



September 2026

Resilient Communities, Resilient Grid

How Electric School Buses Can Help

the
climate
center

Resilient Communities, Resilient Grid

How Electric School Buses Can Help

Table of Contents

Executive Summary	4
California’s Resilience Problems and the Connection to Electric School Buses	4
Introduction to Electric School Buses	7
What Is Vehicle-Grid Integration?	9
How Can Electric School Buses Support Communities and the Grid?	11
What Is California Doing on Electric School Buses and Vehicle-Grid Integration?	14
Developing a Bidirectional Electric School Bus Project	19
State of Play: Barriers and Opportunities for Scaling up Bidirectional Electric School Buses in California	22
Funding, Financing, and Compensation for Grid Services	22
Interconnection	31
Education and Awareness	36
Standards and Interoperability	39
Cross-Cutting Issues and Proposed Solutions	41
Case Studies	44
Pittsburg Unified School District (PUSD)	44
Oakland Unified School District (OUSD)	46
Porterville Unified School District (PUSD)	48
Fremont Unified School District (FUSD)	49
Modesto City Schools	50

Acknowledgements

This report was prepared pursuant to a grant to The Climate Center from the Clif Family Foundation by Kurt Johnson, Pooja Agarwal, and Anna Bella Korbatov. The authors are grateful

for comments and suggestions from reviewers including Vincent Weyl from the California Energy Commission, Robert Stafford and Michelle Levinson from the World Resources Institute, Angel Yin from RIDE, and Barry Vesser from The Climate Center. Any errors are the responsibility of the authors.

Glossary

Key Terms

- **Vehicle-Grid Integration (VGI)** — the coordinated interaction between electric vehicles and the electricity grid, including managed (unidirectional) charging and bidirectional power flow.
- **Vehicle-to-Grid (V2G)** — bidirectional technology allowing an EV battery to discharge stored energy back to the electric grid.
- **Vehicle-to-Building (V2B)** — bidirectional technology allowing an EV battery to directly power a building's electrical load.
- **Vehicle-to-Home (V2H)** — bidirectional technology allowing an EV battery to power a home.
- **V2X** — umbrella term covering V2G, V2B, V2H, and related bidirectional use cases.
- **Electric School Bus (ESB)** — a school bus powered by an electric battery rather than diesel or gas.
- **Bidirectional ESB** — an ESB equipped with hardware enabling V2X power flow.
- **Resilience Hub** — a community facility equipped with backup power that supports residents before, during, and after emergencies.
- **Interconnection** — the technical and regulatory process of connecting a distributed energy resource (like a bidirectional ESB) to the electric grid.
- **Demand Response (DR)** — programs that pay or incentivize electricity customers to reduce or shift usage during periods of grid stress.
- **Time-of-Use (TOU) rate** — an electricity pricing structure that varies by time of day to reflect grid conditions.
- **Public Safety Power Shutoff (PSPS)** — a preemptive utility power outage intended to reduce wildfire risk.
- **Total Cost of Ownership (TCO)** — the full cost of owning and operating a vehicle over its lifetime, including purchase, fuel/energy, and maintenance.

Agencies and organizations

- CEC: California Energy Commission
- CARB: California Air Resources Board
- CPUC: California Public Utilities Commission
- IOU: Investor-Owned Utility
- POU: Publicly Owned Utility
- DWR: Department of Water Resources
- DSA: Division of the State Architect
- WRI: World Resources Institute
- SEPA: Smart Electric Power Alliance
- VGIC: Vehicle-Grid Integration Council

Programs and funding

- ZESBI: Zero-Emission School Bus and Infrastructure
- HVIP: Hybrid and Zero-Emission Truck and Bus Voucher Incentive Project
- EPIC: Electric Program Investment Charge
- LCFS: Low Carbon Fuel Standard
- ELRP: Emergency Load Reduction Program
- DSGS: Demand Side Grid Support
- Technical/equipment
- EVSE: Electric Vehicle Supply Equipment
- BESS: Battery Energy Storage System
- PTO: Permission to Operate
- MHD: Medium and Heavy Duty (vehicles)
- EVITP: Electric Vehicle Infrastructure Training Program
- MW: Megawatt
- kW: Kilowatt
- KWh: Kilowatt-hour

Executive Summary

Bidirectional electric school buses (ESBs) have enormous untapped potential to improve student health, enable community energy resilience during power outages, and build a more reliable grid through vehicle-grid integration. To realize these multiple benefits, California must enact policy to prioritize electric school buses to enhance electricity affordability, resilience, and reliability.

Electric school buses alone will not solve all of California's electricity grid challenges, but electric school buses should be recognized for their health, cost, and climate benefits.

While this white paper provides an introduction to electric school buses, vehicle-grid integration, and bidirectional ESBs, it also covers the context of California's prior work in vehicle-grid integration. This report identifies four main barriers to and possible policy solutions for scaling up bidirectional ESB projects in the state: funding and financing, interconnection, education and awareness, and interoperability. More broadly, this white paper is intended to equip policymakers, advocates, and school districts with the information needed to support ESBs and to accelerate opportunities for ESBs to serve as community energy resilience hubs.

Defining the Problem: California's Resilience Problems and the Connection to Electric School Buses

California's electricity grid faces major challenges, which are only worsening due to the impacts of climate change. Communities across the state — particularly those who disproportionately face overlapping social, environmental, and health harms — are suffering from unaffordable electricity rates, unreliable access to electricity, and few backup power options when the grid fails. The Climate Center has developed a vision for a Grid for the Future that is clean, affordable, reliable, resilient, equitable, and safe¹ in the wake of California's worsening affordability, reliability, and resilience challenges.

Affordability: Californians' electricity bills continue to rise due to a combination of factors, including transmission and distribution infrastructure upgrades, costs of wildfire liability and wildfire mitigation, and rising utility profits.² Together, these factors mean that more than one in five Californians are behind on their energy bills, owing more than \$600 on average.³ Compared to the average Californian, low-income Californians pay a higher proportion of their income

¹<https://theclimatecenter.org/community-energy-resilience/envisioning-the-california-grid-for-the-future/>

²https://eta-publications.lbl.gov/sites/default/files/2025-10/full_summary_retail_price_trends_drivers.pdf

³<https://www.publicadvocates.cpuc.ca.gov/-/media/cal-advocates-website/files/press-room/reports-and-analyses/260210-public-advocates-office-q4-2025-rates-report.pdf>

towards energy bills, even as these costs grow faster than their paychecks.⁴ Meanwhile, California's three major investor-owned utilities earned over \$24 billion in profits between 2021 and 2025.⁵

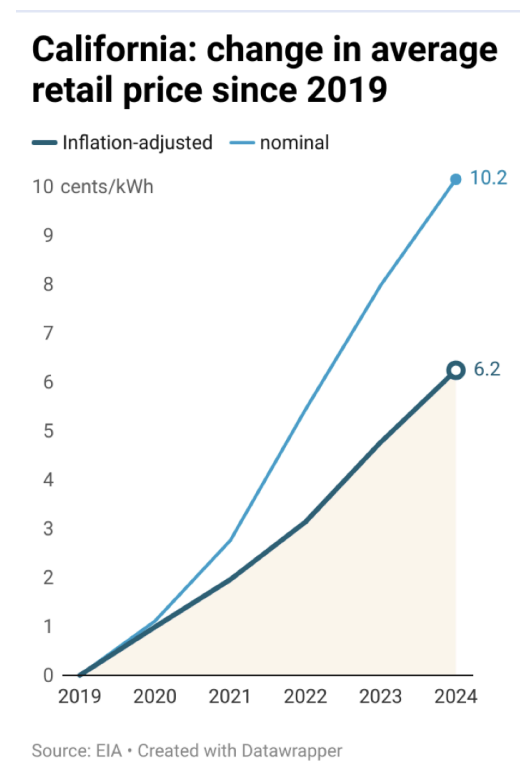


Figure 1. Changes in average California retail price of electricity since 2019, inflation-adjusted and nominal. Source: Lawrence Berkeley National Lab and The Brattle Group.

⁴ <https://www.ppic.org/blog/low-income-households-struggle-with-the-cost-of-electricity-bills/>

⁵ <https://energyandpolicy.org/utilityprofittracker/?utility=san-diego-gas-electric&bill=150>

2019-2025: 29 states with decreases; largest increases in California, Northeast, some states in Mid-Atlantic, West, Great Lakes

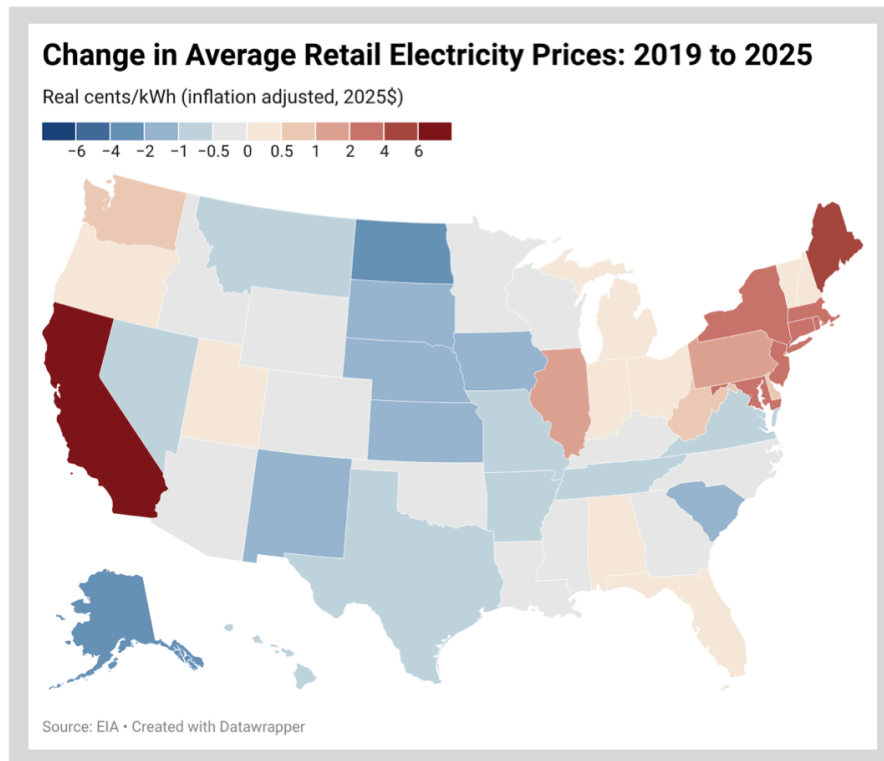


Figure 2. Changes in average state-level, inflation-adjusted retail prices. Source: Lawrence Berkeley National Lab and The Brattle Group.⁶

Reliability: The electricity grid faces increasing reliability challenges, including extreme weather exacerbated by climate change and rising wildfire risk. While California has not experienced a forced outage since 2020, the state is still paying polluting peaker plants to stay online for reliability in case electricity demand spikes.⁷ Peaker plants are often sited in disadvantaged communities, which already face cumulative health, social, and environmental burdens.

Rural communities are disproportionately affected by reliability issues because public safety power shutoffs (PSPS) — which utilities initiate during periods of elevated wildfire risk, often due in part to inadequately maintained electrical infrastructure — occur most frequently in rural

⁶ https://eta-publications.lbl.gov/sites/default/files/2026-03/retail_price_trends_2026_edition.pdf

⁷ <https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/Electricity-Supply-and-Strategic-Reserve-Office/DWR-August-2025-JLBC-Report-1212.pdf>

areas.⁸ Tribal communities across the state also face unreliable access to electricity. For example, up to half of homes in part of the Yurok reservation are off the grid, leaving families reliant on diesel and propane generators.⁹

Resilience: California's electric grid is not adequately prepared for the expected increase in frequency and severity of climate-fueled extreme weather events. Thus, communities are unprepared and underequipped to recover.

Disadvantaged communities — which have older electrical infrastructure and are more susceptible to these disruptions — also cannot recover as quickly.¹⁰ For many medically vulnerable, senior, and disabled residents, uninterrupted access to electricity is a matter of life or death. Schools are increasingly impacted by outages and extreme weather, particularly due to a lack of backup power generation or storage, which puts students at risk.^{11,12} During the 2025-2026 school year, more than 54,000 California students a cumulative 450,000 hours of instruction due to severe weather and public power shutoffs.¹³ For students in disadvantaged communities, losing access to school due to power outages means more than just less learning: it also means losing access to free meals and working parents losing access to childcare.

Scaling up the use of bidirectional electric school buses is one clear approach that California can take to address these affordability, reliability, and resilience issues.

Introduction to Electric School Buses

Electric school buses (ESBs) are a type of zero-emission bus that utilizes batteries for power rather than diesel fuel or gasoline. ESB's are powered entirely by rechargeable battery packs and an electric motor rather than a traditional internal combustion engine and produce zero tailpipe emissions. With transportation comprising approximately half of California's greenhouse gas emissions, close to 80 percent of the state's nitrogen oxide pollution, and 90 percent of diesel particulate matter, transitioning to electric school buses can make a

⁸ <https://www.psehealthyenergy.org/work/california-public-safety-power-shutoff-interactive-map/>

⁹ <https://www.caprado.org/articles/2024/03/08/four-tribes-in-california-receive-federal-funds-to-boost-access-to-electricity>

¹⁰ <https://link.springer.com/article/10.1007/s40518-025-00260-1>

¹¹ <https://www.undauntedk12.org/california>

¹² <https://calmatters.org/environment/climate-change/2026/02/school-power-outages-edison-california/>

¹³ <https://www.undauntedk12.org/california-closures-25-26>

significant difference in improving local air quality, health, and the attainment of California's climate goals.¹⁴

California leads the nation in ESB deployment, with more than 1,800 buses on the road transporting 70,000 students to school each day as of May 2026.¹⁵ Although not all California students ride school buses,¹⁶ the communities they live in remain exposed to diesel pollution every day, increasing their risk of asthma and other respiratory diseases.¹⁷ Electric school buses hold many crucial health and environmental advantages over diesel buses.

Health: Rather than poisoning the lungs of vulnerable children and their communities, ESBs run on electricity powered by an increasingly cleaner electric grid in California.¹⁸ For communities of color and low-income communities, which host the most polluting buses and are disproportionately affected by air pollution, ESBs improve local air quality and lower students' risk of asthma. Reducing student exposure to air pollution from diesel school buses is also linked to better academic achievement.¹⁹ The World Resources Institute (WRI) and Carleton University recently found that switching to electric school buses in California would result in \$155 million in annual health and climate benefits.²⁰ Three California counties, Los Angeles County, Orange County, and Sacramento County, rank in WRI's list of the top ten counties nationally that would reap the greatest health and climate benefits from transitioning to electric school buses.²¹

Environmental: On average, ESBs produce half the amount of greenhouse gas emissions of diesel and propane buses over the course of their lifespan.²² In regions where the electricity grid is powered by cleaner energy, like in California, ESBs produce only one-third the lifecycle emissions of diesel buses.²³

Despite their clear advantages, there are still roadblocks to fully transitioning to electric school buses. ESBs are still much more expensive than diesel buses (up to three times the cost),²⁴ but financial incentives can reduce their total cost of ownership and make ESB purchases more

¹⁴ <https://www.energy.ca.gov/about/core-responsibility-fact-sheets/transforming-transportation>

¹⁵ <https://app.powerbi.com/view?r=eyJrjoiNDc5NTdkYzYtNWlxYS00ZjIwLWFhZDQtNjEyMDRhNjFmOGFmliwidCI6IjQ3NmJhYzFmLTMyYjltNGFkOS04Njk5LWNkYTZiYWQxZjg2MjI0MmMiOjF9>

¹⁶ <https://www.kqed.org/news/11980715/why-dont-more-bay-area-kids-ride-school-buses>

¹⁷ <https://www.epa.gov/dera/learn-about-impacts-diesel-exhaust-and-diesel-emissions-reduction-act>

¹⁸ <https://www.eia.gov/states/ca/data/dashboard/electricity>

¹⁹ https://www.nber.org/system/files/working_papers/w25641/w25641.pdf

²⁰ <https://www.wri.org/insights/electric-school-bus-health-climate-benefits>

²¹ <https://www.wri.org/insights/electric-school-bus-health-climate-benefits>

²² Ibid.

²³ Ibid.

²⁴ <https://www.resources.org/common-resources/why-are-electric-school-buses-so-expensive/>

financially viable for school districts.²⁵ ESBs also require careful planning to deploy compared to diesel buses, so right-sizing bus and charger procurement for the average expected route, planning routes strategically to maximize range, and training bus drivers are all crucial strategies that schools can undertake to optimize the efficiency of their ESBs.

Electrifying school buses already results in major benefits for students and their communities. Going a step further to leverage vehicle-grid integration can lead to even greater advantages.

What Is Vehicle-Grid Integration?

While the primary purpose of ESBs is to safely transport students, they can also provide numerous grid benefits since they are essentially “batteries on wheels.” ESBs can use smart or managed charging to optimize charging for cost savings and grid impacts, and bidirectional charging to actually export power to the grid or to a building. While we are far from realizing the full potential of these grid benefits, California can pioneer the use of bidirectional electric school buses at scale, starting in disadvantaged communities.

Vehicle-grid integration (VGI) describes technologies that enable vehicles to work intelligently with the electricity grid to optimize cost, environmental, and grid benefits. In December 2020, the California Public Utilities Commission (CPUC) adopted a final definition for VGI in Decision 20-12-029 (Order Instituting Rulemaking to Continue the Development of Rates and Infrastructure for Vehicle Electrification):²⁶

“Any method of altering the time, charging level, or location at which grid-connected light-duty electric vehicles, medium-duty electric vehicles, heavy-duty electric vehicles, off-road electric vehicles, or off-road electric equipment charge or discharge in a manner that optimizes plug-in electric vehicle or equipment interaction with the electric grid and provides net benefits to ratepayers by doing any of the following:

- A) Increasing electrical grid asset utilization and operational flexibility.*
- B) Avoiding otherwise necessary distribution infrastructure upgrades and supporting resiliency.*
- C) Integrating renewable energy resources.*
- D) Reducing the cost of electricity supply.*

²⁵<https://files.wri.org/d8/s3fs-public/2025-01/recommended-total-cost-ownership-esb-summary-methods-data-v2.pdf?VersionId=kis.ODd5set5XDgaP57.6QeA1kPf9UBH>

²⁶ <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M355/K794/355794454.PDF>

E) Offering reliability services consistent with the resource adequacy requirements established by Section 380 or the Independent System Operator tariff.”

Figure 3 provides an overview of VGI terms and the status of these different technologies.

Managed (smart) charging (V1G) describes vehicle charging that is optimized for cost savings, renewable power, and grid benefits. Depending on program availability, most EV owners can participate in passive and/or active managed charging through their vehicle manufacturers, third-party platforms, or even their local utility. In passive managed charging, EV drivers can customize settings, like the minimum charge that should be available, then the provider develops a set charging schedule based on the local utility’s time-of-use rates (TOU), which incentivizes customers to use electricity when costs are low and there is less strain on the grid. Through active managed charging, the provider can adjust the vehicle’s charging schedule in real time to respond to grid conditions, manage or reduce demand charges tied to peak demand, keep site electricity usage below a set threshold through automated load management, and enable demand response participation, which pays a set rate per kilowatt-hour of load reduction or exported energy during high-demand, high-price periods.

Bidirectionality describes electric vehicles that are capable of two-way power flow. These EVs can be charged like a conventional electric vehicle and can also discharge power. When paired with a compatible bidirectional charger, the batteries in bidirectional EVs can power the grid (V2G), buildings (V2B), microgrids (V2M), homes (V2H), or a load (V2L), collectively known as Vehicle-to-Everything (V2X). Currently, at least a dozen light-duty EV models are bidirectional-capable,²⁷ and most new ESB models are bidirectional-capable. Bidirectional EVs participating in V2G can support lower electricity costs and a cleaner, more reliable grid by charging when electricity is cleaner and cheaper and exporting back to the grid when electricity is more expensive and demand is high.

²⁷ <https://recharged.com/articles/bidirectional-charging-evs-list-2025>

Definitions for the World of VGI

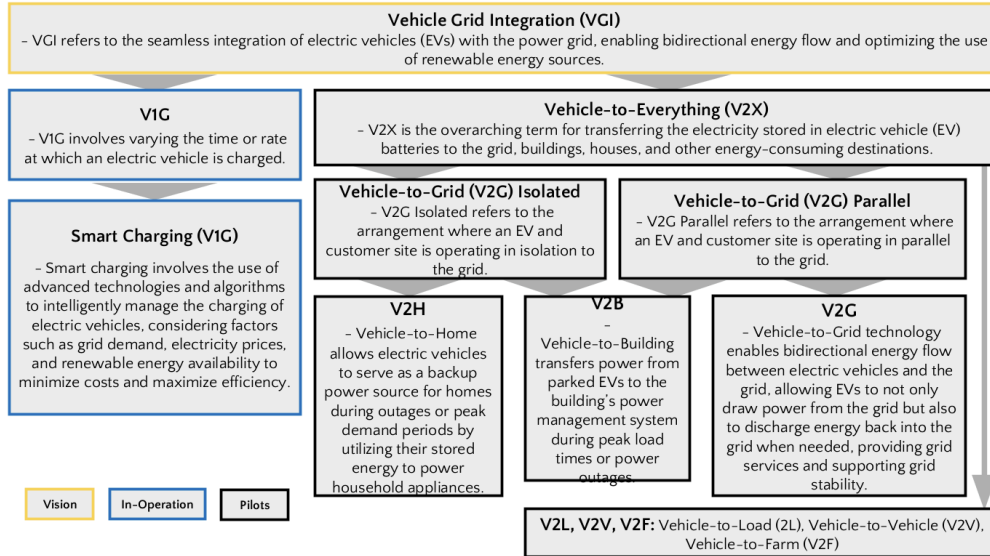


Figure 3. Visual Diagram of Vehicle-Grid Integration. Source: Vehicle-Grid Integration Council.

How Can Electric School Buses Support Communities and the Grid?

Given this context, there are many opportunities for electric school buses to participate in some level of vehicle-grid integration to support community and grid reliability, resilience, and affordability.

Reliability: Today, many school districts support grid reliability and lower their charging costs using managed charging. Some school districts also participate in demand response programs, earning additional revenue for helping to avoid power outages while ensuring buses stay charged for school operations. As V2G applications, rates, and programs become more available, bidirectional ESBs can also provide and be paid for providing energy services that help maintain a stable grid.²⁸

Resilience: While the potential for ESBs to support community resilience is great, few projects have been developed so far due to barriers that will be discussed later in this report. When configured for V2X applications, bidirectional ESBs can function as batteries on wheels. For example, if a school experienced a power outage, an ESB could support community resilience by driving to a school to power specific appliances (V2L) or to a school building (V2B) to power essential services. One study found that a high school in Santa Barbara County only needed approximately 10 kW to power critical loads, which included food storage and a multipurpose

²⁸ <https://www.sciencedirect.com/science/article/pii/S0301421517307619>

room that could be used for centralized emergency operations.²⁹ However, there is no standardized way to value energy resilience, so these considerations may not factor into the financial planning for ESB projects. Developing an energy resilience methodology could help tip the scales in favor of bidirectional ESB projects.³⁰

Affordability: Adopting managed charging at scale can help reduce the need to upgrade existing grid infrastructure or build additional grid infrastructure, both of which are contributing to rising electricity rates. Synapse Energy Economics found that, over a 14-year period (2011-2024), EV drivers in California put downward pressure on electric rates by “contributing \$8.91 billion more in utility revenues than their associated electric system costs,” with managed charging contributing to most of those cost savings.³¹ The Union of Concerned Scientists found that varying levels of vehicle-grid integration of light-duty EVs in CA could lead to electricity grid savings ranging from \$1.8 billion to \$11.7 billion per year in 2045.³²

Box 1. Why are electric school buses well-suited for bidirectionality?

Availability: Today, most ESB models are equipped to be V2G-capable. V2G-capable models can be charged and discharged when used with interoperable bidirectional chargers and V2G infrastructure.³³ California’s zero-emission bus funding programs require funding to be used for bidirectional ESBs, which provides market certainty for manufacturers and could help them reach economies of scale.³⁴ However, older generation ESBs are not all V2G-capable.

Predictability: ESBs are parked most of the day, have regular routes, are often unused during weekends and summer months, and can charge during off-peak hours when clean energy is abundant (during school hours) and electricity is cheap (nighttime).³⁵ Newer

²⁹<https://clean-coalition.org/wp-content/uploads/2021/09/San-Marcos-High-School-Solar-Microgrid-case-study-10-gy-30-June-2020.pdf>

³⁰<https://rmi.org/resources/power-outages-cost-more-than-we-account-for/>

³¹https://www.synapse-energy.com/sites/default/files/Synapse_California_Factsheet_EV_Rates_24-023.pdf

³²<https://www.uccs.org/resources/harnessing-power-electric-vehicles>

³³<https://electricschoolbusinitiative.org/sites/default/files/2025-07/Electric%20School%20Bus%20Market%20Overview%20%28July%202025%29%20%282%29.pdf>

³⁴<https://californiahvip.org/wp-content/uploads/2024/04/Final-FY23-24-ZESBI-Implementation-Manual.pdf>

³⁵<https://docs.nrel.gov/docs/fy17osti/69017.pdf>

ESBs have large batteries (150 KWh on average³⁶) and can have up to 70 percent of charge available at the end of a school day.³⁷

Community Energy Resilience: When power outages occur, ESBs can provide backup power to schools or other buildings, which can act as community resilience centers.³⁸ Schools that have access to backup generators often rely on polluting diesel generators, which are cheaper to own and operate, but which threaten local air quality and public health and can run afoul of state regulations.

Deeper Dive: Resilience Hubs

An important tool for increasing community resilience is through resilience hubs, also called resilience centers. Resilience centers are community facilities (such as libraries, places of worship, recreation centers, municipal buildings, and schools) that support residents' needs before, during, and after emergencies.³⁹ They offer energy resilience through backup power generation, whether through batteries or diesel generators, which enable residents to access WiFi and cooling and keep their devices charged. Resilience hubs help build community resilience year-round by creating opportunities for increased social cohesion and providing residents with access to emergency services.

A growing number of resilience centers are being developed across the state, often led by communities, as climate-fueled disasters and power shutoffs demonstrate the importance of safe sites with reliable access to electricity and cooling. The Governor's Office of Land Use and Climate Innovation has been a major source of funding for planning and developing new resilience hubs in California. Additional information about resilience centers can be found in the USDN Resilience Hub Guidance Document.⁴⁰

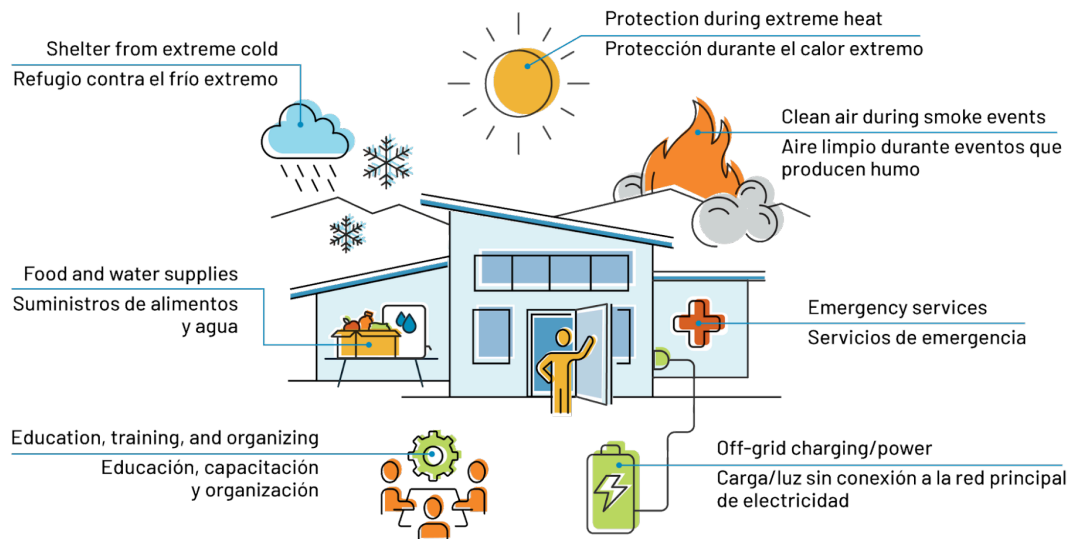
³⁶<https://electricschoolbusinitiative.org/how-electric-school-bus-fleet-owners-can-ensure-their-used-vehicle-batteries-avoid-landfill-and>

³⁷https://environmentamerica.org/wp-content/uploads/2022/03/TX_V2G-2022-scrn.pdf

³⁸<https://electricschoolbusinitiative.org/how-students-rural-midwest-district-led-charge-electrify-and-boost-grid-resiliency>

³⁹<https://www.usdn.org/resilience-hubs.html>

⁴⁰ Ibid.



Source: City of Richmond, Virginia, RVAGreen 2050.⁴¹

School buildings are well-suited to host resilience centers for their students and the broader community. Large school spaces like cafeterias and gymnasiums are equipped to house many students, and when designed or retrofitted for resilience needs, these areas can be wired on designated electrical circuits so that backup power sources, such as bidirectional ESBs, can plug in. One limitation of this model is that most school buildings are not fully electric, so services that rely on fuels (e.g. heating) cannot be backed up with an ESB. While this model is still under development at sites like Porterville Unified and Pittsburg Unified, there are important lessons to be learned and barriers that must be overcome to reach scale.

What Is California Doing on Electric School Buses and Vehicle-Grid Integration?

Fortunately, California has recognized the benefits of electric school buses and VGI, but the state can do more. As with its leadership on ESB deployment, California has the opportunity to advance community energy resilience by investing in vehicle-grid integration through bidirectional ESBs.

⁴¹ <https://www.rvagreen2050.com/resilience-hubs>

School district staff and leadership often cite compliance with state policies as a major reason for transitioning to electric school buses.⁴² SB 579, passed in 2022, requires most California school districts to purchase only zero-emissions school buses by 2035.⁴³ However, the upfront cost of owning an ESB is too high without funding to bridge the gap between the cost of a diesel bus and the cost of an electric bus. Fortunately, the state has followed through on its commitment to ESBs by investing more than \$1.39 billion in funding incentives and technical assistance to support districts in transitioning to ESBs.⁴⁴ Still, gaps remain and continued funding and support will be crucial to help districts comply with SB 579. A survey in early 2025 found that school district leaders are concerned about compliance with the SB 579 mandate given the challenges of procuring ESBs and installing associated infrastructure.⁴⁵

Along with its focus on ESBs, the state has been working on vehicle-grid integration issues for more than a decade.⁴⁶ In 2018, the state convened an interagency working group of stakeholders from the CPUC, CARB, CEC, and CAISO to form the VGI Working Group, culminating in a comprehensive report released in 2020 that details near and long-term opportunities for the state to scale up VGI. One of the findings names electric school buses as a consensus use case for VGI.⁴⁷ Table 1 details California’s current policies relevant to ESBs and vehicle-grid integration.

The potential for electric vehicles of all types to support the grid is vast. The California Energy Commission recently estimated that the batteries in light-duty EVs represent about 18.5 GW of available power capacity in the state.⁴⁸ A 2022 PIRG report found that if “every yellow school bus currently in operation across the United States were replaced with a V2G-capable electric bus of the same type, this would add over 60 gigawatt-hours (GWh) to the country’s capacity to store electricity.”⁴⁹ In California, that same report finds that converting the state’s school bus fleet to electric and bidirectional would provide over 3 MWh of battery capacity (enough to power more than 100,000 homes for a day) and 315 MW of instantaneous power for peak shaving.⁵⁰

⁴² <https://ww2.arb.ca.gov/our-work/programs/school-buses/regulations-affecting-school-fleets>

⁴³ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240AB579

⁴⁴ https://ww2.arb.ca.gov/sites/default/files/2025-12/FY%202025-26%20SB%201403%20Report_0.pdf

⁴⁵ <https://publications.csba.org/issue/winter-2025/zero-emission-bus-survey-reveals-concerns-about-mandate/>

⁴⁶ <https://www.energy.ca.gov/programs-and-topics/programs/vehicle-grid-integration-program>

⁴⁷ https://gridworks.org/wp-content/uploads/2020/09/GW_VehicleGrid-Integration-Working-Group.pdf

⁴⁸ <https://efiling.energy.ca.gov/GetDocument.aspx?tn=268952&DocumentContentId=106145>

⁴⁹ https://environmentamerica.org/wp-content/uploads/2022/03/TX_V2G-2022-scrn.pdf

⁵⁰ Ibid.

These studies reveal the opportunity of ESBs to support the electricity grid, but the right policies must be in place to actually achieve these benefits.

Table 1. Existing policy relevant to electric school buses and vehicle-grid integration

Policy	Summary	Status
SB 676 (Bradford, 2019)	Requires the CPUC to “maximize the use of feasible and cost-effective electric vehicle (EV) grid integration” by January 1, 2030.	Pursuant to CPUC decision D.20-12-019⁵¹, IOUs are required to submit an annual stocktake report to demonstrate progress.⁵² Under section 95483(c)(1)(A)5.b. of CARB’s LCFS regulation and a subsequent 2024 CARB rulemaking, LCFS holdback revenue not required for equity spending may be used for programs supporting VGI.⁵³ Pursuant to CPUC Decision D.20-12-027 (December 2020), the IOUs must file LCFS Holdback Implementation Plans requesting authorization for specific programs, including VGI programs.⁵⁴
SB 579 (Ting, 2023) ⁵⁵	Requires most California school districts to only purchase zero-emissions school buses by 2035.	Implementation on track, but concerns from school districts. ⁵⁶ This bill does not mention bidirectionality.

⁵¹ <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M355/K104/355104591.PDF>

⁵² <https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M527/K512/527512622.PDF>

⁵³ <https://ww2.arb.ca.gov/sites/default/files/2026-04/Guidance%2020-03%20-%202026%20Update.pdf>

⁵⁴ <https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M356/K223/356223853.PDF>

⁵⁵ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240AB579

⁵⁶ <https://publications.csba.org/issue/winter-2025/zero-emission-bus-survey-reveals-concerns-about-maintenance/>

SB 114 (Ting, 2023)	Allocated \$500 million to create ZESBI, which includes \$375 million for a California Air Resources Board (CARB) program for clean school buses and \$125 million for a zero-emission school bus charging infrastructure program through the California Energy Commission (CEC). ⁵⁷ The bill also directs the state's Department of General Services to establish statewide contracts with school bus manufacturers to ensure high-road manufacturing standards.	Initial funding for ZESBI has been fully subscribed and 33 districts remain on the waitlist for funding. Additional funding has been made available through HVIP.
SB 59 (Skinner, 2024) ⁵⁸	Authorizes the California Energy Commission, in consultation with the California Air Resources Board and the Public Utilities Commission, to require any weight class of battery electric vehicle to be bidirectional-capable if it determines there is a sufficiently compelling beneficial bidirectional-capable use case to the EV owner/operator and electrical grid.	Implementation is pending at the California Energy Commission. A related bill that was proposed in 2026 but did not advance, SB 1282 (Becker), would have required CEC to conduct a study on the grid benefits of grid-integrated vehicles and start a standard-setting process if sufficient benefits are identified.
SB 1403 (Lara, 2018) ⁵⁹	Directs CARB and CEC to publish an annual report on California's progress in ESB deployment, funding needs, and strategy for school bus programs.	The report is published annually, but it does not currently report on how many bidirectional ESBs have been sold or are being used.
AB 1111 (Soria, 2025) ⁶⁰	Delays SB 579 timeline for compliance to 2045.	Did not pass.
Advanced Clean Fleets ⁶¹	Requires affected fleets, beginning January 1, 2024, to ensure that 50 percent of their annual vehicle purchases per calendar year are	Changes to regulation were approved in September 2025.

⁵⁷ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB114

⁵⁸ https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202320240SB59

⁵⁹ https://leginfo.legislature.ca.gov/faces/billStatusClient.xhtml?bill_id=201720180SB1403

⁶⁰ <https://www.govtech.com/education/k-12/ca-bill-to-delay-electric-bus-mandate-would-help-schools-comply>

⁶¹ <https://ww2.arb.ca.gov/resources/fact-sheets/advanced-clean-fleets-regulation-state-local-government-agency-fleet>

zero-emissions, and beginning January 1, 2030, that 100 percent of vehicle purchases are zero-emissions.

Affected fleets include “white fleets” at public agencies (including school districts), such as groundskeeping crew trucks and district vehicles.

Today, at least 100 electric school buses (out of 1,700 operating ESBs, or less than 5 percent) are reportedly being used bidirectionally across the state in Oakland (74)⁶², Cajon Valley (8)⁶³, Fremont (6)⁶⁴, Torrance (6)⁶⁵, and Ramona (8).⁶⁶ Through CEC funding and other funding sources, at least an additional 180 V2G ESB applications are planned in San Francisco (104)⁶⁷, Modesto (37)⁶⁸, Conejo Valley, Los Angeles County (20)⁶⁹, Richmond (20)⁷⁰, Pittsburg, and Napa (6).⁷¹ While these projects represent major progress for the state as it adopts this technology, bidirectional use of ESBs remains in the pilot, or early adopters, phase of the S-curve of technology adoption (see Figure 4). Many of these projects have been funded as pilot projects by the CEC with a clear goal to develop toolkits and lessons learned to help these projects scale.⁷² Reducing these complexities and developing enabling policies can help scale and increase adoption of this technology into the system integration phase to deliver benefits across California.

⁶² <https://www.ridezum.com/press-release/nations-first-all-electric-school-bus-fleet-oakland-ca/>

⁶³ <https://nuvve.com/projects/cajon-valley-v2g-project/>

⁶⁴ <https://fremontunified.org/about/operations/transportation/v2g/>

⁶⁵ <https://nuvve.com/projects/torrance-electric-school-buses/>

⁶⁶ <https://www.schoolbusfleet.com/10182943/california-school-district-rolls-out-eight-ev-buses-with-v2g-ambitions>

⁶⁷ <https://chargedevs.com/newswire/san-francisco-unified-school-district-to-deploy-104-electric-school-buses-with-bidirectional-charging/>

⁶⁸ <https://www.sargentlundy.com/news/storer-coachways-electric-school-buses/>

⁶⁹ <https://www.businesswire.com/news/home/20240318233335/en/California-Energy-Commission-Award-s-a-%243-Million-Grant-to-BorgWarner-Fermata-Energy-and-Lion-Electric-for-Innovative-Vehicle-to-Grid-Project-with-Bus-Operator-American-Transportation-to-Service-Student-Transportation-for-California-School-Districts>

⁷⁰ https://ww2.arb.ca.gov/sites/default/files/2025-12/FY%202025-26%20SB%201403%20Report_0.pdf

⁷¹ https://www.mobilityhouse.com/usa_en/our-company/newsroom/article/cec-grant-bidirectional-school-bus-charging

⁷² https://www.mobilityhouse.com/usa_en/our-company/newsroom/article/cec-grant-bidirectional-school-bus-charging

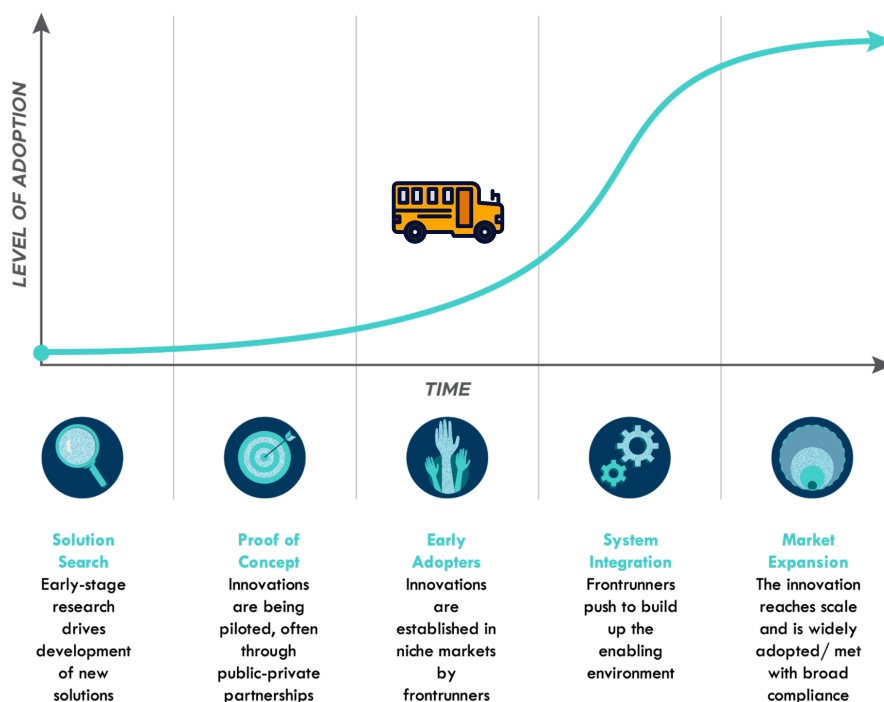


Figure 4. The S-Curve of Technology Adoption. Source: Rocky Mountain Institute.⁷³

Developing a Bidirectional Electric School Bus Project

Since bidirectional electric school bus projects (also called V2X ESB projects throughout this report) are still relatively new, there are many complexities in the planning, financing⁷⁴, development, and ongoing operation of these projects.

Early coordination with utilities is crucial for districts planning bidirectional ESB projects. Proactive utility coordination enables utilities to evaluate existing electrical infrastructure, assess available power capacity, identify potential power constraints, and explore utility make-ready funding opportunities with the district. An initial site assessment with an electrical contractor can help evaluate the technical feasibility and potential upgrades that may be required to stand up a project, as well as the resulting cost and timelines. While not all bidirectional ESB projects require the Division of the State Architect (DSA) approval, scheduling

⁷³ <https://rmi.org/insight/harnessing-the-power-of-s-curves/>

⁷⁴ <https://electricschoolbusinitiative.org/sites/default/files/2024-07/Electric%20School%20Bus%20Financial%20Solutions%20Guide%20%28July%202024%29.pdf>

a pre-application meeting with the DSA, which has jurisdiction over many school construction projects, can also help avoid unnecessary delays in the permitting process.^{75,76}

A V2B project can serve as a bridge to a V2G project, which can be more logistically challenging to implement. Figure 5 shows how V2X ESB projects can be configured and Table 2 is a non-exhaustive list of the many elements required for a bidirectional electric school bus project.

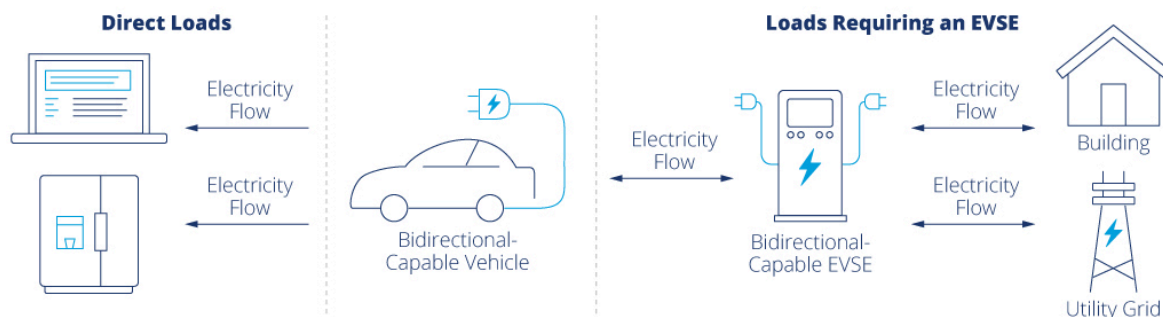


Figure 5. Illustration of Bidirectional Charging System. Source: SEPA⁷⁷

Table 2. What is needed for a bidirectional ESB project?

Category	Items
Staff	- Project manager (e.g. transportation director, energy manager) - School district decisionmaker buy-in (superintendent, school board) - Bus driver training and buy-in
Interoperable Hardware	- Bidirectionally-enabled ESB (with appropriate hardware and firmware) - Bidirectional charger⁷⁸ with sufficient power, communications protocols, and safety certifications to support duty cycles and power export — currently DC chargers only (see Appendix for list of compatible interoperable chargers)

⁷⁵<https://www.dgs.ca.gov/DSA/Resources/Start-Construction-Project-by-Submitting-Plans-for-Review>

⁷⁶ If the V2G project is not sited.

⁷⁷<https://sepapower.org/knowledge/the-x-in-v2x-matters-energization-versus-interconnection-of-bidirectional-charging-systems/>

⁷⁸<https://calstart.org/wp-content/uploads/2025/07/ESB-Network-Guide-to-Selecting-EV-Chargers-7.22.25.pdf>

Software	• Vehicle-grid integration software (charge management or V2G optimization platform or DERMS platform) that communicates with utility side
Utility Coordination	• Reliable electricity supply • Utility-side electrical upgrades to serve higher load on-site (if needed, varies based on additional infrastructure needed) ◦ Some sites may be eligible to participate in utility's flexible service connection pilots (e.g. PG&E⁷⁹, SCE⁸⁰) • Customer-side electrical infrastructure (utility disconnect, transfer switch, dedicated circuit for critical loads, inverter, service panel capacity, transformers, switchgear, trenching) • Interconnection agreement
Government Coordination	• Mutual Aid Agreement⁸¹ • Certificate of land ownership (title) or easement if land is leased • Local, state, federal permitting (e.g. CEQA if not exempted) • Division of State Architects, which must approve all construction projects at K-12 public schools
Stakeholder Coordination	• Community (students, parents, faculty and staff, community members) • Board of Education (for project approval) • Staff (superintendent, superintendent of business services, facility directors, bus operators, maintenance workers) • Utility • Electrical contractor • Architectural/Design firm, Engineering, Procurement, & Construction • VGI services providers/vendors (sell V2G hardware and software services; manage V2G/energy services)

⁷⁹<https://investor.pgecorp.com/news-events/press-releases/press-release-details/2025/New-PGE-Service-Offering-Makes-It-Easier-and-Faster-to-Connect-EV-Chargers-EV-Fleets-and-Big-Batteries-to-the-Grid/default.aspx>

⁸⁰<https://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M550/K610/550610226.PDF#:~:text=SCE%20previously%20developed%20a%20playbook.upgrades%2C%20substation%20capacity%20upgrades%2C%20new>

⁸¹https://electrificationcoalition.org/wp-content/uploads/2023/01/V2X-Paper_Final-Reader-File-Form2.pdf

State of Play: Barriers and Opportunities for Scaling up Bidirectional Electric School Buses in California

This section outlines the main barriers that are preventing bidirectional ESBs from scaling in California.

Funding, Financing, and Compensation for Grid Services

Background

Access to funding to offset the upfront cost of bidirectional ESBs and associated infrastructure and compensation mechanisms that provide ongoing revenue for ESBs' grid services are crucial enabling factors for scaling up VGI.

California has leading incentive programs for purchasing ESBs and charging infrastructure, having invested \$1.39 billion in zero-emission school buses and related infrastructure as of 2025.⁸² While the state's funding is notable, additional sources from the federal government, utilities, and local governments have also supported ESB procurement in the state. Having access to multiple funding programs and permission to "stack" funding from various sources is important because school districts often rely on more than one funding source to fully fund a bus and its associated infrastructure.

Federal grants from the EPA Clean School Bus Program significantly scaled up ESBs in California. Regional funding through local air quality management districts is another major stream of ESB funding. Utilities provide financial support for electrical infrastructure upgrades and chargers through "make-ready" funding programs. State grants are also available for transportation planning and pilot projects of novel technology applications. Proposition 2, passed in 2024, created a \$10 billion bond that will become another new statewide source for school modernization funding.⁸³ Districts may also use municipal bonds, low-interest loans, or other types of financing to supplement grants. Table 3 provides an overview of these funding programs and approximate allocations.

In addition to upfront financial incentives, ongoing cost savings and revenue opportunities can make bidirectional ESBs more economically competitive. Switching from diesel to ESBs leads to lower fuel and maintenance costs, and districts in California can register for Low Carbon Fuel Standard (LCFS) credits for operating ESBs and chargers, which pay electric vehicle

⁸²https://ww2.arb.ca.gov/sites/default/files/2025-12/FY%202025-26%20SB%201403%20Report_0.pdf

⁸³ <https://www.casbo.org/articles/advocacy/newsbreak/proposition-2-passes/>

owners a certain dollar amount for each metric ton of carbon dioxide avoided. Financial tools can bring these expected lifetime operating savings relative to diesel forward to serve as part of the upfront capital stack for ESB purchase. The Community to Advance Finance for Electric School Buses, led by World Resources Institute and Clean Energy Works, is working to develop and deploy new innovative financing structures for ESBs to bridge gaps in public funding.⁸⁴

Additionally, ESBs that engage in VGI are providing value through grid services, so they should be fairly compensated for their contributions. Currently, ESBs that use managed charging can leverage time-of-use rates to lower energy costs. A California Energy Commission pilot project at Stockton Unified School District estimated that implementing managed charging for the ESB fleet reduced energy costs by 26-53 percent compared to unmanaged charging.⁸⁵ ESBs can also participate in virtual power plant programs, which aggregate many types of distributed energy resources (e.g. solar, batteries, electric vehicles) to support the grid through demand response. ESBs can also get paid for their contributions through utility demand response programs and statewide programs such as Demand Side Grid Support (DSGS) and the Emergency Load Reduction Program (ELRP), which provide financial compensation to resources that reduce peak load during critical hours. When ESBs participate in V2G, they have limited opportunities to be compensated for energy exported to the grid and the energy capacity they have available during peak hours (resource adequacy).

Finally, the state provides dedicated funding for energy resilience. The Strategic Growth Council has offered funding for Community Resilience Centers as well as extreme heat and community resilience programs, and expects to make additional funding available in 2026. Several school districts were awarded funding for resilience hub projects.⁸⁶ In the past, the Governor's Office of Emergency Services provided \$125 million funding through the Community Power Resiliency Program in response to prolonged power outages in disadvantaged communities.⁸⁷

Problem

Funding remains the number one barrier to scaling bidirectional ESBs in California. While California leads the nation in ESB deployment with more than 1,700 on the road, much more

⁸⁴<https://electricschoolbusinitiative.org/new-community-practice-sparks-financial-solutions-electric-school-buses>

⁸⁵ https://www.energy.ca.gov/sites/default/files/2023-03/CEC-600-2023-028_0.pdf

⁸⁶ <https://www.lci.ca.gov/wp-content/uploads/20250529-EHRGPRound-1-AwardsList.pdf>

⁸⁷<https://www.caloes.ca.gov/office-of-the-director/policy-administration/finance-administration/grants-management/community-resiliency-listos-grants/community-power-resiliency-program/>

funding is needed.⁸⁸ Demand far exceeds the available funding for these incentives, and 33 school districts were waitlisted in the latest round of Zero-Emission School Bus Infrastructure (ZESBI) funding.⁸⁹ Analysis has also found that bus manufacturers raise the prices of buses to capture the value of grants, so districts end up paying the same amount.⁹⁰ Tariffs, inflation, and supply chain issues continue to drive up the cost of bidirectional ESB infrastructure.

Even when this funding is available, upfront incentives may not fully cover the incremental cost of bidirectional equipment. The cost of bidirectional chargers and the associated infrastructure upgrades required could total \$100,000 more than standard ESB chargers.⁹¹ Additionally, these programs primarily fund buses and chargers, and infrastructure upgrades are a large proportion of the cost of V2X projects. While ZESBI allows up to 10 percent of the grant award to be used for a range of eligible “School Transportation” costs, which include VGI software and electrical infrastructure upgrades, these costs likely exceed the available funding.⁹²

When it comes to V2G ESB bus projects, compensation for exported electricity and reducing demand on the grid are crucial for these projects to “pencil” for school districts. Funding for state programs, DSGS and ELRP, are reliant on public funding and are short-term, reducing investment certainty for districts that would want to factor these incentives into their planning.^{93,94} Further, the rollout of long-term compensation mechanisms to fully value V2G contributions to the grid has been slow. Currently, no California IOU has a V2G tariff that pays per kilowatt hour (kwh) of energy exported, and a recent stakeholder-driven static V2G export tariff from Southern California Edison was rejected by the Public Utilities Commission.⁹⁵ Although there are California IOU dynamic rate pilots open to bidirectional charging equipment, such as PG&E’s Hourly Flex Pricing Pilot, these dynamic rates are complicated to implement and optimize for, do not provide a guaranteed revenue stream for grid export, and will sunset at the end of 2027.

“Ultimately, bidirectional ESB’s have no reliable revenue stream upon which to build a compelling business case or return on investment for fleet operators or school districts.”

⁸⁸<https://app.powerbi.com/view?r=eyJrJoiNDc5NTdkYzYtNWlxYS00ZjIwLWFhZDdtNjEyMDRhNjFmOGFmliwidCI6IjQ3NmJhYzFmLTM2YjltNGFkOS04Njk5LWNkYTZiYWQxZjg2MjlsImMiOiF9>

⁸⁹https://ww2.arb.ca.gov/sites/default/files/2025-12/FY%202025-26%20SB%201403%20Report_0.pdf

⁹⁰<https://www.resources.org/common-resources/why-are-electric-school-buses-so-expensive>

⁹¹<https://www.resources.org/common-resources/vehicle-to-grid-programs-for-electric-school-buses-worth-it/>

⁹²<https://californiazesbi.org/applicants/incentives/>

⁹³<https://dsgs.olivineinc.com/>

⁹⁴<https://elrp.olivineinc.com/>

⁹⁵<https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M606/K032/606032513.PDF>

Ultimately, bidirectional ESB's have no reliable revenue stream upon which to build a compelling business case or return on investment for fleet operators or school districts. Additionally, it can be challenging to meter energy exported by vehicles, particularly when there are other renewables on site being compensated for exports, as demonstrated by a pilot V2X project in Massachusetts.⁹⁶ Even under existing V2G pathways, projects must install cost-prohibitive revenue grade meters and there is a lack of clear guidance from utilities on how to treat metering and interconnection requirements for DER-paired bidirectional charging projects.

Proposed Solutions

The California Air Resources Board should:

- Maintain a consistent state funding stream for ESBs for the next five years.
- Set ESB incentive amounts that cover the Total Cost of Ownership (TCO) incremental cost of an ESB compared to a diesel bus.
- Maximize ESB funding stackability with other programs.
- Increase price transparency for manufacturers to be eligible for HVIP and ZESBI funding.
- Continue to require V2G capability for all ESBs funded through HVIP and ZESBI.

The California Public Utilities Commission should:

- Approve and accelerate development of long-term VPP programs and export tariffs beyond pilot programs, such as through a V2G “adder” or “market transition credit” for valuing the electricity exported by bidirectional ESB projects (like the ConnectedSolutions Daily Dispatch Demand Response program offered by Eversource and National Grid).⁹⁷
- Update Resource Adequacy program methodologies to fully value the capacity that bidirectional ESBs can provide to the grid.
- Approve device-level telemetry standards that enable ESBs and other DERs to be compensated for grid export without the need for revenue-grade meters (following best practices of the Demand Side Grid Support program).

The Department of General Services should:

⁹⁶ <https://www.canarymedia.com/articles/ev-charging/massachusetts-evs-feeding-grid>

⁹⁷ <https://www.nyserda.ny.gov/All-Programs/NY-Sun/Contractors/Value-of-Distributed-Energy-Resources>

- Facilitate expanded fleet procurement programs for bidirectional chargers to enable smaller school districts and fleets to access economies of scale and better financing terms.⁹⁸

The California Infrastructure and Economic Development Bank (IBank) should:

- Create technical assistance opportunities for combining private and public funding to fully finance V2G infrastructure (e.g. green banks).⁹⁹

The California Energy Commission should:

- Coordinate funding opportunities across state agencies to achieve grid reliability and climate resilience goals, such as integrating community resilience centers¹⁰⁰ and ESB infrastructure funding.
- Develop EPIC program funding solicitation for scaling V2B ESB projects for resilience. Funding opportunities can also pilot export compensation mechanisms for any grid-exporting bidirectional ESB projects.

Utilities should:

- Offer fleet electrification technical assistance to school districts in disadvantaged communities (e.g. PG&E EV Advisory Services¹⁰¹).
- Offer V2G ESB project incentives to school districts, modeled after Portland General Electric.¹⁰²
- Integrate school bus electrification and V2G applications into energy project planning and demand forecasting (like the CPUC's Transportation Electrification Proactive Planning Framework).¹⁰³
 - Reduce costs of grid upgrades when planning for several school districts.

⁹⁸<https://californiahvip.org/wp-content/uploads/2024/04/DGS-Statewide-Contract-Guide-Final.pdf>

⁹⁹<https://www.ctgreenbank.com/electric-school-bus-financing/>

¹⁰⁰<https://sgc.ca.gov/grant-programs/crc/>

¹⁰¹https://docs.google.com/presentation/d/19YCvGyqR1hSIRwWmB-FeXkG8IMqyf70e3ug_sOFG0ao/edit?usp=sharing

¹⁰²<https://portlandgeneral.com/energy-choices/electric-vehicles-charging/funding-your-ev-or-charging-project/electric-school-bus-charging-incentives>

¹⁰³<https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification/transportation-electrification-proactive-planning>

- Upgrade grid infrastructure for future fleets (future proofing) — especially given the 40-year lifespan of transformers — and provide bridge financing without increasing ratepayer costs.¹⁰⁴
- Build upon fleet calculator tool to inform districts of potential V2X savings.¹⁰⁵

Table 3. California Funding for Electric School Buses

Funding Program	Implementing Agencies	Amount	Description	Status (as of May 2026)	Equity Provisions
ZESBI ¹⁰⁶	CARB (buses), CEC (charging)	\$280,000 to 375,000 (per bus, depending on type); \$20,000 to 95,000 (per charger, depending on type)	Districts can apply for funding for a new ESB for every older (model year 2010 or earlier) bus that is scrapped. The ZESBI infrastructure award is intended to first cover charger procurement and then installation and other associated infrastructure costs. New ESBs must have V2G functionality but applicants are not required to utilize the technology.	Closed to new applicants	Prioritizes small and rural public school districts as well as those serving high percentages of foster youth, students receiving free or reduced-price meals, or English learners.
HVIP ¹⁰⁷	CARB	\$81,000 to \$276,000 (per bus, depending on type)	Supports private and public fleets with purchasing zero-emissions heavy duty vehicles.	Open to new applicants (previous Public School Set Aside has	At least 50 percent of funding supports vehicles in

¹⁰⁴<https://ece.engin.umich.edu/stories/meeting-ev-electricity-demand-upgrade-grid-first-then-add-v2g-chargers>

¹⁰⁵<https://fleets.pge.com/>

¹⁰⁶<https://californiazesbi.org/>

¹⁰⁷<https://californiahvip.org/funding/>

		ng on type)	ESBs funded by HVIP must be V2G bidirectional capable, and no hardware or firmware changes should be required to allow the bus to immediately serve demand that is independent of the utility grid (e.g. vehicle-to-load functions that are “islanded” or electrically separated from the utility system). ESBs should also be able to receive a remote update enabling grid interconnected V2G functions (e.g. vehicle-to-building functions connected to the utility system).	not issued funding since FY22-23)	disadvantaged communities.
Reliable Electric Charging for Eligible Schoolb us Sites (RECESS) ¹⁰⁸	CEC	\$20,000 to \$75,000 per charger (depend s on type)	Grants for charging infrastructure for districts procuring new electric school buses or for districts that lack sufficient chargers for existing ESBs. Bidirectional chargers are covered but applicants are not required to participate in	Most recent solicitation closed August 2026	Projects are scored based on the degree to which they benefit priority populations and disadvantaged communities.

¹⁰⁸<https://www.energy.ca.gov/solicitations/2026-04/gfo-25-605-reliable-electric-charging-eligible-school-bus-sites-recess>

emergency load reduction events.					
Clean Mobility in Schools program ¹⁰⁹	CARB	Varies (awards ranged from \$5.2 to 9.8 million in last round)	Grants for clean transportation projects around school communities, including zero-emission vehicles, charging, alternative modes of transportation, fleet and energy transition plans, education, and workforce training.	Closed to new applicants (last round in 2023)	Most recent solicitation required that more than 50 percent of the project community is in disadvantaged or low-income community census tracts.
Low Carbon Fuel Standard credits ¹¹⁰	CARB	April 2026 price was \$63 per 1 metric ton of carbon dioxide avoided ¹¹¹	Districts can apply for LCFS credits through their utility for operating zero-emissions school buses and charging stations. The value of LCFS credits is higher when renewable energy is used for charging. To ensure energy is accurately measured, IOU programs require districts to use smart chargers or for existing chargers to be connected to a dedicated meter.	Ongoing	None

¹⁰⁹ <https://ww2.arb.ca.gov/our-work/programs/clean-mobility-schools>

¹¹⁰ <https://electricschoolbusnetwork.org/wp-content/uploads/2023/10/ESB-CA-WG-February-2023.pdf>

¹¹¹ <https://ww2.arb.ca.gov/sites/default/files/2026-05/April%202026%20-%20Monthly%20LCFS%20Credit%20Transfer%20Activity.pdf>

Community Air Protection Program ¹¹²	Local air districts	Varies	Funding is allocated to air districts through the Community Air Protection Incentives program to deploy advanced technologies for cleaner air, including ESBs, in communities disproportionately impacted by air pollution.	Varies by District	As mandated by AB 617 (Garcia, 2017), all funding focuses on reducing emissions and exposures in communities most impacted by air pollution.
Planning and Capacity Building ¹¹³	CARB	Up to \$500,000	Supports early-stage planning, outreach, workforce development, and local readiness for tribal governments, rural communities, and schools in planning for clean, equitable transportation solutions.	Closed (last round in February 2026)	More than 50 percent of the project community must be within low-income or disadvantaged community census tracts. ¹¹⁴
Electric Program Investment Charge Program (EPIC) ¹¹⁵	CEC	Varies	Invests in research to transform the clean energy sector to meet California's climate and energy goals. At least 12 EPIC-funded projects support	Ongoing	At least 25 percent of EPIC technology demonstration and deployment investments must be to

¹¹² <https://ww2.arb.ca.gov/capp/fund/capi/community-air-protection-incentives>

¹¹³ <https://ww2.arb.ca.gov/our-work/programs/community-planning-and-capacity-building>

¹¹⁴ https://gis.carb.arb.ca.gov/portal/apps/experiencebuilder/experience/?id=5dc1218631fa46bc8d340b8e82548a6a&page=Priority-Populations-4_0

¹¹⁵ <https://www.energy.ca.gov/programs-and-topics/programs/electric-program-investment-charge-epic-program>

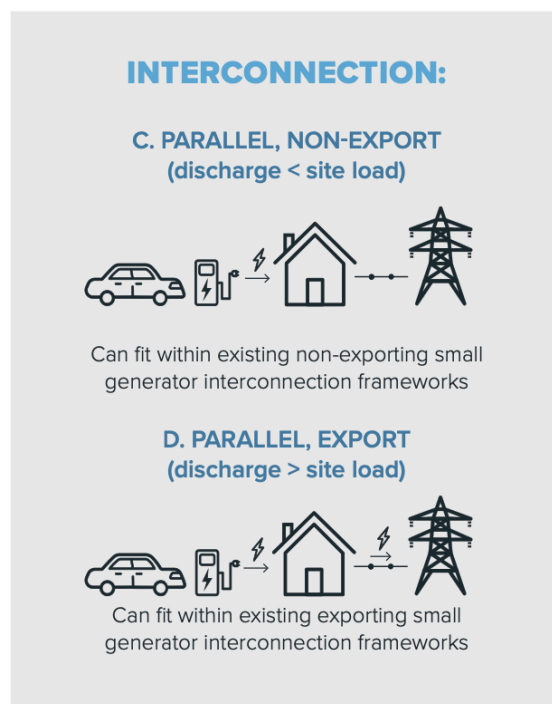
bidirectional EV charging.	sites located in, and benefiting, disadvantaged communities and at least 10 percent additional to sites located in, and benefiting, low-income communities.
----------------------------	---

Interconnection

Background

Timely energization and interconnection are crucial for getting bidirectional electric school buses equipped to be charged unidirectionally (energization) and to provide power bidirectionally (interconnection). In California, Rule 21 is the tariff that governs interconnection requirements for V2X projects, and each investor-owned utility operates its own Rule 21 tariff. While certain bidirectional chargers are approved for Rule 21 interconnection, there are still challenges with getting chargers through the process.

Two of the interconnection configurations most applicable for bidirectional ESBs are grid-isolated bidirectional charging and grid-parallel bidirectional charging.



Source: VGIC, V2X Bidirectional Charging Systems: Best Practices for Service Connection or Interconnection, August 2022.

As an alternate pathway to long energization and interconnection timelines, investor-owned utilities like PG&E are starting to offer flexible interconnection pilots, which enable projects to get interconnected more quickly if site load is limited to a certain level.¹¹⁶ This pathway avoids or delays the need for distribution grid upgrades, and while still in the pilot phase, flexible interconnection could make sense for school bus fleets, since electric school buses have fairly regular charging and trip schedules.

Permitting is a major factor in getting interconnection agreements in place, but may get delayed by many factors, including reviews required from the Division of the State Architect to ensure project plans comply with the state's school building code requirements.

Smaller publicly owned utilities generally have less capacity and experience with these V2G projects. LADWP, which is the largest publicly owned utility in the state, offers Commercial Energy Storage to Grid (CES2G), the country's first municipal utility V2G pilot program with 20 MW of enrolled capacity as of May 2026.¹¹⁷ Program participants receive a range of benefits,

¹¹⁶<https://www.canarymedia.com/articles/transmission/a-new-way-to-fix-grid-bottlenecks-for-ev-charging-flexible-connection>

¹¹⁷<https://www.ladwp.com/commercial-services/programs-and-rebates-commercial/energy-storage/ces2g>

including access to incentive electricity rates and partial reimbursement of interconnection costs.¹¹⁸ Another large publicly owned utility considering V2G programs for ESBs is SMUD, which has up to 72 bidirectional ESBs in its territory, demonstrating a huge load flexibility and resilience potential.¹¹⁹

Problem

The process of energizing EV chargers and interconnecting V2G infrastructure for bidirectional electric school buses can run into the same bottlenecks that hinder interconnection of other distributed energy resources. Even with early coordination with utilities, upgrading local electrical infrastructure and installing chargers can take much longer than the bus delivery. For example, ZESBI guidance estimates the development stage of bus electrification projects can take between six and 48 months depending on the complexity of upgrades required.¹²⁰ Due to these delays, districts may end up having buses they cannot use for months, if not years, because not enough chargers are in operation.

The process for upgrading a school's electric system to accommodate a bidirectional EV charger must be coordinated with other school modernization investments and permitting, and the school may not be able to pay for the upfront cost of electrical infrastructure. Utilities offer "Make Ready" programs, initially authorized by SB 350¹²¹, in which the utility covers a percentage or all of the upfront cost of electrical infrastructure. However, customers that have chosen the utility-built Make Ready funding option, under which the utility provides all customer and utility-side infrastructure, are not eligible to later enable V2G capabilities on existing equipment or swap out existing equipment for V2G-capable equipment.¹²² Figure 6 is an example of what infrastructure is covered under SDG&E's utility-owned "Make Ready" program, which offers no-cost installation to customers.

¹¹⁸ Ibid.

¹¹⁹ <https://www.smud.org/-/media/Documents/Corporate/About-Us/Board-Meetings-and-Agendas/2026/Apr/Exhibit-to-Agenda-Item-1-SMUD-Presentation--V2G-Technologies.ashx>

¹²⁰ https://californiahvip.org/wp-content/uploads/2020/09/Infrastructure-Planning_Guide_SCHOOL-BUS_FINAL-Digital.pdf

¹²¹ <https://www.cpuc.ca.gov/industries-and-topics/electrical-energy/infrastructure/transportation-electrification/charging-infrastructure-deployment-and-incentives>

¹²² <https://electricschoolbusinitiative.org/sites/default/files/2024-01/Electric%20Vehicle%20%28EV%29%20Make%20Ready%20Programs%20Guide%20%28October%202023%29%20-%20WRI%27s%20Electric%20School%20Bus%20Initiative.pdf>

Option 1: SDG&E-Owned

No Cost Installation



A Sempra Energy utility®
Power Your Drive for Fleets

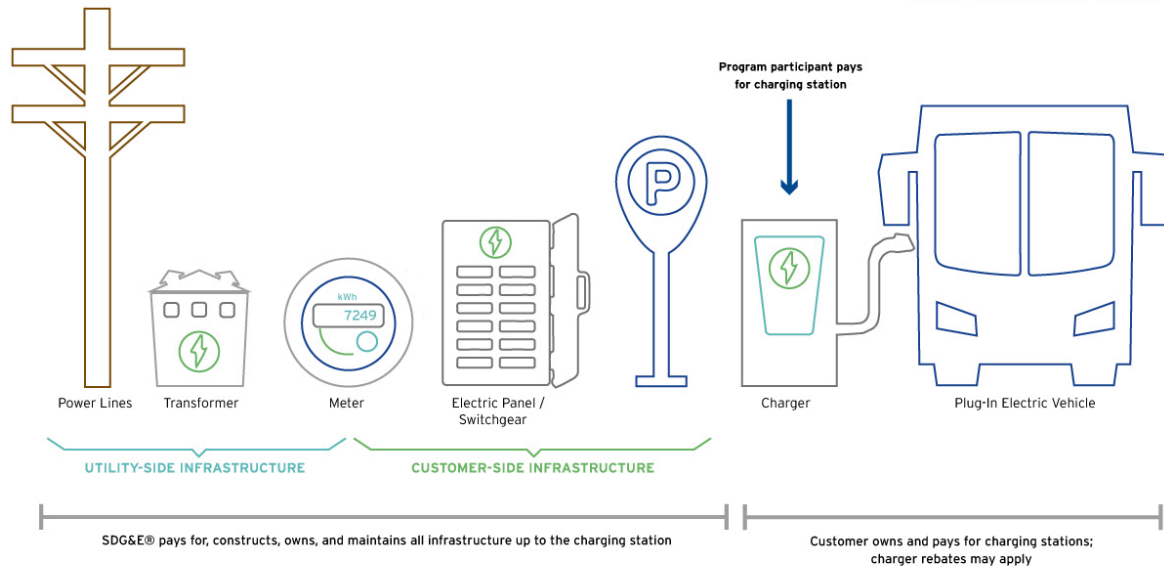


Figure 6. Source: San Diego Gas & Electric (SDG&E).

Finally, V2G projects are limited to pilots because there are no comprehensive, streamlined V2G interconnection options for EVs. Islanded, backup-power-only V2B projects — in which buses power an on-site building or form a microgrid without exporting to the grid — may be exempt from the full interconnection review process, making them the fastest path to deploying V2X for community resilience.

Proposed Solutions

Go-BIZ should:

- Develop a guidebook similar to the clean energy permitting guide¹²³ with detailed guidance for school districts and vendors to successfully interact with utilities on V2G ESB projects.
- Provide technical assistance to help schools assess the need for initial engineering work and electrical upgrades for V2G ESB projects to streamline interconnection requests with utilities.

¹²³ <https://business.ca.gov/wp-content/uploads/GO-Biz-CEP-Playbook-Full-10.22.25-Draft.pdf>

The Division of the State Architect should:

- Update the CalGreen code or Title 24 code to enable more school bus electrification and bidirectional ESB projects (Long Term).
- Develop a checklist of bidirectional ESB project planning considerations.

The California Energy Commission should:

- Provide upfront financing for electrical upgrades, similar to charging infrastructure funding, that do not prohibit participation in V2G programs and allow for future-proofing (the installation of infrastructure that could be used in the future).
- Require investor-owned utilities' Make Ready programs to allow participation in V2G programs.
 - For example, Southern California Edison's Make Ready funding program (through SB 350) offers a utility-built option that covers the cost of charging infrastructure for school districts, but this program prohibits districts from participating in V2G programs.
- Provide guidance to publicly owned utilities and municipally owned utilities to ensure districts in these smaller utilities have models for V2X ESB pilot programs.

The California Public Utilities Commission should:

- Direct investor-owned utilities to prioritize streamlined interconnection pathways for bidirectional ESBs to provide resiliency at school sites.
- Develop interconnection fee structure for bidirectional charging systems.

Utilities should:

- Scale up the use of flexible interconnection options for school districts and other public entities to expedite interconnection of V2G ESB projects and transition flexible interconnection from pilots to a standard offer for eligible customers.

Local Permitting Agencies/Authorities Having Jurisdiction (AHJ's should):

- Strengthen coordination with utilities and regularly share information on common vehicle-to-grid (V2G) use cases and system configurations. This collaboration will help AHJs develop familiarity with the inspection and permitting requirements for V2G school bus projects, streamline the permitting process, and reduce delays in obtaining utility Permission to Operate (PTO).

Education and Awareness

Background

While awareness of electric school buses has grown across stakeholder groups including school districts, especially due to funding programs and SB 579 compliance, there is still limited familiarity with bidirectional electric school bus technology and its co-benefits.

There are many stakeholders involved in bidirectional ESB projects, including school district staff, school boards, local governments, state agencies, utilities, contractors, students, and community members. Each of these stakeholder groups has a different degree of connection to bidirectional ESB projects, and therefore may need stakeholder-specific resources.

- **Districts:** Less than 13 percent of California public school districts employ a staff member focused on environmental literacy and sustainability across campuses, curriculums, or district-wide staff.¹²⁴ District transportation directors, facility managers, and energy directors often take on the role of learning about these opportunities, applying for grant funding, and managing bidirectional ESB projects, in addition to their existing responsibilities. The business offices of school districts are also important to build buy-in. These stakeholders are interested in the impact on school finances, the availability of grants and incentives, long-term return, and impact on electricity and maintenance bills. Internal champions for bidirectional ESB projects are crucial to their success, given the complexities that must be addressed throughout the project development process. Information technology departments are involved because V2X projects rely on strong cell or WiFi connectivity and these projects may introduce cybersecurity considerations. Bus drivers and maintenance workers must also be trained appropriately and given tools to adjust to operating and maintaining a new type of bus.
- **Students and community members:** Since students and communities are directly benefitting from the transition to electric school buses, they should also be consulted and informed about the potential for ESBs to support community resilience and improved air quality. Grassroots initiatives, like the Alliance for Electric School Buses,

¹²⁴<https://sites.google.com/tenstrands.org/ca-envlit-scrs-data-project/explore-data-focus-areas/district-indicators-for-action-and-analysis/statewide-indicator-tracking-system>

are important for equipping advocates with tools and resources and building community support for ESBs.¹²⁵

- **Utilities:** Investor-owned utilities are important partners for school districts developing bidirectional ESB projects, particularly for facilitating Make Ready funding applications and assessing utility-side infrastructure upgrade needs. Each IOU also offers some type of free ESB fleet electrification technical assistance. However, districts should not rely solely on IOUs and can access technical assistance from independent providers and nonprofit organizations.
- **Technical assistance providers,** like CALSTART and its CalFleetAdvisor program funded by the state, are essential to provide trusted information to school districts considering bus electrification. Membership associations like the Coalition for Adequate School Housing (CASH), California Association of School Business Officials (CASBO), and California Association of School Transportation Officials (CASTO) provide peer-to-peer learning opportunities through regional meetings and annual conferences.
- **Government agencies** involved in bidirectional ESB projects, from permitting to financing, may not have enough background on the unique considerations of bidirectional ESB projects. Staff on different teams in the same state agencies may be siloed and therefore have different levels of experience and buy-in with bidirectional ESB projects.

Problem

Bidirectionality and vehicle-grid integration are still new concepts for a majority of stakeholders involved in ESB projects. Bridging this awareness gap will be crucial for building demand and scaling these projects in California.

A lack of detailed guidance or case studies on developing and financing a V2G electric school bus project in California makes it difficult for school administrators to get started. CEC-funded bidirectional ESB pilot projects, such as at Fremont Unified School District, are required to share robust project learnings and recommendations for scaling up V2X ESB projects when completed. Limited internal capacity at districts can also serve as a barrier to applying for grants and other project financing opportunities, which are detailed and complex. This limited capacity is even more magnified in school districts serving disadvantaged communities.

¹²⁵ <https://electricschoolbuses4kids.org/>

Common concerns with V2X applications of ESBs (such as battery safety) can make districts hesitant to adopt a new type of technology. The financial impact on V2X applications on battery health and warranties are also a major consideration when districts are calculating whether a V2G ESB project pencils out. Evidence from various studies have found that the economic benefits (e.g. V2G compensation) of increased battery cycling could offset the costs of a shorter battery life.¹²⁶ Further, grid services have varying impacts on battery health, with frequency regulation a potentially more intensive impact than normal battery cycling. Additionally, some ESB manufacturer warranties may not cover batteries that participate in V2X. However, bus manufacturer BlueBird claims that buses that participate in V2X applications have not seen significant battery degradation after eight years, and their warranties are based on gross battery discharge and are not voided by V2X participation.¹²⁷

Proposed Solutions

The California Energy Commission should:

- Share case studies on how to execute V2X ESB projects and guidance on how to scale from pilot projects to larger programs.
- Develop resources in coordination with utilities for school administrators on the opportunity provided by bidirectional electric school buses through partnerships with the Electric School Bus Initiative¹²⁸ and the California Association of School Transportation Officials.¹²⁹

The California Air Resources Board should:

- Create dedicated resources about bidirectional ESBs, their benefits, and frequently asked questions to address common concerns about the technology.
- Fund internal positions or contractors to support deployment of bidirectional ESB projects and other campus sustainability projects (e.g. climate resilience school coordinators).¹³⁰
- Host site visits at bidirectional ESB pilot projects for interested district leaders.

¹²⁶ <https://www.sciencedirect.com/science/article/pii/S0360544225049448?via%3Dihub>

¹²⁷ https://www.mobilityhouse.com/usa_en/knowledge-center/webinar/grid-interactive-school-bus-fleets-v2g-technology-and-utility-programs

¹²⁸ <https://electricschoolbusinitiative.org/step-step-guide-school-bus-electrification>

¹²⁹ <https://castoways.org/>

¹³⁰ <https://www.energy.ca.gov/sites/default/files/2023-11/CEC-600-2023-062.pdf>

Standards and Interoperability

Background

For bidirectional electric school buses to operate in V2X configurations, they must be paired with interoperable infrastructure. Infrastructure includes a compatible charger and a charge management system that can communicate with the bus and grid operators. Interoperability refers to standards for hardware, data sharing, and security that allow buses, chargers, and the grid to operate together seamlessly.

While there are more interoperable electric school bus infrastructure options compared to passenger EVs, gaps still remain. Numerous international standards certify that electrical equipment meets safety, communications, data-sharing requirements. Multiple international efforts, including Task 53 and CharIN, exist as forums to bring together technology providers, engineers, governments, academics, and NGOs to update and develop new bidirectional EV charging standards.¹³¹ These standards are still being developed, however, and the existence of a standard does not guarantee multi-party interoperability. Manufacturers can determine which standards to adopt and they may implement standards differently. Thus, testing interoperability of equipment produced by different vendors is critical.

In response, the CEC has funded the state's first interoperability testing lab (Charge Yard) that will help ensure any vehicle can charge or discharge at any charger, regardless of the vehicle manufacturer, which network operates the charger, or which distribution grid it is connected to.¹³² Having an in-state facility to test interoperability will be a major step forward for ensuring technical feasibility of V2G ESB projects and allowing them to scale more quickly.

The CEC has also helped fund the Electric Truck Research and Utilization Center (eTRUC), co-managed by EPRI and CALSTART, to advance interoperability testing for MHD vehicles. eTRUC is the state's leading research hub for electric truck technologies, and it recently launched the CEC-funded Advanced Transportation Research Center — a charging testing hub for heavy-duty electric trucks hosted by Southern California Edison (SCE).¹³³ SCE will upgrade its High-Power Charging Lab at the Electric Vehicle Technical Center (EVTC) to enable megawatt-level testing, operating as a user facility open to third parties and manufacturers across the vehicle and charging industries.¹³⁴ While eTRUC focuses on Class 7 and Class 8

¹³¹ <https://www.charin.global/news/charin-and-task-53-forge-strategic-partnership/>

¹³² <https://efiling.energy.ca.gov/GetDocument.aspx?tn=268952&DocumentContentId=106145>

¹³³ <https://calstart.org/etruc-celebrates-launch-of-atrc-truck-charging-lab/>

¹³⁴ <https://calstart.org/etruc-celebrates-launch-of-atrc-truck-charging-lab/>

truck charging infrastructure, initiatives like this offer a replicable model for ESB interoperability testing.

As it relates to interconnection standards, the CEC has already set an important precedent with the establishment of its CEC V2G Equipment List (V2GEL), which tracks bidirectional charging equipment certified to the UL 1741 standard, including any subsequent supplements.¹³⁵ UL 1741 is a national safety standard used with distributed energy resources, and most utilities require that V2G chargers be certified to this standard in order to obtain interconnection approval. This list has proven to be a helpful resource for customers and project developers in search of information about UL-certified V2G equipment.

Problem

All bidirectional electric vehicle supply equipment (EVSE), such as buses and chargers, cannot be easily used together (i.e. interoperable). Even as universal interoperability standards continue to be developed, manufacturers are not yet adopting the same standards, and the standards can be implemented differently, so integration testing prior to deployment is necessary.¹³⁶ Incomplete interoperability risks the transition to more bidirectional ESBs because districts will not invest in bidirectional EV chargers that could potentially become stranded assets. When equipment does not meet interoperability standards, data cannot be easily shared and operational issues arise, which can reduce ESB participation in managed charging and demand response programs. California stands as a leader by requiring equipment interoperability for ZESBI and HVIP funding without the need for hardware or firmware changes, but this requirement is not consistent across all the funding and financing programs districts may access.¹³⁷

Proposed Solutions

The California Energy Commission should:

- Build and maintain a running list of tested, interoperable ESB product integrations, including tested V2G chargers, ESBs, and charge management platforms to support progress towards interoperability for electric school buses with the V2G ecosystem.

¹³⁵ <https://v2gel.energy.ca.gov/>

¹³⁶ <https://v2gnews.com/blog/interoperability-will-not-happen-by-design-alone/>

¹³⁷ <https://californiazesbi.org/wp-content/uploads/2025/09/ZESBI-Approved-Product-List-06.13.25-ada-1.pdf>

- Continue requiring that projects utilizing any type of state ESB funding procure equipment that adheres to open standards, as is already required by ZESBI and the CEC's V2G-focused grant funding opportunities.
- Require that any recipient of state grant funding for a V2G ESB project using a new EVSE-ESB pairing undergo interoperability testing at Charge Yard for evaluation.
- Establish regional interoperability testing hubs.

Cross-Cutting Issues and Proposed Solutions

Equity

Through its intentional program design, California's funding for electric school buses and infrastructure prioritizes disadvantaged communities. For example, the state's flagship Zero-Emission School Bus and Infrastructure (ZESBI) Program prioritized small and rural public school districts, as well as those serving high percentages of foster youth, students receiving free or reduced-price meals, or English learners. More than 75 percent of ZESBI applicants were districts that serve disadvantaged communities.¹³⁸

California's investor-owned utility Make Ready funding programs can also offer increased funding to electrification projects sited in low-income areas, pursuant to the projects meeting specific program and eligibility requirements. CEC grant funding opportunities also prioritize applications that propose V2G ESB projects in low-income/disadvantaged community areas. However, it is also true that these same communities may face more barriers to applying for this funding, including staff capacity and electrical infrastructure readiness. More proactive outreach to districts in underserved communities and tribal communities and funding for comprehensive technical assistance can help fill those gaps.

Workforce

ESB manufacturing and installation of electrical infrastructure for V2X projects should be installed by workers with high-road jobs, prevailing wages, and worker protections. Project labor agreements can help memorialize such commitments.

Due to AB 841 (Ting, 2020), any electric vehicle chargers funded by the state must be installed by appropriately licensed contractors with at least one electrician on the crew being certified through the Electric Vehicle Infrastructure Training Program (EVITP).¹³⁹ EVITP is an optional

¹³⁸ <https://californiazesbi.org/about/application-insights/>

¹³⁹ <https://www.energy.ca.gov/programs-and-topics/programs/clean-transportation-program/clean-transportation-funding-areas-2-0>

certification program for certified California electricians that includes participation in a 20-hour online training tailored to EV chargers and a 90-minute online exam.¹⁴⁰ Charger installation will be a major driver of jobs as school buses continue to be electrified, including highly-skilled electrician jobs.

While additional training is required for school bus drivers transitioning from driving diesel to electric buses, most drivers prefer the quiet, clean, and healthier experience of driving an ESB. ESBs require less maintenance than diesel buses, but the specialized maintenance required for the ESBs and charging infrastructure requires additional training for existing mechanical staff.¹⁴¹ Manufacturers often offer training to drivers and staff for new ESBs and chargers. For districts engaging in VGI, additional training is also needed for the charge management system to ensure bus operators understand when buses can be unplugged and know how to troubleshoot common issues.

Proposed Solutions

Cross-Agency Coordination Among CARB, CEC and CPUC:

- Develop a target for ESB enrollment in V2G programs and use this target to increase cross-agency coordination on V2G ESBs.

The California Air Resources Board should:

- Use the SB 1403 annual reporting process to collect and release data on V2G applications of ESBs.
- Issue guidance on ESB vehicle-grid integration that addresses common concerns, including battery warranties or battery degradation and mechanics of and maintenance needed for participating in V2G.
- Provide dedicated funding for workforce training programs specific to VGI ESB applications, including for high school students, and targeted towards disadvantaged communities.

The California Energy Commission should:

- Draft a follow-up to the SB 59 report focused on the unique capabilities of ESBs to participate in managed charging and V2G for grid and resilience benefits (estimate capacity, research the actual battery participation given average bus route mileage).

¹⁴⁰ <https://db.evtp.org/addclient.php>

¹⁴¹ https://jobstomoveamerica.org/wp-content/uploads/2022/05/Driving-the-Future-REPORT-FINAL_WEB_4.pdf

- Continue prioritizing disadvantaged communities by dedicating at least 50 percent of funding across all funding programs.

Case Studies

Pittsburg Unified School District (PUSD)¹⁴²

- Utility: PG&E
- Contact: Matthew Belasco, Transportation Director
- Current number of ESBs: seven out of 33 total fleet
 - Two type D transit buses
 - Three Microbird
 - Two other ESBs (Lions) were decommissioned
 - 26 are propane and diesel powered
- Planned number of ESBs: Two RIDE Type D's on order, delivery date Q1 2027; Two Type C BlueBird ESBs to be ordered soon, by July 2027 an additional four ESBs will be operational
- Current number of chargers: Nine Level 2 Chargers along with a charge management system
 - 86 L2's currently operational throughout district — yard, school sites, district office
- Planned number of chargers:
 - Five chargers / ten ports — L3/DCFC — in final permitting/approval phase
 - Construction beginning in August 2026
 - Operational by Jan 2027
- Student demographics: 10,716 students¹⁴³, 80.9 percent socioeconomically disadvantaged (2023)¹⁴⁴
- Major sustainability program provisions
 - 3.9 MW on-site solar at 15 campuses
 - One acre Bioswale
 - Four vertical axis wind turbines (10 kw each, 40 kw total)

¹⁴² For additional information see

https://docs.google.com/presentation/d/19YCvGyqR1hSIRwWmB-FeXkG8IMqyf70e3ug_sOFG0ao/edit?slide=id.g3b9607b202e_0_172#slide=id.g3b9607b202e_0_172

<https://olivineinc.com/wp-content/uploads/2020/10/Pittsburg-USD-Electric-School-Bus-Final-Project-Report-Final.pdf>

https://www.mobilityhouse.com/usa_en/knowledge-center/webinar/grid-interactive-school-bus-fleets-v2-g-technology-and-utility-programs

¹⁴³ <https://www.cde.ca.gov/sdprofile/details.aspx?cds=07617880000000>

¹⁴⁴ <https://caschooldashboard.org/reports/07617880000000/2023>

- Edible garden projects in progress
- Battery storage 1.6 MW once complete (Sept 2026 completion; PTO by July 2027)
- Sustainability Goals: 100 percent fleet electrification by 2035, V2B Resilience Hub
- V2X progress: Two pilot projects in progress. First is a V2G pilot project, bringing five bidirectional chargers at a school site. The other project is a planned V2B pilot climate resiliency center, which would utilize an export-only device that enables one-way discharge from the vehicle to the building to power a multipurpose room and kitchen during emergencies.
- Partners: PG&E, Olivine, Liberty Plugins, ClipperCreek, and Blue Bird (PG&E Fleet Electrification Pilot), California Energy Commission, Mobility House
- Funding: \$2 million for pilot program from PG&E, HVIP covered half of e-Lion cost
- Roadblocks/barriers: While PUSD is an award-winning national sustainability leader, with early recognition for its Edible Garden program, the district has increased its focus on electric school buses in the past decade. From purchasing its first two e-Lion buses in 2017 before having any EV chargers installed on site, to now working on a CEC-funded V2G pilot project, PUSD has made tremendous progress on its school bus electrification journey. Meanwhile, as an early adopter of this technology, the district has also run into some of the challenges:
 - As an early adopter, PUSD was awarded incentive funding from PG&E for ESB fleet electrification. When PUSD was later planning for a V2X project at a school bus yard, they found out that the PG&E funding restricted additional infrastructure upgrades on that yard for a certain period.
 - PUSD faced a long waiting period for PG&E interconnection and electrical upgrades to accommodate the increased power needed.
 - The PG&E pilot program funding contract has a ten-year waiting period.

Oakland Unified School District (OUSD)¹⁴⁵

- Contact: Kim Raney, Executive Director of Transportation at Oakland Unified School District
- Student demographics:
 - Economic Status: 83.5 percent qualify for free or reduced-price meals¹⁴⁶
 - According to district staff, Oakland communities are disproportionately disadvantaged and affected by high rates of asthma and exposure to air pollution from diesel fuels
- Number of ESBs and chargers:
 - 74 ESBs - RIDE
 - 74 chargers - manufactured by Tellus Power
- Major sustainability program provisions¹⁴⁷
 - On October 28, 2020, the OUSD Board of Education unanimously passed the District's Climate Emergency Action Resolution (CEAR) 2021-0081, declaring a

¹⁴⁵ For additional information see:

<https://www.prnewswire.com/news-releases/zum-launches-nations-first-school-district-with-100-electric-bidirectional-v2g-school-bus-fleet-in-oakland-302146022.html>

<https://www.pge.com/en/newsroom/currents/future-of-energy/articles-4040-pge-helps-zum-deploy-nations-100-electric-school-bus-fleet-oakland-new-school-year.html>

<https://www.prnewswire.com/news-releases/zum-launches-nations-first-school-district-with-100-electric-bidirectional-v2g-school-bus-fleet-in-oakland-302146022.html>

<https://www.pge.com/en/newsroom/currents/future-of-energy/articles-4040-pge-helps-zum-deploy-nations-100-electric-school-bus-fleet-oakland-new-school-year.html>

<https://www.microgridknowledge.com/vehicle-to-grid/article/55387412/pges-bidirectional-charging-programs-look-to-answer-million-dollar-question-about-lowering-customer-costs>

<https://www.pge.com/en/clean-energy/electric-vehicles/getting-started-with-electric-vehicles/vehicle-to-everything-v2x-pilot-programs.html>

<https://www.telluspowergroup.com/ap/en/case-studies/empowering-sustainable-student-transportation-with-tellus-powers-v2g--v2x-technology>

<https://www.ridezum.com/blog/zum-launches-nations-first-100-electrified-bidirectional-v2g-school-bus-fleet-in-oakland-ca/>

¹⁴⁶ <https://www.ousd.org/latino-student-achievement/our-students>

¹⁴⁷ <https://www.ousd.org/facilities-planning-management/about/facilities-department/sustainability>

climate emergency, setting the goal to eliminate the use of fossil fuels in district operations by 2040 and transition to 100 percent clean electricity by 2030.

- In March 2025, the OUSD Board of Education also passed a comprehensive, district-wide sustainability policy.¹⁴⁸
- Clean Energy and Climate Goals
 - Clean Electricity: Shift to 100 percent clean electricity across all district buildings by 2030.
 - Fossil Fuel Phaseout: Eliminate fossil fuel usage completely by 2040.
 - Healthy Schools: Joined the Efficient and Healthy Schools Campaign to upgrade ventilation and optimize HVAC performance.
- Campus and Community Projects
 - Living Schoolyards: Transform hard, paved asphalt schoolyards into green, natural spaces for student wellness and outdoor learning.
 - Waste Reduction: Optimize cafeteria sorting stations, cut single-use plastics, and use smart dispenser systems to lower trash output.
 - Water and Health: Maintain strict water testing protocols under the Clean Drinking Water Policy.
- Education and Engagement
 - The Center: Provide hands-on TK-12 learning through the Environment, Food, and Garden (EFG) programs.
 - Advisory Groups: Involve community voices through the Sustainability Advisory Council and local workshops.
- V2G Progress
 - The V2G ESB project, which launched in May 2024, made OUSD the first major school district in the United States to transition to a 100 percent electrified school bus system with V2G.
 - Participating in PG&E's V2X Commercial Pilot
 - Bidirectional chargers are approved for grid export and participating in ELRP A.5 and enrolled in PG&E's Hourly Flex Pricing dynamic rate pilot
 - V2G fleet can discharge up to 2.1 gigawatt hours of energy back to the power grid at scale annually to act as a Virtual Power Plant (VPP)
- Funding: Environmental Protection Agency's (EPA) Clean School Bus program, California Air Resource Board (CARB), Heavy Vehicle Incentive Program (HVIP)

¹⁴⁸<https://ousd.legistar.com/View.ashx?M=F&ID=13902901&GUID=2260A5C6-C023-4388-9F68-11F49FD3E08D>

vouchers, Bay Area Air Quality Management District (BAAQMD) and Clean Mobility Operations (CMO) programs.¹⁴⁹

- Utility Partner: PG&E

Porterville Unified School District (PUSD)¹⁵⁰

Porterville USD is developing several ESB projects. This case study spotlights one particular CEC-funded project.

- Utility: SCE
- Contact: [Brad Rohrbach, Ed.D.](#), Assistant Superintendent, Business Services
- Partners: Fermata Energy, Nuvve, UC Riverside, Energetics
- Funding: \$1,910,703 CEC grant and \$1,198,400 match funding as part of the RESCHOOL project
 - Performance period: December 13, 2023 to March 31, 2028
 - What: CEC grant-funded project to demonstrate a Vehicle-to-Grid (V2G) integrated microgrid
 - Where: Porterville Unified School District and Baldwin Park Unified School District
 - Why: Provide energy savings and backup power to critical school infrastructure using electric school buses
 - How: Installation of 3 V2G chargers, a stationary battery, and microgrid controls at each of two sites for backup power and demand response
 - RESCHOOL: first of its kind testbed for the Resilience Hub concept
- Current number of ESBs: Zero
- Planned number of ESBs: Three RIDE Buses as part of the RESCHOOL project (but PUSD has a total of 12 RIDE buses and EBSs of other makes and models)
- Current number of chargers: Zero
- Planned number of chargers: Three 60 kW V2G DC Nuvve chargers
- Planned number of battery electric storage systems (BESS): One 125kW-426kWh BESS
- Facility to be backed up: cold storage facility
- Student demographics: Public PUSD data puts the district at more than 14,000 TK-12 students across 22 campuses, 88.9 percent from socioeconomically disadvantaged households

¹⁴⁹<https://www.ridezum.com/blog/zum-launches-nations-first-100-electrified-bidirectional-v2g-school-bus-fleet-in-oakland-ca/>

¹⁵⁰ For additional information see: <https://ceganet.lci.ca.gov/2023120532/2>
<https://www.forefrontpower.com/porterville-usd-zev-infrastructure-project/>

- Major sustainability program provisions:
 - PUSD's Climate Action Pathways for Schools (CAPS) initiative.
 - PUSD launched its Energy & Sustainability Program in 2019, aiming to reduce energy costs and GHG emissions by 80 percent by 2030.

Project Goals and Use Cases

- Project use cases: demonstrating islanding/backup power via BESS and V2G for the Emergency Load Reduction Program (ELRP). Time of Use and Demand Charge Management (including BESS-buffered demand charge management) as the cost-saving mechanisms to demonstrate
- Project challenges: interconnection, access to make ready funding, utility infrastructure upgrades (plan to implement Automated Load Management to avoid cost and delays from utility infrastructure upgrades)
- Grant requirements/objectives: produce VGI blueprint/roadmap, demand response program participation, resiliency/backup power
- Key questions to be investigated by the grant: how to close the technical/engineering knowledge gaps in VGI/V2G/microgrid deployment, how to overcome market barriers (limited consumer knowledge, thin supply/maintenance infrastructure), and how to navigate regulatory/institutional hurdles and financing

Fremont Unified School District (FUSD)

- Contact: Erney Epley
- Number of ESBs: 14 (Four Thomas Built and ten Blue Bird buses)
- Number of bidirectional chargers: 22
 - Fourteen lower-power chargers, six high-power V2G direct current (DC) fast chargers, and two additional high-power unidirectional chargers
- Student demographics: 30.2 percent socioeconomically disadvantaged (2025)¹⁵¹
- Major sustainability program provisions:
 - In 2026, the district was recognized as a California Green Ribbon School District Sustainability Honoree for its sustainability initiatives
 - Fleet electrification: FUSD's participation in PG&E's EV Fleet program, starting in 2019, has supported 17 electric school buses and 13 electric medium-duty vehicles with incentives for infrastructure and charging equipment.
 - Zero-Waste Trays: Transitioned elementary schools (starting with a pilot at Blacow Elementary) from single-use plastics to reusable stainless steel lunch trays and utensils in partnership with local groups.

¹⁵¹ <https://caschooldashboard.org/reports/01611760000000/2025>

- Urban Forestry: Partnered with local organizations and the city's forestry program for campus tree plantings to combat extreme heat and expand outdoor learning.
- V2G progress: pilot site for CEC-Mobility House V2G project
 - Chargers are participating in Emergency Load Reduction Program (ELRP) A.5, managed by TheMobilityHouse's ChargePilot® charge management system for fleets and utility-facing market aggregation platform
 - The project will support the displacement of six internal combustion engine buses
 - The site is also interconnected via Rule 21, enabling energy export to the grid
- Funding: CEC
- Utility Partner: PG&E
 - To enable this V2G deployment, PG&E upgraded the site's electrical infrastructure, including:
 - A new 480 volt 3-phase service entrance (upgraded from 208V)
 - A 750 kVA transformer
 - Facilitated installation of a 2,500 Amp switchgear to meet current and future charging needs
 - PG&E expedited the energization process through a streamlined Rule 15/16 service upgrade, ensuring the site could accommodate the full allocation of six V2G DC fast chargers.

Modesto City Schools¹⁵²

- Contact: Steven Fernandes, Director of Transportation, Modesto City Schools
- Number of ESBs and chargers
 - Thirty 2022 BlueBird All American ESBs
 - Five T3RE EV: 54 Amb, 1WC (VAR 5WC)
 - Twenty-five T3RE EV: 78 Amb Pass
 - Working on acquiring 14 additional T3RE EV: 78 Amb
 - Fifty-three chargers
 - Thirty Level 2 AC Chargers (night-time)
 - Twenty-three Level 3 DC Fast Chargers (day-time)
- Major sustainability program provisions
 - Solar

¹⁵² For additional information see:

https://www.mobilityhouse.com/usa_en/our-company/references/article/modesto-city-schools

- Phase 1 – 180 kWh (in Service 10/20/23) 11,530 square feet of shaded bus parking; Phase 2 – 60 kWh (in service July 2025) 3,755 square feet of shaded bus parking
- VGI progress: V1G - charge management software
- Funding: The \$14 million fleet was funded through general funds, CARB HVIP, state grants with San Joaquin Valley Air Pollution Control District, and EPA Clean School Bus Funding¹⁵³
- Utility Partner: Modesto Irrigation District

¹⁵³ <https://www.mcs4kids.com/o/mcs/page/sustainability-transportation>