

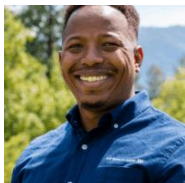
Resilient Communities, Resilient Grid: How Electric School Buses Can Help

September 30, 2026



Moderator

Michelle Levinson, World Resources Institute



Alex Macharia, PowerFlex



Matthew Belasco, Pittsburg Unified School District



Kurt Johnson, Vehicle-Grid Partnership

Housekeeping notes

1. **Please mute microphones**, until we open up for conversation at the end
2. **Please revise Zoom title**: check name, add organizational affiliation
3. **Web meeting is being recorded**, to make available for those that were not able to join today
4. **Note Qs (& comments) in the chat box**, we'll open for Q&A discussion after presenters are done

Vision of the Bidirectional Electric School Bus Coalition

Every school bus in California is **electric** and **bidirectional**, serving the dual purpose of **safely transporting students** and ensuring that **reliable, affordable, and resilient power** reaches **every neighborhood**.



Thanks to the Clif Family Foundation



A photograph of several wind turbines in a field at sunset. The sun is low on the horizon, creating a bright orange glow and long shadows. The sky is filled with soft, orange clouds. The turbines are silhouetted against the bright light of the setting sun.

About World Resources Institute

WRI is a global research organization working to improve people's lives, protect nature and halt climate change.

Why Electrify School Buses?

Electrification can accelerate decarbonization while bringing other direct, tangible benefits to every community.



Improved health and cognitive outcomes for children



Cleaner air than with diesel buses, especially in communities of color



Reduced operating expenses for school districts



New jobs in green manufacturing



A **tipping point** for MHD + electrification



Enhanced **resiliency** and **renewables integration** with V2G



The Status of School Bus Electrification in California

24K

24,325 school buses in California

42%

>10,000 buses are 2009 models or older
Most are diesel or gasoline

3k

3,424 electric buses committed in the state

12.6%

Electric share of new school bus purchases

33

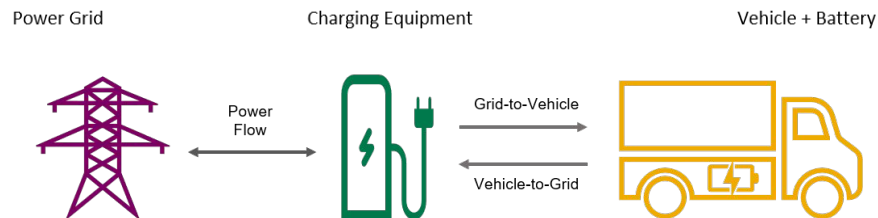
Districts with ~\$200M in unmet demand last year

Types of Charging Technologies

Vehicle-grid integration (VGI) is where charging and discharging of the vehicle is done in coordination with grid demand to work as a grid asset.

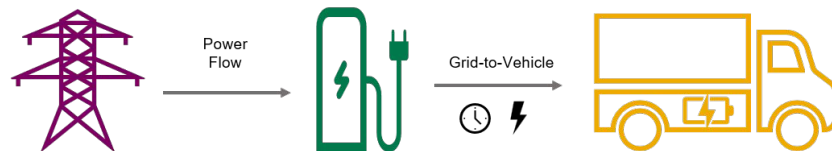
Bidirectional Charging (V2X)

Energy stored in vehicle is discharged back to a facility/building (V2B), the grid (V2G), or some load (V2L).



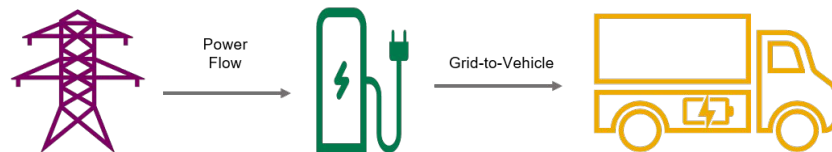
Managed Charging (V1G)

Electricity flows from grid to vehicle. The time at which charging occurs and/or the quantity of power used to charge are managed to benefit the grid.



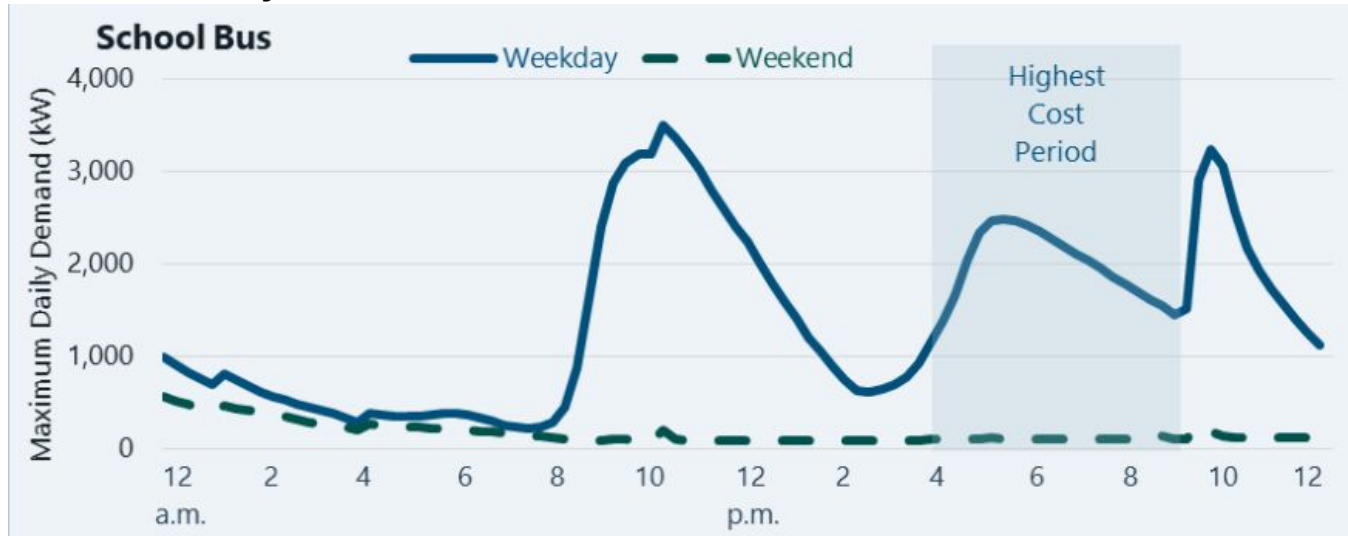
Unmanaged Charging

When vehicle is plugged in to the charger, electricity flows from the grid to vehicle at the greatest power capable until full charge.



VGI Adoption Among ESBs in California

Statewide Daily Load Curve, Q4 2024



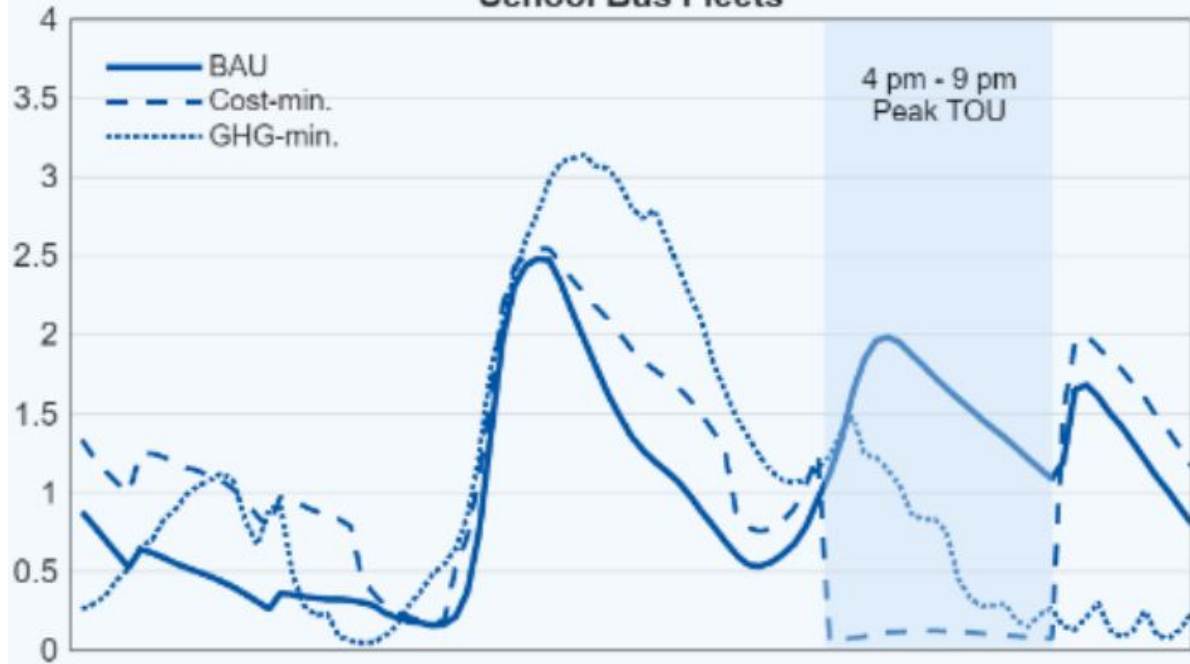
=> ESBs similar to other MHDVs in CA's utility-funded programs

“Only 45 of the 219 (21%) activated sites exhibited the use of load management”

VGI Adoption Among ESBs in California

Potential of Shifting Energy Usage to Reduce Electricity-GHG and Utility Costs

School Bus Fleets



=> Modeling of VGI potential of ESBs in CA's utility-funded programs

*“Around **two-thirds** of school bus sites could realize over **\$5,000 per year in savings**, and **one-quarter** could achieve over **\$10,000**”*

*“**70%** of operators could save **20% annually** while **over 40%** of operators could save over **30% annually**”*

SCHOOL BUSES & V2X

Electric school buses are well-suited to support V2X



*Predictable
operational
schedules*



*Large
battery
capacity*



*Schools often
serve as
community
resilience sites*



Benefits of V2X



Grid Flexibility & Emergency Preparedness

- V2X services provide grid operators with an on-demand source of power that can provide a range of services. Vehicles can also provide back-up power and mobile power supplies in emergencies.



Decarbonization: Support Renewables

- V2X allows vehicles to absorb renewable energy generation when it is abundant and release that energy when it is not.



Compensation: Lowers Total Cost of Ownership (TCO)

- V2X can generate value by providing services to the grid where vehicle operators are compensated.

Emerging Resilience Opportunities



Unplanned outages



Grid emergencies



Community resource centers

Challenges of V2X



Operational concerns

- There are few bidirectional charger options that are properly certified



Charger availability

- Most chargers are unable to satisfy NEVI's 97% uptime requirement

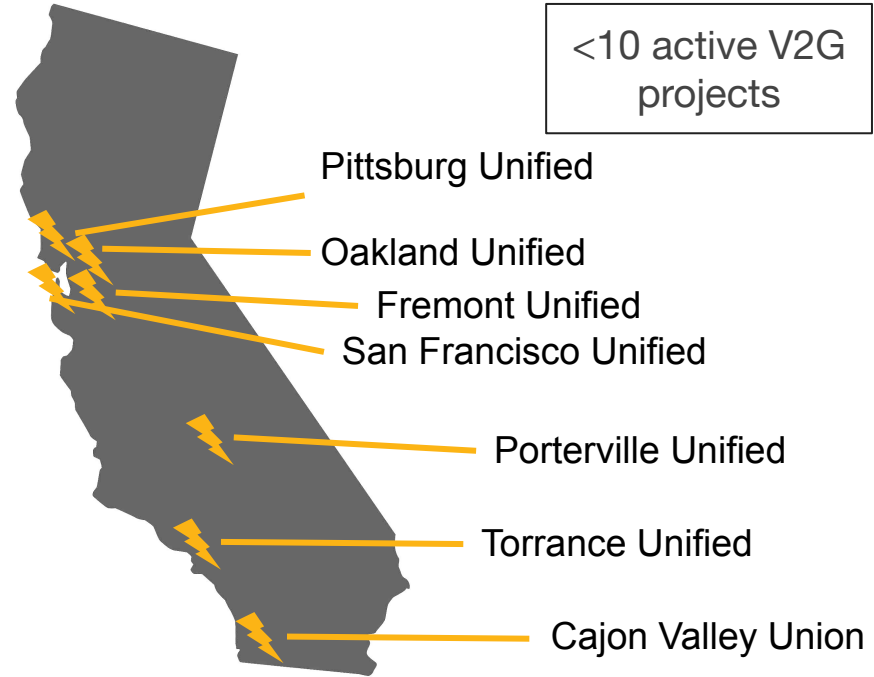


Lack of compensation mechanisms

- For most school districts, there are no means for them to be compensated for bus discharges



V2G ESB Projects in California



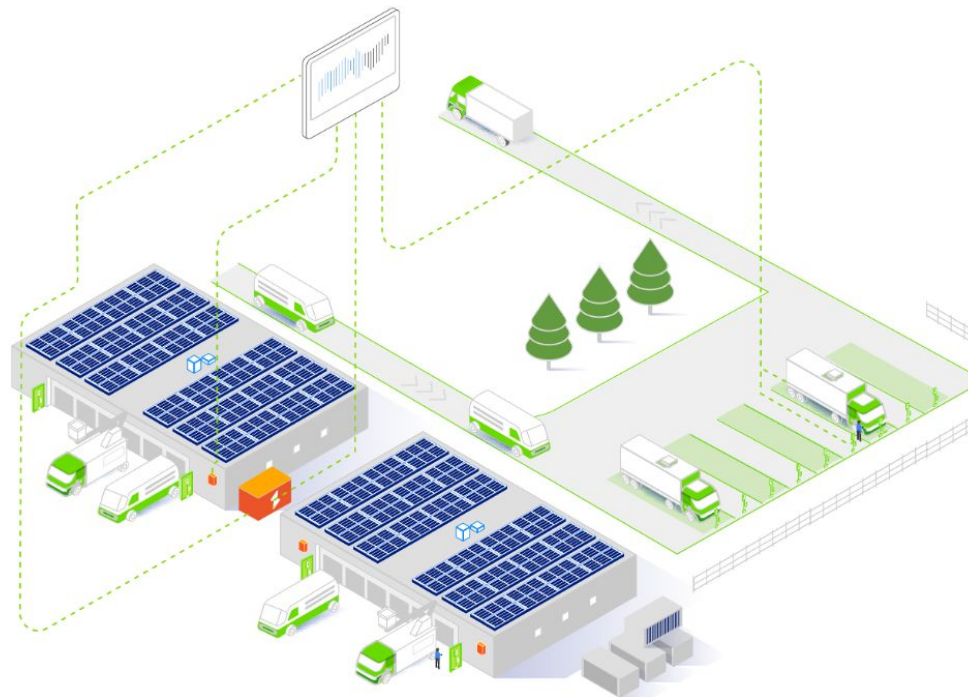
Sources: [3 Design Considerations for Electric School Bus Vehicle-to-Grid Programs | World Resources Institute](#), [Utilities, schools see growing value in electric buses for virtual power plants](#), [Electric School Bus Data Dashboard](#)



Resilient Communities and Grids Electric School Bus Webinar

September 2026

Alex Macharia
VGI Program Manager



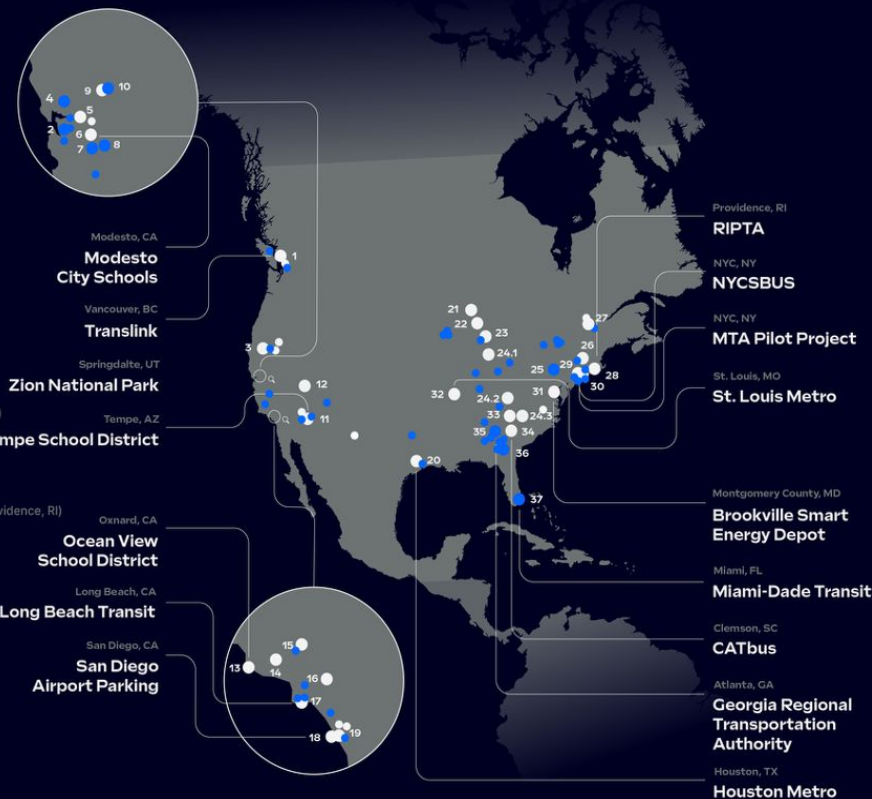
100+ North American Projects

- Operation
- Implementation

Highlights

- Translink** (Vancouver, BC)
- Replicable V2X Deployment For Schools**
2a. Pittsburg Unified School District (Pittsburg, CA)
2b. Fremont Unified School District (Fremont, CA)
- Trinity Alps USD** (Trinity, CA)
- City of Vacaville** (Vacaville, CA)
- Stockton Unified School District** (Stockton, CA)
- Modesto City Schools** (Modesto, CA)
- Chatom Unified School District** (Turlock, CA)
- Turlock Unified School District** (Turlock, CA)
- Gold Oak Unified School District** (Placerville, CA)
- El Dorado Union High School** (Placerville, CA)
- Tempe School District (AZ)** (Tempe, AZ)
- Zion National Park** (Springdale, UT)
- Ocean View School District** (Oxnard, CA)
- Moorpark Unified School District** (Moorpark, CA)
- Antelope Valley Transity Authority** (Lancaster, CA)
- Colton Joint Unified School District** (Colton, CA)
- Long Beach Transit** (Long Beach, CA)

- Ace Parking at San Diego Airport** (San Diego, CA)
- SP+ Parking at San Diego Airport** (San Diego, CA)
- Houston Metro** (Houston, TX)
- Mortenson Headquarters** (Minneapolis, MN)
- Rochester Public Transit** (Rochester, MN)
- Madison Metro Transit** (Madison, WI)
- Central States Dealerships** (Oswego, IL) (Lexington, KY) (Lebanon, TN)
- Newfield Schools** (Newfield, NY)
- Connecticut Department of Transportation** (New Haven, CT)
- Montréal International Airport YUL** (Montréal, QC)
- Rhode Island Public Transportation Authority (RIPTA)** (Providence, RI)
- NYCSBUS** (The Bronx, NY)
- MTA** (New York City, NY)
- Brookville Smart Energy Depot** (Montgomery County, MD)
- St. Louis Metro** (St. Louis, MI)
- Knoxville Area Transit** (Knoxville, TN)
- CATbus** (Clemson, SC)
- Georgia Regional Transportation Authority** (Atlanta, GA)
- Yancy Bus Sales** (Macon, GA)
- Miami-Dade Transit** (Miami, FL)



PowerFlex VGI Projects in North America

Commercial V2B



Oakland V2B project
(PG&E) Target 2 BEVs

Commercial V2G



Porterville Unified School District (SCE)

Commercial V2G

Pass-car & Truck



Stellantis V2G (DTE)

Commercial & Residential V2G

Pass-car, Bus & Truck



MassCEC V2X (Eversource,
Nat Grid)
Target 100 BEVs (+1MW)

Commercial V2G



Fremont Unified School District
(PG&E) Target 6+ ESBs

Commercial V2G & V2B



Pittsburg Unified School District
(PG&E) Target 6+ ESBs

Commercial V2B



Weld RE-5J School District
(Xcel) Target 3 ESBs

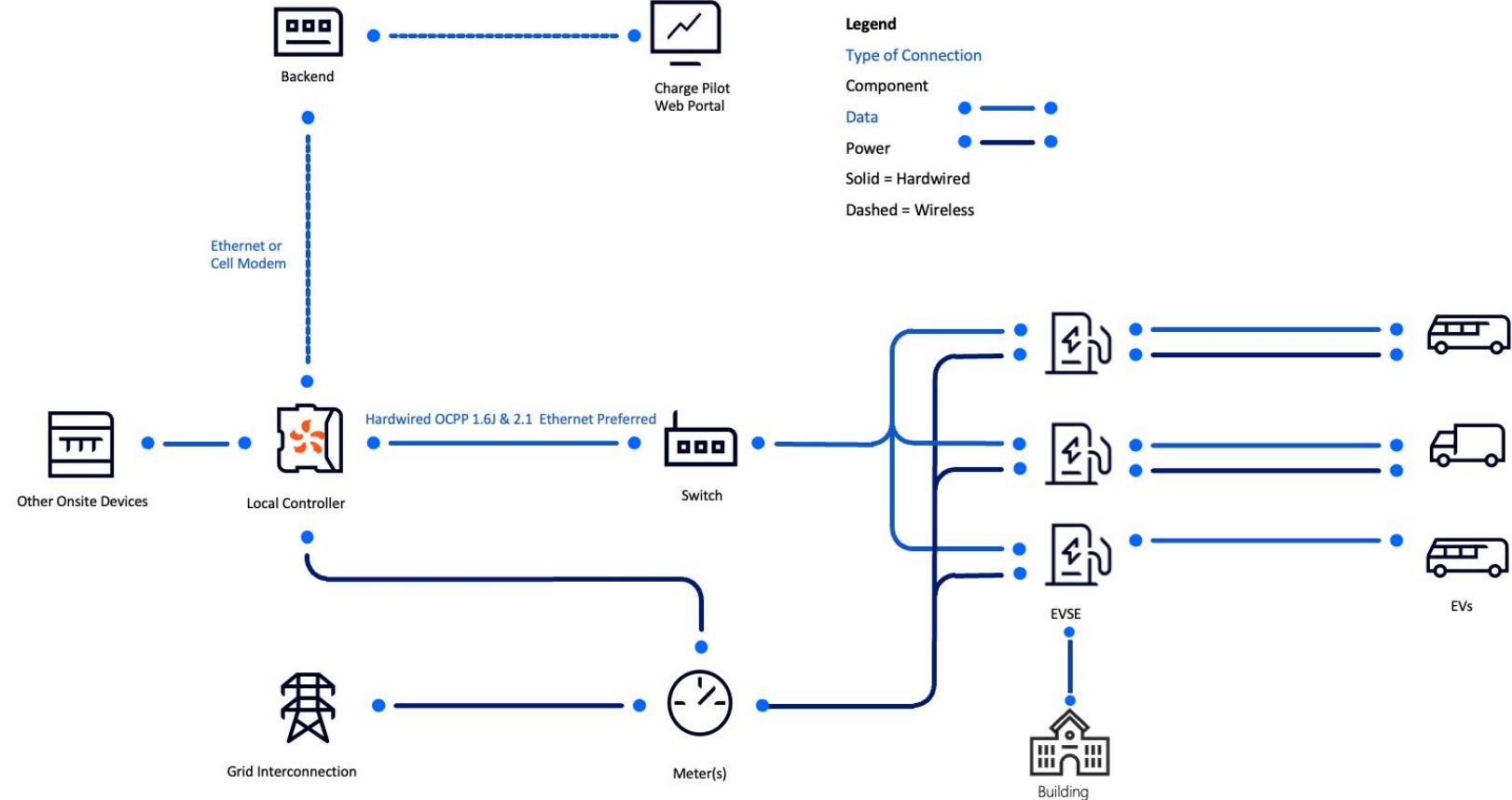
Commercial V2G



NYC Bus V2G Project (ConEd)
Target 15+ ESBs



PowerFlex V2X CMS Operation

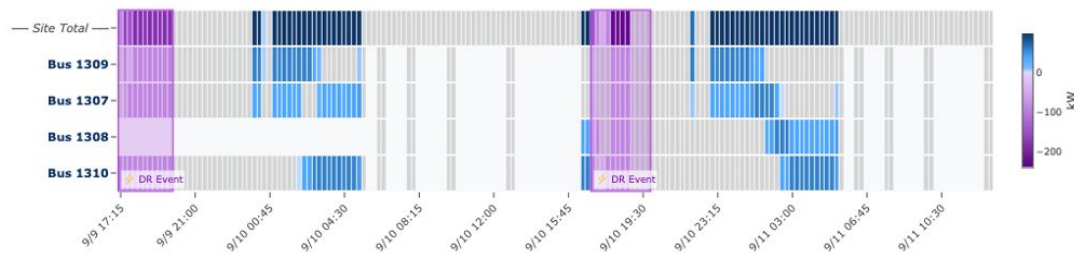


Fremont USD – ELRP V2G Session

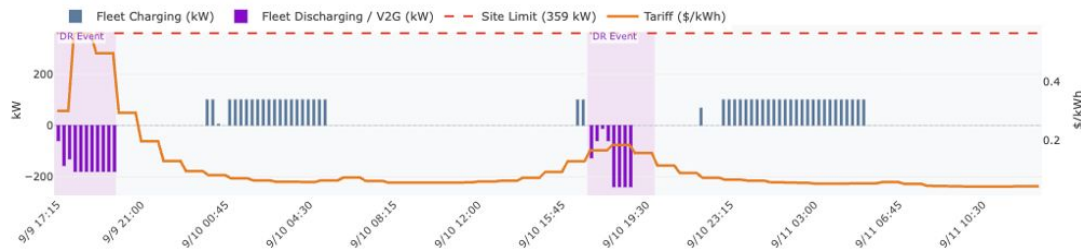
Wednesday, September 9, 2026

Dispatch Plan Click a bus row to drill down

Charging Power Heatmap Each row is a vehicle - color = charging power (kW) - gray = plugged in but idle - white gap = bus away from depot - click any row to drill down



Fleet Charging vs. Tariff



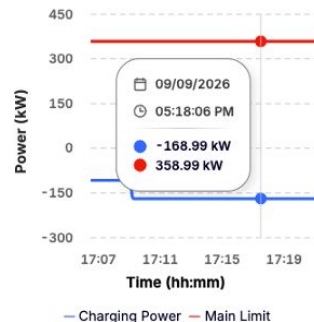
ESB Fleet Charge Plans

ChargePilot Dashboard

Device Status

● Controller online

Power & Limits



Charging Points

Overview Details

● 2 Available ● 3 Charging
● 1 Paused (LM)



Cascade Services Deployed

HFP + ELRP + Fleet Charge Optimization

Replicable V2G at Fremont USD



V2G, Electrification and interconnection - Capacity expansion, infrastructure build-out & interconnection



1 Charging Hardware Procurement



2 Architecture & Design



3 Operations & Maintenance



4 Installation & Construction



5 Charging & Energy Management

Goal: Replicable V2G deployment for schools

Implementation: Complete, operational since Aug 2025

Highlights:

- New PG&E 3-phase 480V service with increased site capacity
- Completed Rule 21 interconnection for energy export
- Currently exporting to grid and enrolled in ELRP and HFP
- PF is providing ongoing fleet charging and operational support

Replicable V2G & V2B at Pittsburg USD

Goal: Replicable V2G charging at the PUSD Adult Ed. Center & V2B implementation for community resilience at Heights Elementary School

Implementation: Fall 2026

Considerations and Challenges

- Energization requisition approach and fleet needs
- Site selection (accessibility, fire, egress etc.)
- Hardware specification & charger-bus interoperability
- V2B complexity (BSM, ATS & grid-interfacing requirements)
- DSA and other AHJ permitting requirements
- Regulatory requirements around interconnection
- Overall project costs and other administrative challenges





Photo credits: Rich McKie, Elizabeth Hughes, Polara



Thank you!

Alex Macharia

alex.macharia@powerflex.com

Curious about our V2G solutions?



Scan to Learn More

About the Vehicle-Grid Partnership

ABOUT US

The Vehicle-Grid Partnership

Accelerating the policy reforms needed to harness electric vehicles for lower electricity costs and a more resilient grid.



Who We Are

- **Partners** — corporate and government organizations integrating bidirectional EVs to lower costs and enhance resilience
- **Business members** — product and technology providers that enable VGI project development
- **EV owners** — people interested in harnessing their EV for vehicle-grid integration and taking action to support needed policy reforms
- **Coalition partners** — allied organizations with shared goals

Initial Partnership Activities

- Supporting public sector fleet bidirectional EV owners in lowering electricity costs and enhancing resilience
- Organizing educational events, including national policy summit in Washington, DC on May 12, 2027
- Building GridReadyEV, a web tool connecting users to information on harnessing bidirectional EVs and taking policy action

Questions about Policy Summit sponsorship or becoming a Vehicle-Grid Partnership partner? Let's talk.

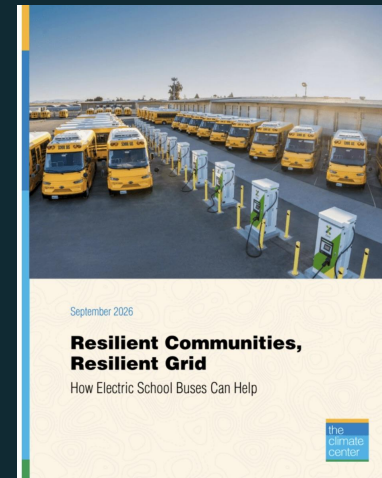
 Kurt Johnson, Vehicle-Grid Partnership

 kurt@vehiclegridpartnership.org

 970-729-5051

New Climate Center Report

How California can scale Vehicle-to-Grid school bus technology to advance health, energy resilience, and grid reliability



<https://theclimatecenter.org/community-energy-resilience/resilient-communities-resilient-grid/>

California's Grid Is Under Strain

Rising costs, wildfire risk, and extreme weather are hitting disadvantaged communities and schools hardest.



AFFORDABILITY

1 in 5

Californians are behind on their electric bills, owing over \$600 on average — while the state's investor-owned utilities earned \$24B+ in profits (2021–2025).



RELIABILITY

24/7

Polluting peaker plants stay online to meet demand spikes — often sited in disadvantaged communities that already bear the heaviest pollution burden.



RESILIENCE

450,000+

Hours of instruction lost by over 54,000 CA students in the 2025–26 school year alone, due to severe weather and public safety power shutoffs.

Early Progress, Early Days

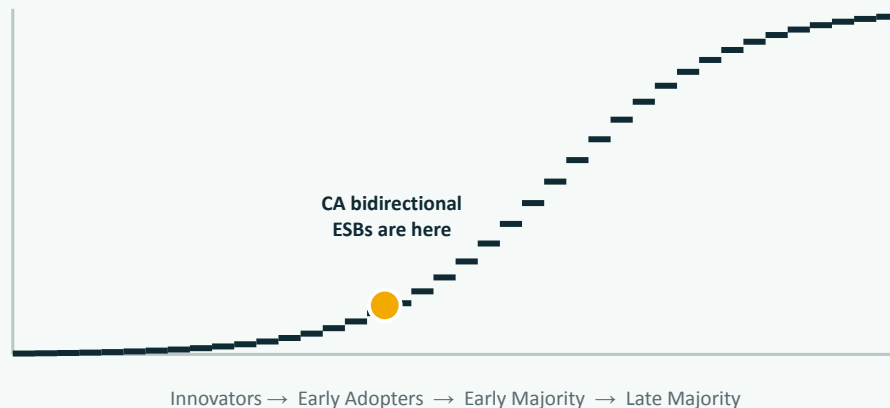
~100

bidirectional ESBs being utilized today — out of 2000+ ESBs statewide

180+

more V2G ESB applications planned in San Francisco, Modesto, Richmond, Pittsburg, and beyond

Technology Adoption S-Curve



Source: RMI — most CA bidirectional ESB projects remain pilot / early-adopter stage

What's Holding Back Scale?

Four barriers stand between today's pilots and accelerated statewide impact.

1



Funding & Compensation

Upfront costs & limited revenue streams for grid services

2



Interconnection

Slow, complex utility processes to connect to the grid

3



Education & Awareness

Limited familiarity among districts & agencies

4



Interoperability

Buses, chargers & software don't always work together



Funding, Financing & Compensation

THE PROBLEM

- Demand for ESB incentives far exceeds funding — 33 districts were waitlisted in the latest ZESBI round.
- Bidirectional chargers & infrastructure can cost thousands more than standard equipment.
- No CA utility offers a per-kWh V2G export tariff — leaving no reliable revenue stream for exported power.
- Available dynamic-rate pilots are complex.

PROPOSED SOLUTIONS

- Maintain consistent, multi-year state funding covering the full incremental cost (TCO) of ESBs.
- CPUC: approve long-term V2G export tariffs / “adders” beyond pilot programs.
- Update Resource Adequacy rules to value the capacity bidirectional ESBs provide: SB 913 (Becker) awaits Governor’s signature
- Enable telemetry-based compensation so projects avoid costly revenue-grade meters: SB 913 (Becker) awaits Governor’s signature



Interconnection

THE PROBLEM

- Under Rule 21, grid-parallel (grid-exporting) projects require a lengthy approval process and high upfront fees.
- Electrical upgrades and permitting can take 6–48 months — far longer than bus delivery, leaving buses idle.
- Utility “Make Ready” funding often prohibits later adding V2G capability to the same equipment.
- No comprehensive, streamlined V2G interconnection pathway exists yet — projects remain pilots.

PROPOSED SOLUTIONS

- CPUC: direct utilities to prioritize streamlined interconnection for school-site resilience projects.
- Require IOU Make Ready programs to remain compatible with future V2G participation.
- Scale flexible interconnection pilots into a standard offering for school fleets.
- Strengthen coordination between permitting authorities and utilities to speed approvals.

Education, Awareness & Interoperability



Education & Awareness

- Fewer than 13% of CA districts have a staff member focused on sustainability — transportation & facilities staff often carry this alone.
- Little guidance or case-study material exists for planning & financing a V2G project.
- Concerns about battery health and warranties may make districts hesitant, though evidence suggests VGI has minimal impact.
- **Fix: state-published case studies, FAQs, site visits, and dedicated technical-assistance funding.**



Standards & Interoperability

- Manufacturers can adopt bidirectional standards differently — an existing standard doesn't guarantee two devices actually work together.
- Non-interoperable equipment risks becoming a stranded asset districts won't invest in.
- CA's new Charge Yard interoperability testing lab is a first step — but coverage & funding requirements are inconsistent.
- **Fix: require open-standard equipment statewide and expand independent testing hubs: Charge Yard just opened**

Turning School Buses Into Community Energy Assets

School bus policy meeting Monday afternoon October 5 in Berkeley:
<https://theclimatecenter.org/events/2026-california-bidirectional-electric-school-bus-policy-coalition-meeting/>



CARB & CEC: sustain funding that covers the full incremental cost of bidirectional ESBs.



CPUC: approve long-term V2G export compensation and streamlined interconnection: earlier this year, the CPUC killed a V2G export compensation mechanism that Southern California Edison had proposed



Utilities: expand technical assistance, flexible interconnection, and Make-Ready programs compatible with V2G.



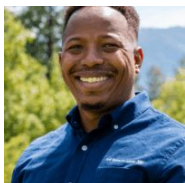
State agencies: require open standards: the CEC just announced an interoperability workshop scheduled for November 4th

California pioneered electric school bus deployment. Now it can lead the nation in scaling bidirectional ESBs — delivering cleaner air, a more resilient grid and safer communities.

Questions?



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