San Diego Regional Clean Cities

School Bus Electrification - Lunch & Learn 1/9/25

Energetics, CLEAResult Energy Sustainability Consulting

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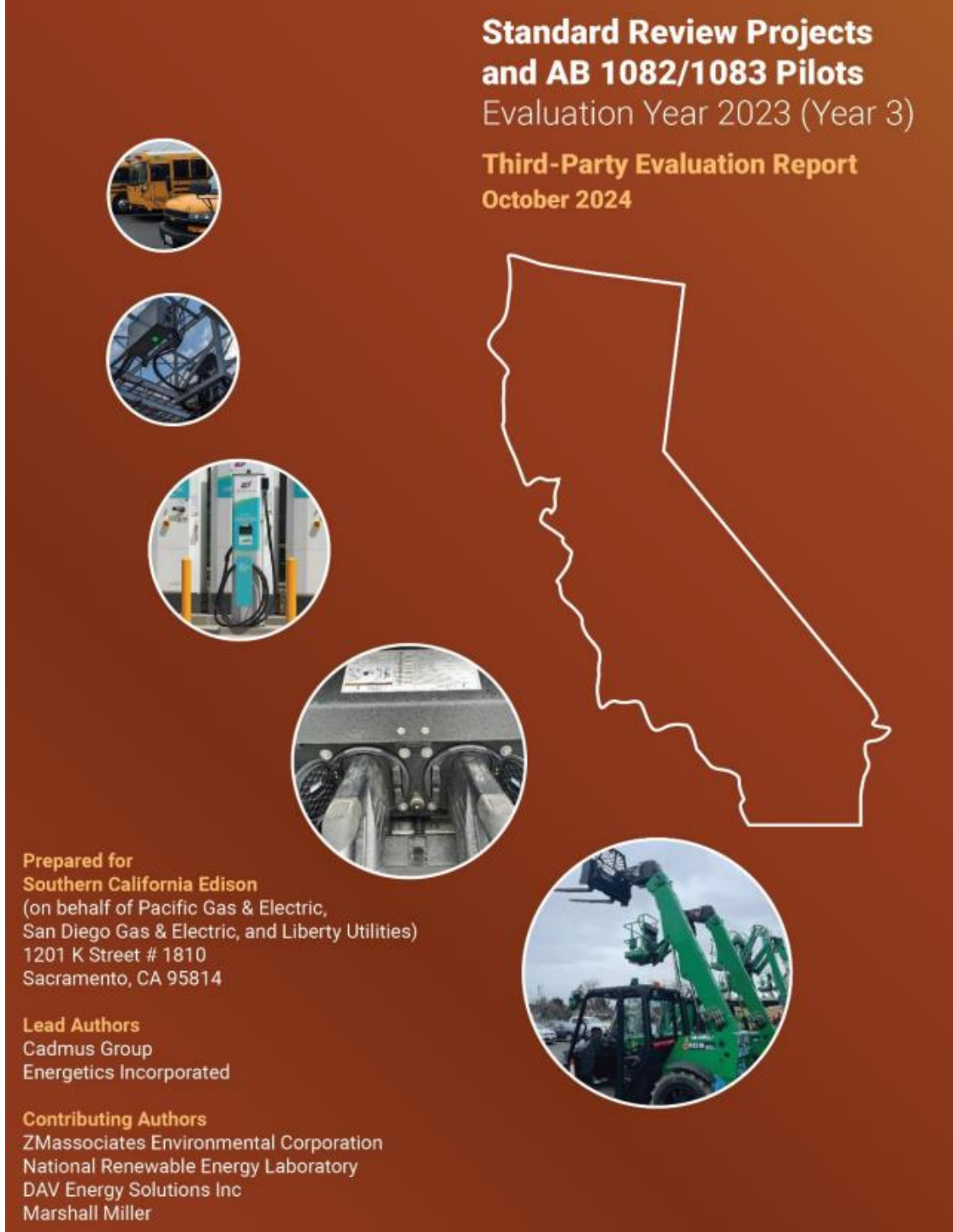
Evaluation Year 3 (2023)

Fleet, Public& Workplace Charging Investments

	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**

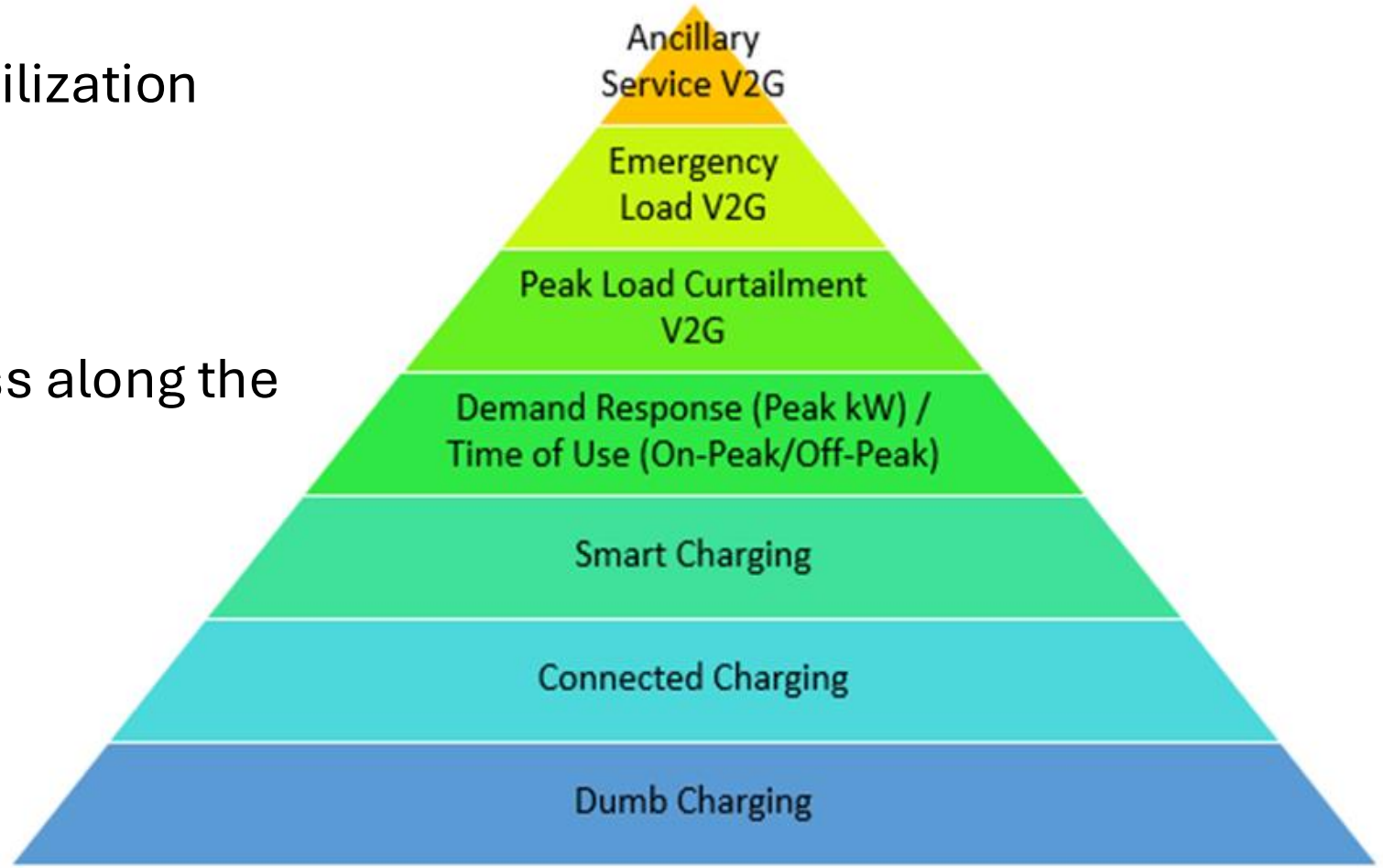


Pritchard Hierarchy of Electric Vehicle Charging

Make sure assets provide vehicle utilization

Then do the special stuff

Iterate, assess, implement, reassess along the way



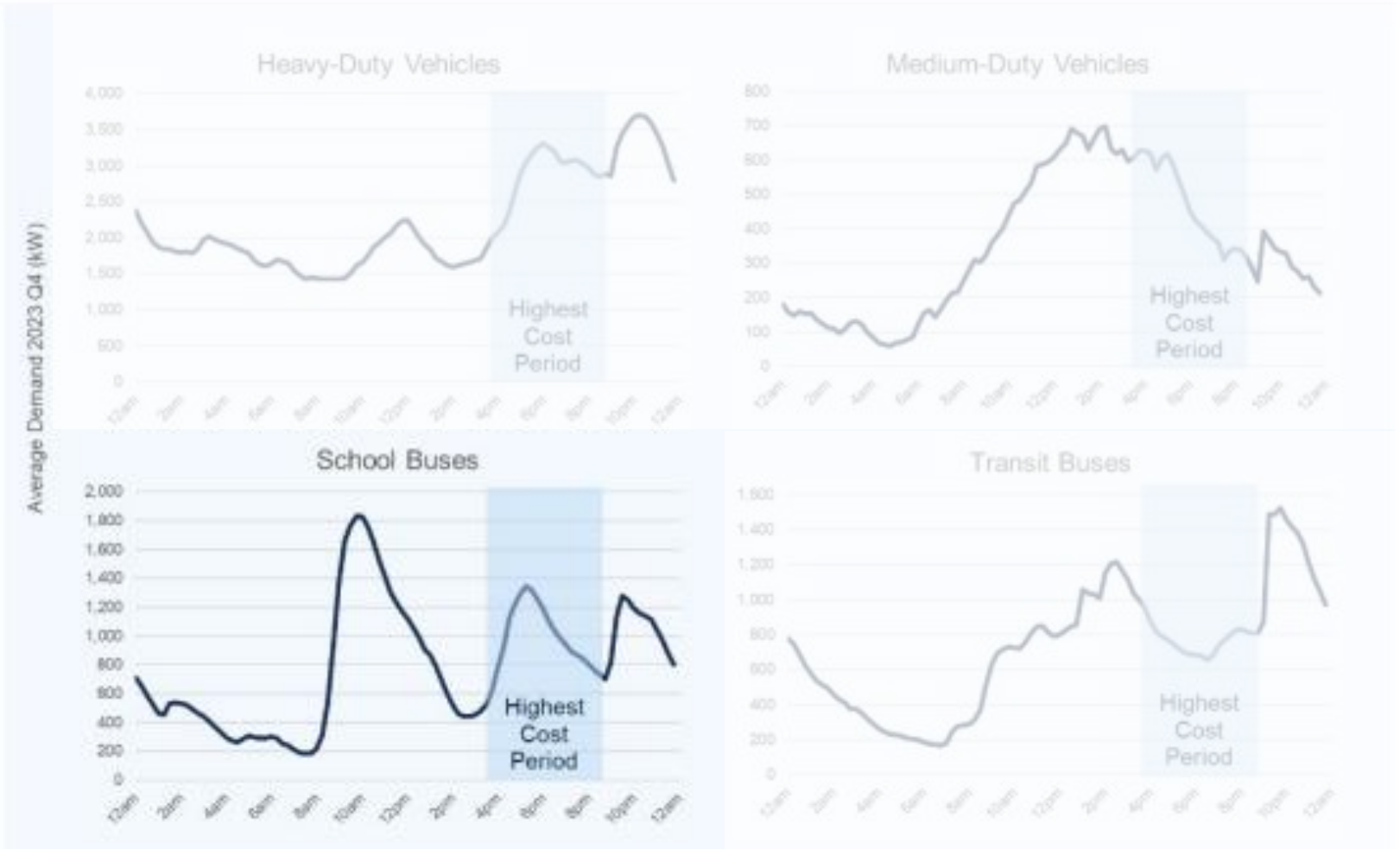
EV hierarchy of needs, each user, manufacturer, supplier, etc. must be able to master the technology below a level before a new level can be mastered, thus the greatest impediment to smart charging is mastery of connected charging.

School bus (and other markets) Charging Operations

AMI (utility meter data)

- Typical morning peak at 10AM
  - <5 hours of dwell time
- Typical evening charging
  - >12 hours of dwell time
  - Two evening peaks
    - *split by use of load management*

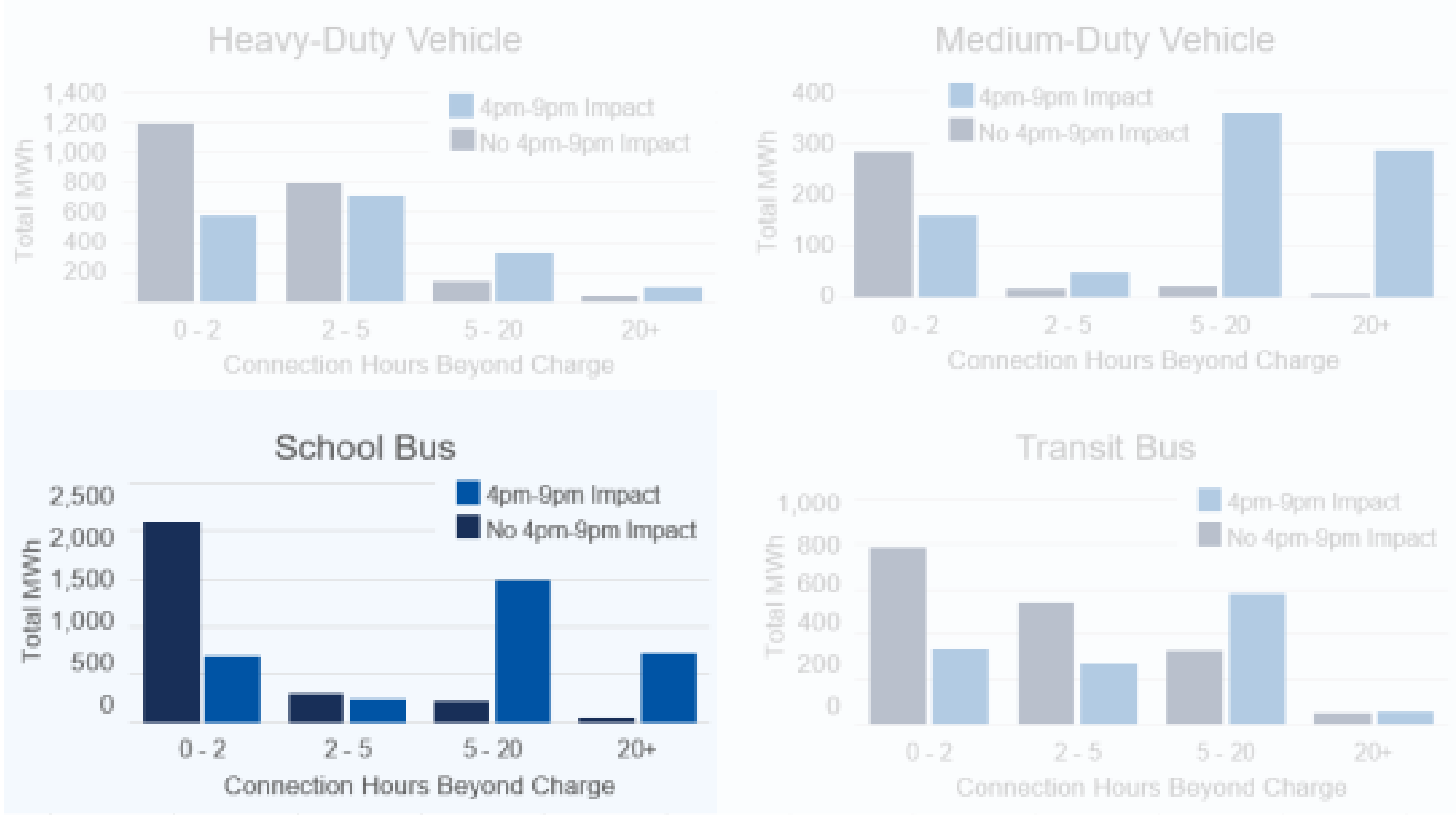
Figure 21. Daily Average Load Curve for Four Market Sectors across Utility MDHD Programs in Q4 2023



Network Service Provider (Charging Session) Data

- Useful to characterize “charging flexibility”
- Time stamps
  - Session start (plug in/out)
  - Power draw (start/end)
- Consumption and demand
- EVSE/port

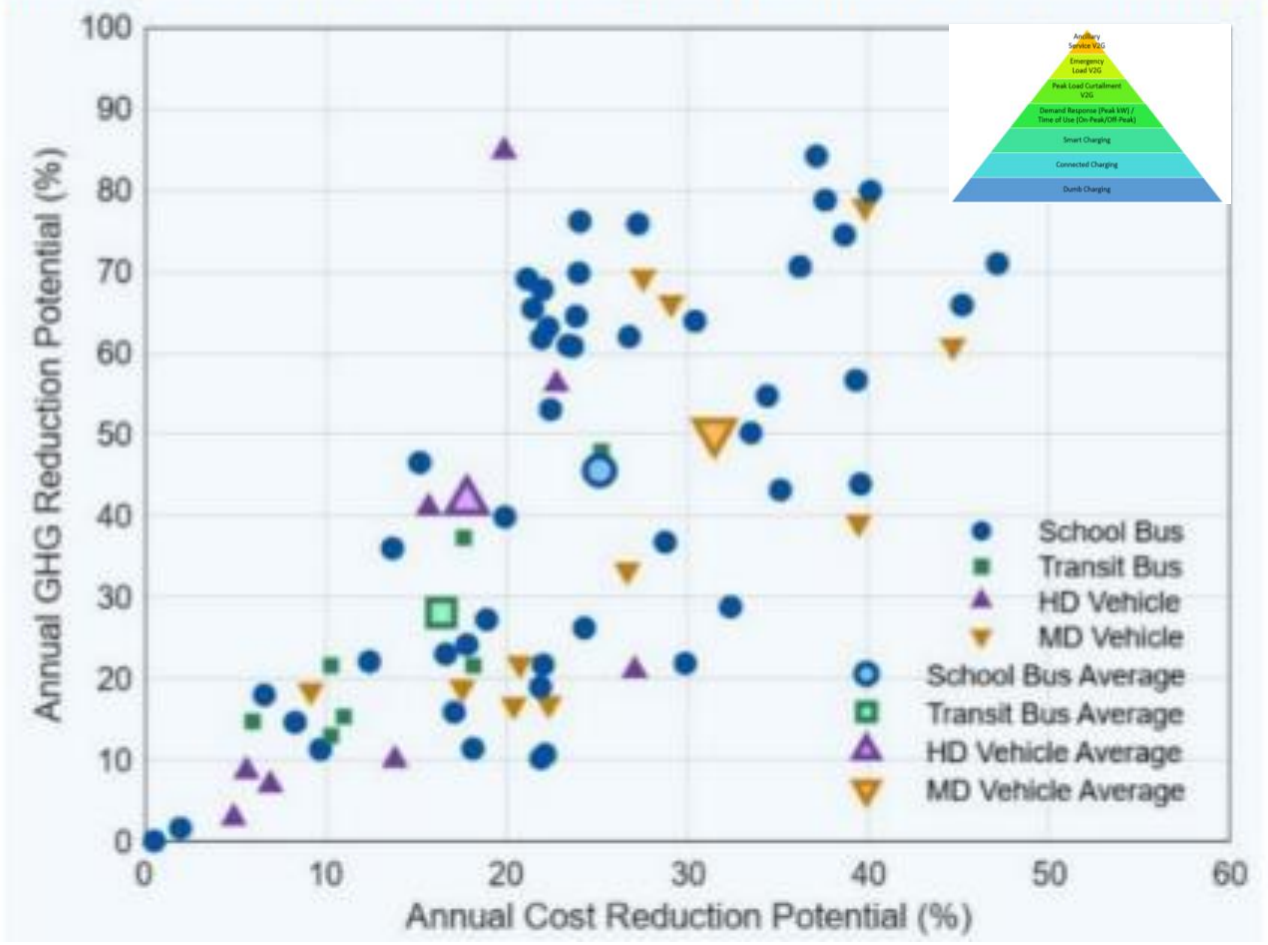
Figure 22. Charging Flexibility of Four Market Sectors Across Utility MDHD Programs in 2023



Plentiful Opportunity to Save $$$ on Monthly Utility Bills

- Cost and GHG analysis based on Charg Flexibility & hardware
- Other utilities have aligned Super Off Pe (lowest cost times) with least emissions times
  - SDG&E is in process with CPUC
- Optimization prioritized Cost savings
  - Following Year 4 (2024) analysis to dig into emissions optimization

Figure 23. 2023 Cost and GHG Reduction Potential if Each Site Used Load Management



General Reporting Awareness

- Costs by Site, installed kW, Vehicle
  - See also HD, MD, Transit Bus

Figure 15. School Bus Costs (n=51 sites)

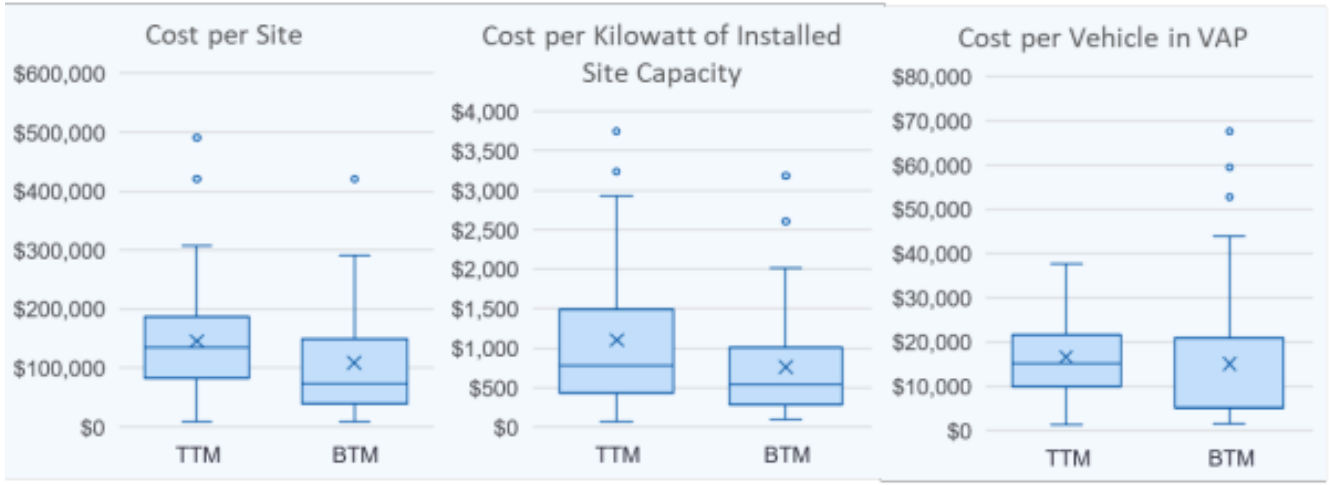
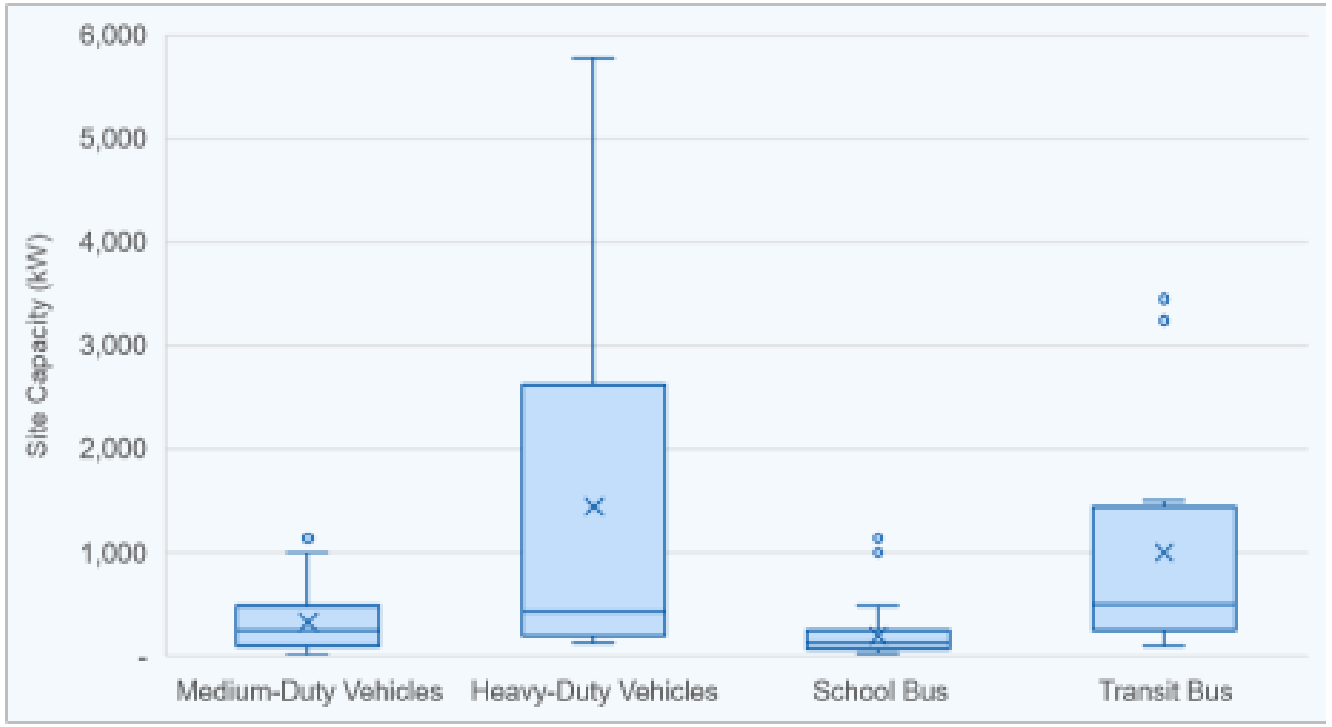


Figure 17. Average Installed Charging Capacity per Site by Market Sector, All Utilities



Cajon Valley EV and V2G Pilot

Unique option to jointly bill Building & EV Charging
Several years of operations
Early generation technology (buses and chargers)
Discharging under SDG&E's ELRP in '22&'23 (as reported)

6 Borg Warner – Rhombus DC chargers
Mix of bus generations
- 45-60kw charging
- 25-45 kw discharge
- 120-210 kWh
- One data logger swapped mid project to another bus

Significant mix of DC & Level 2 Charging
- L2 an indicator of DC issues
  - results in limiting V2G

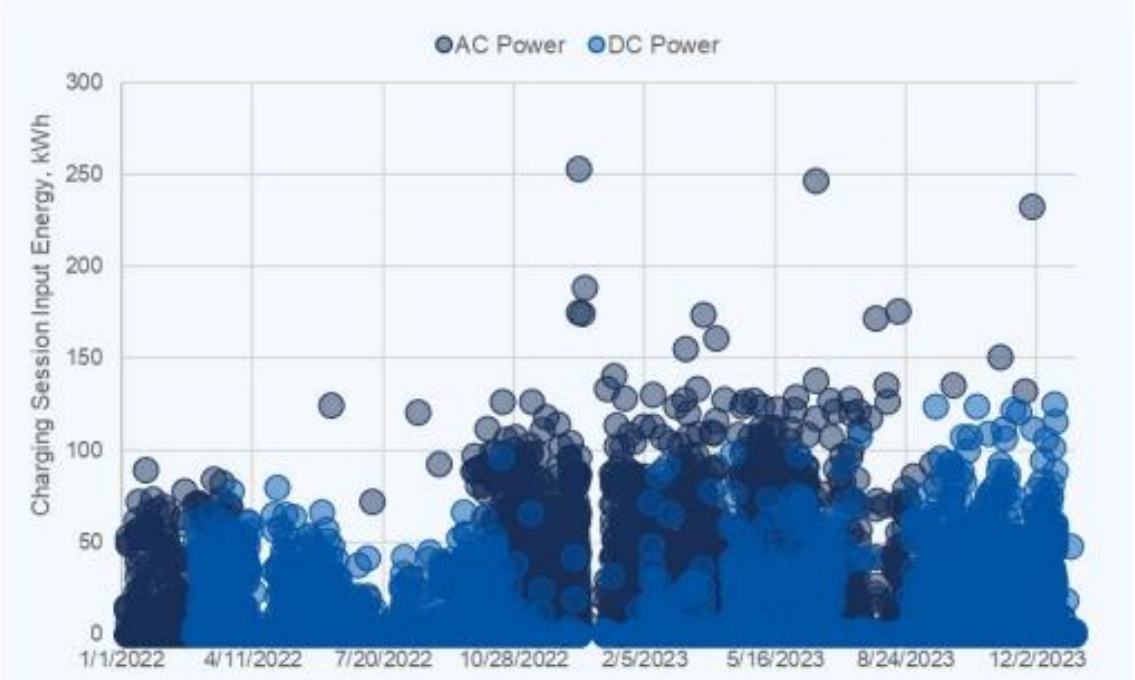
Table 161. V2G Pilot Bus Average State of Charge at Start of Charging

Bus Number[a]	Average Start Charge State	Maximum Charge Added (kWh)
521	58%	128
524	57%	130
525	56%	138
526	67%[a]	176
520	50%	136
522	58%	156
523	58%	151
Average	**58%**	**145**

[a] Bus 526 has a larger battery than the rest of the fleet.

Significant energy remaining in battery after each driving shift

Figure 256. Lion Beat Telematics V2G Pilot Electric School Bus Charging Session Input Power Source



Bus and Building Experience and Modeling

Figure 257. V2G Pilot Building and Bus Charging Load Curves

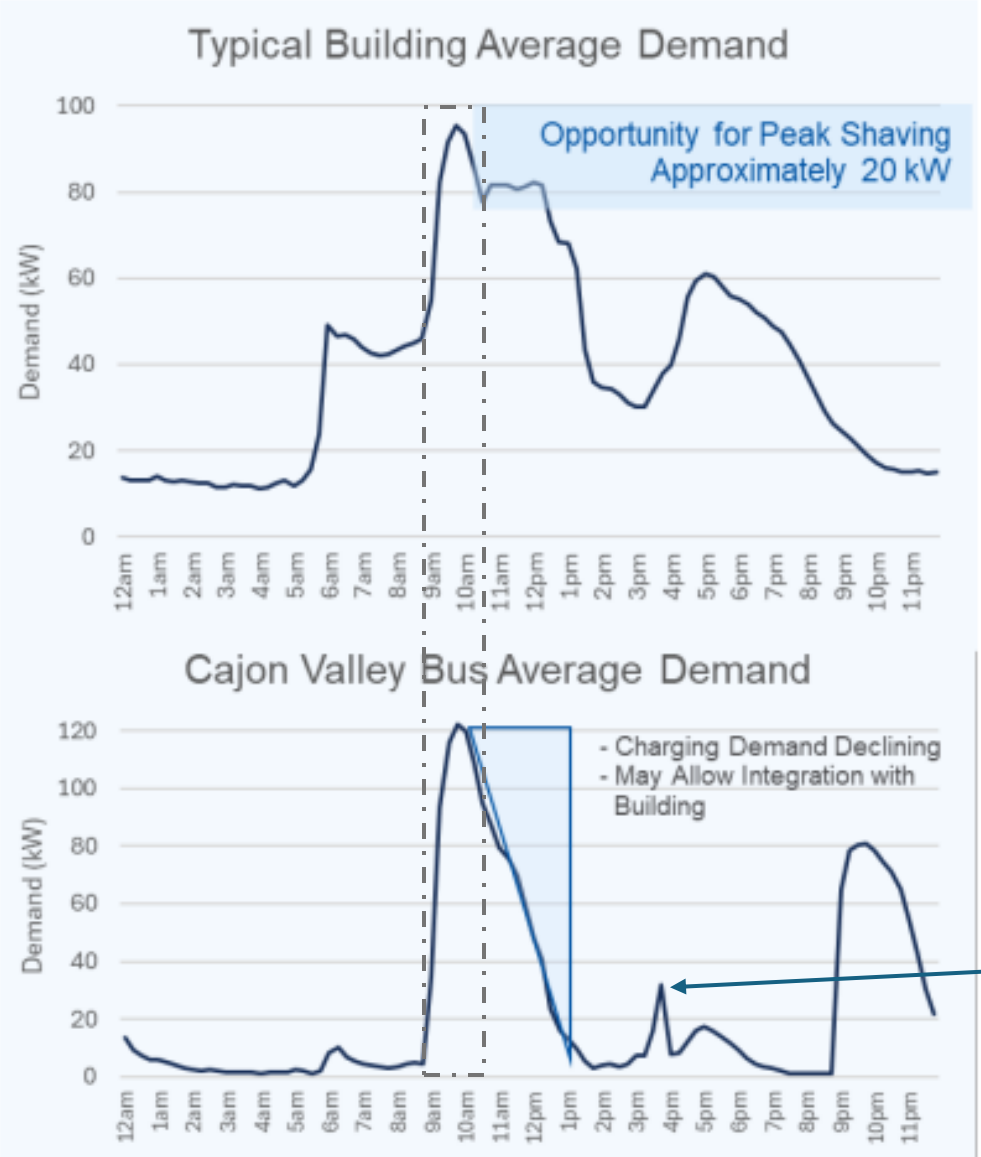


Table 162. V2G Financial Modeling Scenario Assumptions and Results

Scenario / Parameter	Value	Unit
Average Remaining Bus Battery Capacity After Daily Driving Complete (per bus)	57%	%
Average Remaining Bus Battery Capacity After Daily Driving Complete (per bus)	74	kWh
ELRP		
Annual ELRP Events	10	Events
ELRP Compensation per Kilowatt-hour	$2.00	$/kWh
Value per Bus Annually (Based on Average Remaining Bus Battery Capacity)	$1,482	$/bus/year
Net Metering		
Annual Peak Weekdays	260	Days/year
Net Metering Compensation per Kilowatt-hour	$0.15	$/kWh
Annual Compensation per Bus for Daily Net Metering (Based on Average Remaining Bus Battery Capacity)	$2,890	$/bus/year
Peak Shaving (small for 6-chargers & buses)	**365 - Daily**	
Peak Shaving Demand, kW	20	kW
Monthly Peak Shaving Value per Kilowatt-hour	$0.75	$/kWh
Annual Peak Shaving Value	$7,200	$/year

- Limited (~50) hours of annual ELRP availability
- Increase usable hours throughout year with Net Metering (>500%) and Peak Shaving (>900%)
- Some opportunity to charge before On Peak
  - Prepare for energy-price arbitrage from Net Metering discharge
- Future V2G oriented rates on horizon

Considerations

- Funding options towards projects
  - Rule 45, SB350, HVIP, etc.
  - Easements, ownerships/site control, etc.
- Power capacity and access
- How can different electricity consumption needs work together?
- Options re: billing tariffs, programs
  - New VGI oriented tariffs from each IOU
  - Continued demonstration projects (PG&E V2X and SCE Rialto USD, Large Oakland Unified Zum V2G)