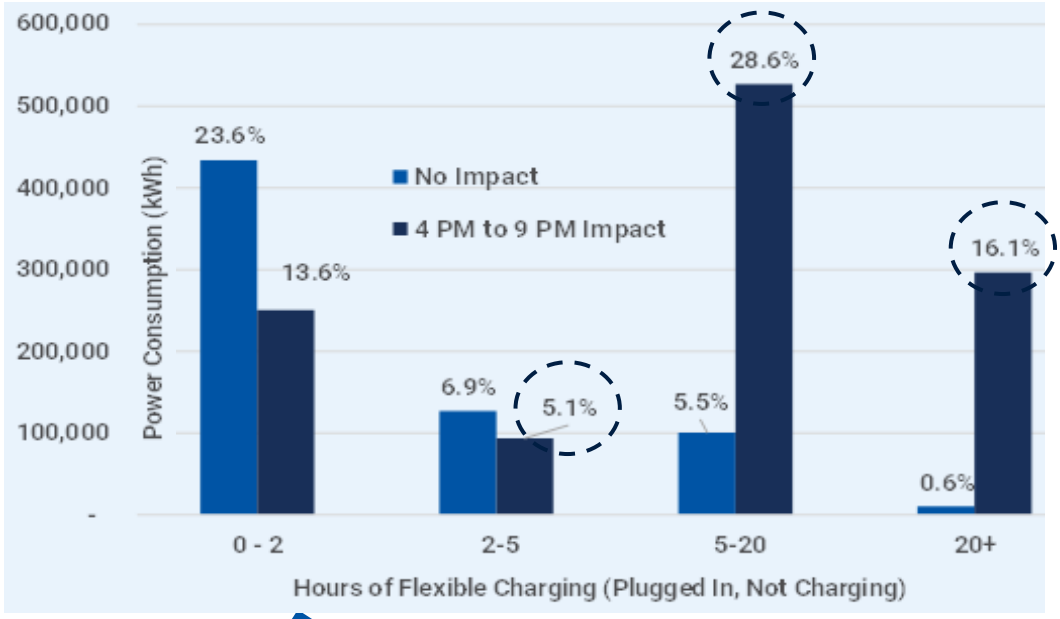
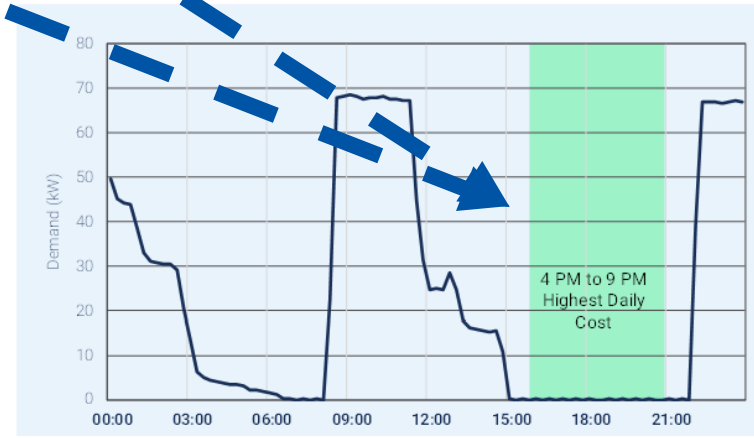


Figure 35. PG&E EV Fleet Program Example of Customers Using Load Management in 2022



Significant unnecessary consumption from 4 to 9 PM

- 50% of charging energy and 40% of school bus charging sessions have evident flexibility to avoid charging 4-9 PM
- Operators, often different than those receiving utility bills, need encouragement to implement Load Management
- Operators will often pursue Load Management if they ae aware of the potential cost savings

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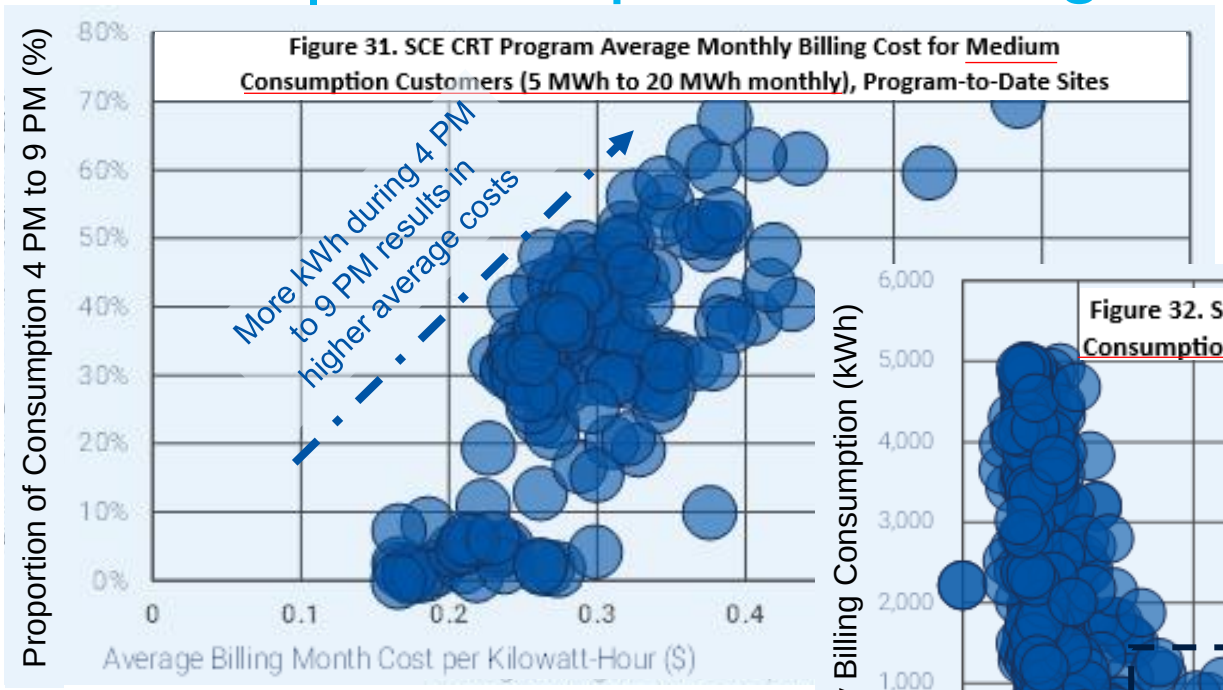
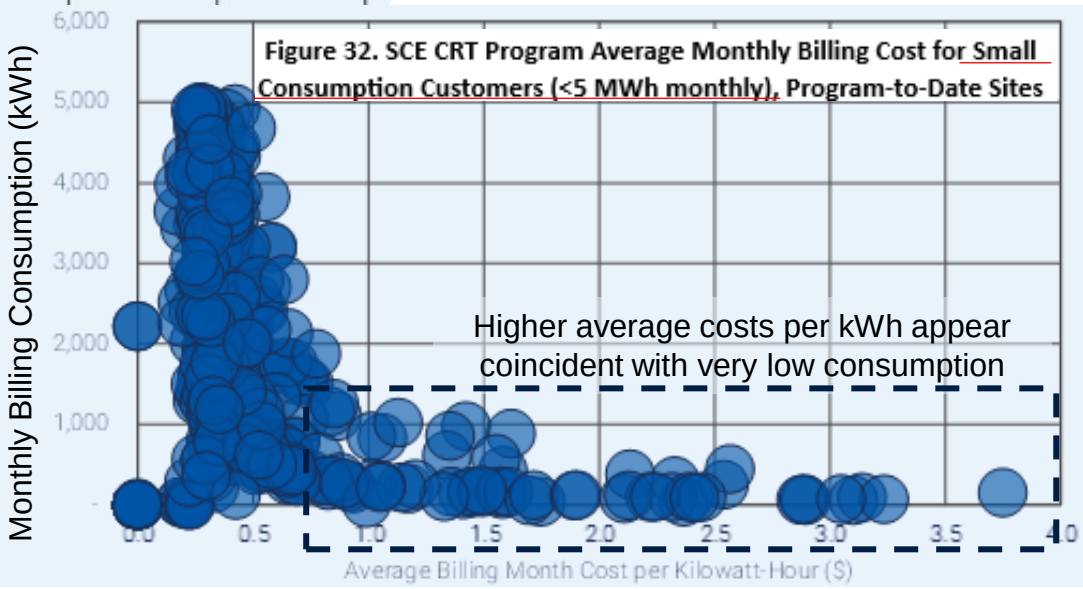
MDHD | Grid Impacts – Billing





- Large billing months generally had consistently lower costs per kilowatt-hour (not pictured)
  - This could be due to around the clock charging (4 PM to 9 PM still has significant consumption but low %)
- Medium billing months (left) appear to see costs scale by proportion of 4-9 PM consumption
- Small billing months (right) appear to show average cost decrease with increased consumption
  - many examples may represent not yet fully implemented fleets
- Some CCA's offer exceptionally low pricing during certain seasonal hours heavily influencing fleets in the know and able to adapt

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MDHD | Liberty Utilities EV Transit Bus Project

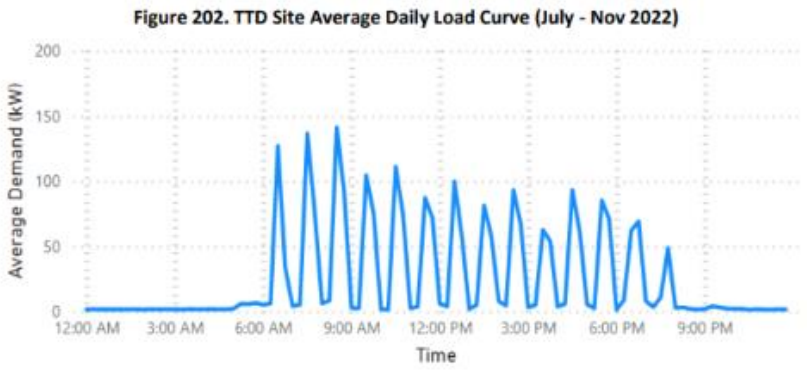
Customer's changing needs increased scope, budget, and timeline

Scope: From two 60 kW DCFC, added two 450 kW overhead fast chargers (pantographs) and associated infrastructure to support >1 MW of new load to operate three transit buses

Budget: From $223k to $876k for line extension, new transformer, and 3,000-amp switchgear

Timeline: TTD started regularly charging buses in July 2022. The Cadmus team will complete the impacts evaluation as part of EY2023 report to enable 12 months of data.

Tahoe Transit District's Proterra Electric Bus Charging on the 450 kW ABB Pantograph at LTCC



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MDHD | Lessons Learned

Findings based on limited operational data from 41 fleets, eight market sectors:

- Utility programs are progressing well toward their goals for number of EVs but are lagging goals for number of sites.
- Program spending is ramping up slowly across Utilities; however, spending in disadvantaged communities (DACs) exceeds targets for most programs.
- TTM and BTM infrastructure costs continue to vary widely across project sites and Utility infrastructure incentives continue to be necessary to overcome incremental costs.
- Program timelines were longer than expected, and site costs and supply chain delays continued to be a challenge.
- Across all Utility programs, significant new charging capacity was installed in EY2022 but is so far underutilized. The majority of fleet operators are not actively employing load management, and many are not tracking their charging costs.
- Fleet programs are having a measurable and increasing impact on petroleum reduction, GHG emission reductions, criteria pollutant emission reduction, and health benefits.
- 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.

Bundle 2:
Public Charging

Public Charging | Program Overview

Utility	Program /Pilot	Target
Liberty	Schools	• 17 schools • 56 L2 and 2 DCFC charging stations
	Parks and Beaches	• 3 sites • 5 dual-pedestal charging stations with 2 charging ports each
PG&E	Schools	• 40% DAC • 22 K-12 schools • 4 or 6 L2 charging ports per location
	Parks and Beaches	• 25% DAC • 15 state parks and beaches • 40 L2 and 3 DCFC charging ports
	EV Fast Charge	• 25% DAC • 52 sites • 234 DCFCs
SCE	Schools	• 40% DAC • 40 K-12 schools • 250 L1 and L2 charging stations
	Parks and Beaches	• 40% DAC • 27 state parks and beaches • 120 L2, 10 DCFC, and 15 mobile charging stations
SDG&E	Schools	• 40% DAC • 30 schools • 184 L2 and 12 DCFC charging stations
	Parks and Beaches	• 50% DAC • 74 charging stations at 12 state parks and beaches • 66 charging stations at 10 city and county parks (100% DAC)

Public Charging | Summary Findings

Impact Parameter	Public Charging Bundle
Population of Activated Sites in EY2022 (#)	27
Ports Installed in Analyzed Sites (#)	200
Electric Energy Consumption (MWh)	445
Petroleum Displacement (gallons)	36,688
GHG Emission Reduction (metric ton [MT] GHG) [a]	283
Particulate Matter (PM_{10}) Reduction (kg)	1.5
Particulate Matter ($PM_{2.5}$) Reduction (kg)	1.3
Reactive Organic Gases (ROG) Reduction (kg)	23.3
Carbon Monoxide (CO) Reduction (kg)	762

[a] 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).

Public Charging | Lessons Learned

- The Schools and Parks Pilots' sites, as well as PG&E EV Fast Charge program sites, are promoting EV adoption.
- The Schools and Parks Pilots' sites, as well as the PG&E EV Fast Charge program sites, are helping to displace petroleum, reduce GHG and local emissions, and achieve nominal health impacts overall and within DACs.
- 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.
- Market conditions contribute to higher-than-expected site costs.
- As the School Pilots mature, Utility staff are improving coordination with and approvals from schools.
- Sufficient time must be built into Parks Pilot implementation planning when anticipating contract negotiations between two or more large organizations.
- Market conditions and program requirements resulted in higher-than-expected site costs for the PG&E 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.
- Coordination and training with EVSPs who partner with the PG&E EV Fast Charge program is key to minimizing the number of sites that are screened out early in the application process.

Bundle 3:
Vehicle to Grid Pilot

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V2G | Pilot Background

SDG&E selected the Cajon Valley Union School District for the V2G pilot.

- **Pilot team:**
  - **SDG&E:** Site manager
  - **CVUSD:** Site host
  - **Lion Electric:** School bus provider
  - **Nuvve:** Charging provider
  - **Baker Electric:** Construction manager
  - **ViriCiti:** School bus telematics provider
- SDG&E installed six Rhombus 60 kW DCFC bi-directional chargers
- Construction was completed in summer EY2021, but school bus retrofits and interconnection issues delayed commissioning until June 2022

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V2G | Lessons Learned

- This pilot successfully transferred 650 kWh to the grid over the course of nine total events in 2022, which under ELRP resulted in ~$1,300 revenue.
- Interoperability between V2G-capable EVSE and V2G-capable EVs is not guaranteed.
- EV battery degradation impacts are of high concern to vehicle and battery manufacturers.

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Q&A

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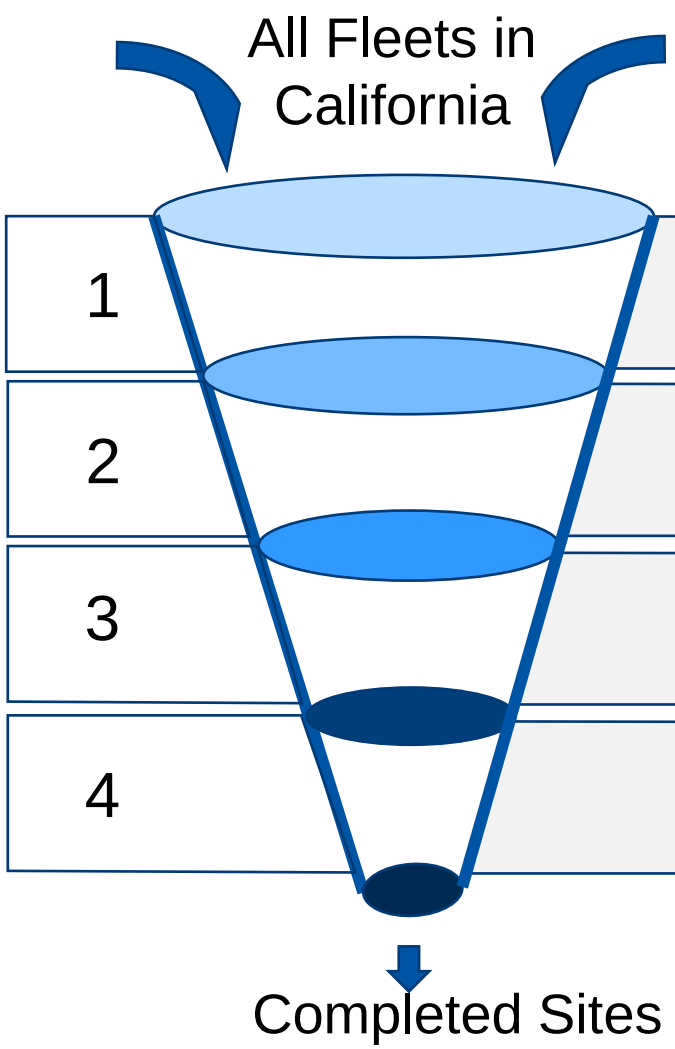
Operations Lead: Allie.Marshall@Cadmusgroup.com
Technical Lead: Daniel.Hazelton@Cadmusgroup.com

SRP Fleet Funnel



Awareness Barrier
Fleets are not aware of programs

Willingness Barrier
Fleets are aware but not interested

Program/Regulatory Barrier
Fleets want to participate but cannot convert interest to signed contract

Pipeline Barrier
Customers in program drop out because of delays

EXAMPLES

Fleet manager is not actively searching for EV and does not check IOU website before vehicle acquisition

Fleets are unwilling to take the risk to company's bottom line to electrify today (wait and see approach).

Fleets apply but are deemed ineligible due to cost thresholds

Fleets cannot obtain the necessary land use easement.