DOCKETED	
Docket Number:	19-IEPR-04
Project Title:	Transportation
TN #:	229200
Document Title:	Richard Schorske, Executive Director, EV Alliance Comments Suggested Program Design Strategies to the CEC re. the AB 118 Program and Related EV Ecosystem Investments
Description:	N/A
Filer:	System
Organization:	Richard Schorske, Executive Director, EV Alliance
Submitter Role:	Other Interested Person
Submission Date:	8/1/2019 7:53:40 PM
Docketed Date:	8/2/2019

Comment Received From: Richard Schorske, Executive Director, EV Alliance
Submitted On: 8/1/2019
Docket Number: 19-IEPR-04

Suggested Program Design Strategies to the CEC re. the AB 118 Program and Related EV Ecosystem Investments

Additional submitted attachment is included below.

Suggested Program Design Strategies for Consideration by the California Energy Commission re. the AB 118 Program and Related EV Ecosystem Investments

Accelerating EV and EVSE Adoption in Multi-Unit Residential Properties and Accelerating School Bus Fleet Electrification with Vehicle-To-Grid Integration

Submitted by the EV Alliance

in collaboration with Powertree Services Inc. and Highland Electric Transportation

The following information is provided to the California Energy Commission to inform future program design and resource allocation to address two leading opportunities for accelerating the pace of transportation electrification in California. This input focuses on two areas of special need and great opportunity within the state's EV ecosystem. First, we discuss program strategies to promote cost-effective adoption of EV charging and Electric Vehicles in the multi-unit residential property segment, which houses more than 40% of all Californians. A concentrated program of assistance to MUDs is needed to open up this critical segment of the market for accelerated EV adoption -- and to address SB 1000 and SB 350 requirements for proportionate distribution of infrastructure and equitable access to clean transportation. Second, we discuss the need for technical and financial assistance to support accelerated electrification and grid-integration of electric School Buses. Electric school buses reduce children's exposure to dangerous diesel emissions, and V2G enabled school buses can provide important load-balancing resources to the California grid, while providing grid services revenue that can make electric school buses cost-competitive with diesel alternatives.

Background on EV Alliance: EV Alliance was founded in 2009 to accelerate mass adoption of Electric Vehicles, with a focus on California. With our sister organization, ZNE Alliance, we have sponsored the following projects – most of which have been supported in part through CEC or EPIC resources.

- **Bay Area EV Corridor Project:** Led the development of $4M+ CEC and privately funded project deploying 400+ public EV charging ports in the region, including Level 2 chargers, Fast Chargers, and the state's first solar-powered and battery-backed DC Fast Charger. Key partners included the Association of Bay Area Governments as administrative lead.
- **EV and Alternative Fuel Vehicle Plans** for the Cities of San Francisco and Richmond, and six counties in the Monterey Bay and Central Coast regions. Supported by $400K+ in grant resources from CEC and matching funds from local Air Districts.
- **E-Fleet Accelerator Project** -- Providing fleet transition assistance for major public and private fleets in six counties (with $200K in CEC grants and local AQMD resources.)
- **California E-Bus-to-Grid Project**, developing VGI revenue-generation programs and strategies for 80 BYD E-Buses in deployment by the Antelope Valley Transportation Authority (funded in part by $3.5M in CEC funds) and developing technical guidance for E-Bus and E-Truck fleet operators in partnership with Prospect Silicon Valley and CalStart.
- ***Ready, Set, Charge,* California!** - provided the state's first EV readiness guidance doc and technical assistance on EV friendly policies (privately funded)
- **Regional EV Councils –** designed and developed the CEC-supported network of 8 regional EV Councils statewide (supported by $5M+ in CEC funds)
- **Bay Area EV Strategic Council** – co-developed the regional EV council which attracted $14M in local support for EV programs in the Bay Area.

- **Silicon Valley Clean Energy** – Developing EV program designs for $8M ratepayer investment in EV infrastructure.

SECTION 1. A Scalable Approach to Bridging the EV Access Gap for Residents of Multi-Unit Developments

1.1. The Lack of Scaled MUD Penetration is Undermining Transport Electrification Goals: Multi-unit residential properties are a critical area of ZEV infrastructure that must be addressed to achieve the GHG reduction goals set forth by the State of California and to improve economic and environmental conditions for California residents. Today almost all (93%+) of plug in vehicles (both BEV & PHEV) have been sold to drivers wealthy enough to own a home in California -- while only 4% have been sold to either condominium or apartment residents (per CVRP data). Yet the US Census notes that 42% of Californians reside in rental apartments. Further, much larger majorities of the population are renters in key urban markets such as San Francisco, Los Angeles, and their surrounding cities. Thus, the advantages of EV ownership have been inaccessible to nearly the entire population of California renters, critically undermining efforts to achieve mass adoption of EVs and to provide equitable access to the benefits of e-mobility, as called for in SB 350, SB 1000 and other state policies.

1.2. Bridging the EV Access Gap for Renters Requires Greater Investment in MUD Charging: Reliable data on the number of EV charging ports in multi-unit developments is difficult to obtain as these chargers are typically not registered with the DOE or PlugShare. However, it can be deduced that very few MUDs are equipped with charging insofar as minimal resources have been allocated to this key segment by the California Energy Commission and other investors. Further, anecdotal evidence suggests that the make-ready program sponsored by NRG settlement funds not yielded the number of conversions to actual EVSE installations that was hoped for. Likewise, California IOU programs, which initially required the installation of a minimum of ten EVSE, have had slow uptake, as the preponderance of MUD owners remain unwilling to take on the complexity and liabilities associated with charging even when provided with free installation and equipment. Finally, private investors and EV Service Providers have not been willing to carry the financial burden of the "build it and they will come" approach to EV charging. This reflects the reality that most MUD residents are trapped in the "chicken vs. egg" problem that they will not purchase EVs without charging already being in place, while MUD owners see no compelling reason to provide EVSE when residents have not yet adopted EVs.

In light of the well-known difficulties of promoting EVSE adoption in this segment, some analysts have suggested that MUD residents will need to simply charge at work or at DC Fast Charge plazas. While a small minority of EV owners <u>do</u> have access to reliable and economical workplace charging, most workplaces are not yet equipped with EVSE. Given the sheer number and broad dispersion of workplaces, it is not likely that a workplace-focused strategy for apartment dwellers is going to viable anytime soon. With regard to a DCFC focused strategy for MUD residents, several factors must be considered: 1) Most BEVs, and nearly all PHEVs, are <u>not</u> equipped for DC Fast Charging and many of the DC capable vehicles charge a premium for the DC capability; 2) Apart from Tesla-only DCFC plazas, most DCFC charging stations are currently prone to significant congestion, requiring an unpredictable and inconvenient wait even before the Fast Charging session can begin; 3) Fast Charging stations are ~3x to 30x more expensive per port to install than a Level 2 port in a multi-unit residential setting, with costs per port and led times for installation increasing significantly as higher power standards (150kW – 350kW come online) [PG&E is currently quoting 12-15 MONTHs for any upgrades]; 4) Charging costs at most DCFC are much higher than home charging, with some DCFC pricing coming close to the cost of gasoline on a per-mile basis, despite the relative inconvenience. While DCFC through-put will be enhanced when combined with the faster charging capabilities of the most recent high-end vehicles, it is important to note that: a) the public DCFC port-to-vehicle ratio is not catching up to vehicle deployment at a rapid rate, and; b) most existing vehicles cannot charge at the higher speeds (150kW+) in any case.

1.3. MUD Charging Investments Will Yield Substantial Increases in EV Ownership: Given the realities described above, we believe that the state must work closely with key market actors to define a new approach to build out residential MUD charging that unlocks this "hidden half" of the EV market. The good news/ bad news consequence of the MUD charging challenge is well-illustrated in a recent survey by the UCLA Luskin Center, in which 65% of prospective early EV adopters in the Los Angeles metro area were MUD residents, yet 42% of MUD residents believe that the current lack of at home or near home charging will prevent their purchase of a plug-in vehicle. By overlaying this data with income data on renters in the EV purchase demographic, it can be inferred that if a viable MUD infrastructure strategy had been in place from the beginning of EV deployment in the state, there would now be at least double the current number of EVs in California. The Bay Area EV MUD access study funded by the CEC and conducted by the EV Alliance also supports this match of EV purchase demographics with MUD residents in the state's key metro areas. That study showed that several hundred thousand MUD residents in the San Francisco Bay Area are in the prime EV purchase demographic but had no access to EV charging solutions and therefore have not purchased EVs at anywhere near the same rate as single family home owners in the equivalent demographic.

1.4. New Business Models are Needed to Open the EVSE Market: Fortunately, there is now a renewed focus on the importance of the MUD market and useful experience from which to craft scaled EVSE deployment strategies. Also, the emergence of a robust market for used EVs has lowered the potential purchase price for EVs and thus broadened the addressable market substantially. (For example, relatively low-mileage Leafs are available for well under $10K and Volts for well under $15K in the used market.) While MUDs face well-known and unique challenges, new business models are being purpose-built to address the hot-button issues of key decision-makers in the MUD context – especially property owners and managers. These solutions range from load sharing systems and full turnkey operations, to business model innovations that combine charging with other onsite energy upgrades, incentives, and revenue streams.

To drive meaningful MUD market acceleration, the most critical need is to address the two greatest MUD challenges: 1) The need for business models that motivate widespread adoption by building owners; and, 2) the development of affordable approaches that enable electric mobility for MUD residents at low cost. As described in more detail below, one model (developed by Powertree) that can address both challenges is to combine shared use of EVSE with solar and energy storage to provide multiple revenue streams to building owners, reducing or eliminating costs and delays due to utility upgrades while dramatically lowering the cost of EVSE *per apartment enabled for EV ownership and use.* While shared use is not practical everywhere, and is not a panacea for all the challenges of MUD charging, it is the most efficient approach (by far) and deserves high-priority investment by the CEC in light of its cost-efficient approach to market-enablement for MUD residents. Further, the shared approach will become increasingly viable as battery capacities and range continue to increase, thereby reducing the frequency of charging sessions.

1.5. Shared Use Enhances MUD Charging Efficiency and Accessibility: A MUD charger with shared access for all building residents and nearby neighbors can enable substantially more cost-efficient EVSE access per apartment or vehicle compared to other residential approaches, while delivering a faster charging experience. For example, a typical MUD property in San Francisco has approximately 25 apartments with an average of 1.4 vehicles per apartment. Under current laws (AB 2565) a single installation can cost $375 for permits, $1500 for electrical work, and $700 to $3500 per single-port EVSE – ***at a total cost of ~$3,600 to $6600+ to enable charging for a single vehicle if no upgrades are required***. This does NOT count the full costs of parking space rental, electricity, or potential cost of a utility electrical upgrade.

By comparison, the same MUD property equipped for shared use will enable any of the residents in the building to purchase an EV with on-site or nearby EVSE accessibility. In our example, this approach spreads the initial costs to the residents of 16 apartments resulting in a cost of under ***$375 per apartment enabled for EV adoption*** at the higher end of potential costs ($6000/16 = $375).

While this approach is not as convenient for EV drivers as a dedicated charger per space, in many urban environments, *there simply has been no demonstrated history of viable business models for retrofitting chargers to a dedicated space given the churn in tenancy*. Further, both tenants and owners/managers of properties are extremely reluctant to “start from scratch” on a new installation with each new EV buyer in the property -- and are often prevented by local rent ordinances from re-assigning parking spaces across different units. In effect, the single charger per dedicated space model is acting as a powerful barrier to initial EV purchases, whereas the shared use approach (managed by a responsible EVSP) resolves the problem of EV access for the entire building with a comprehensive and scalable approach. In addition, both battery sizes and charging rates are increasing at a significant rate, such that home charging sessions – while still essential for most owners -- will become both less frequent and faster over time, reducing the inconvenience of shuttling vehicles in and out of the electrified spaces.

By contrast with the many unknowns and stranded asset risk accompanying a new charger install in a dedicated space, the shared use approach *establishes an up-front protocol for expanding the number of charging ports within the building as demand increases*. The shared use approach also involves installation of the requisite equipment and capacity to facilitate cost-efficient capacity growth through managed charging and integration of other distributed energy resources as appropriate to the use case, such as solar PV and stationary energy storage.

Once the comprehensive shared use agreement is in place, the MUD-focused EVSP will also be empowered to deploy newly emerging technologies – such as wireless charging and new load management strategies – to enable even greater convenience and ubiquity of charging as technologies evolve and costs decline. The key to this highly cost-efficient shared access strategy is that a long-term agreement (up to 20 years) is established with the owner to build out all the infrastructure needed to serve *as many residents as choose to adopt EVs over time – from 1% to 100% of the building's tenants – **and to include neighboring EV owners** as capacity permits.*

1.6. Shared Use EVSE Efficiency Compares Favorably to Utility MUD Programs: The following table shows the reported success of different MUD focused efforts in California as reported by SCE and PG&E to the CPUC in their most recent quarterly filings. This approach is compared with recent deployments by Powertree in a shared use deployment in San Francisco, which was supported by a combination of $9.4 million in investor funding and a $500,000 CEC grant.

MUD Project Costs Comparison			
	PG&E	**SCE**	**Powertree**
Vehicles Served	1	1	10
Shared Y/N	N	N	Y
Operating Costs Covered for Host?	N	N	Y
Cost per Apartment Enabled	$ 13,500	$ 13,731	$ 690
Cost per vehicle at 17% EV penetration (5 MM Evs)	***$ 13,500***	***$ 13,731***	***$ 2,058***
Ratio to Powertree	6 : 1	6 : 1	1 : 1
17% chosen as 5 million/28 million residential vehicles EV penetration to CA car fleet			
Apartments Supported in Pilots	**-**	**35**	**14,487**

See footnote [1] below.

As commented in other filings, Utility programs, while well funded, have been poorly received by MUD owners due to flaws in program design These include a focus on charge port deployment counts based on a 1:1 model of chargers to EVs, which leaves MUD owners and drivers vulnerable to stranded asset problems due to the well-documented churn in occupancy. Further, utility programs have been significantly non-responsive to property owner business concerns – including a need for significant and immediate revenue, and/or increases in building equity value.

Key benefits of the shared approach include: 1) enablement of revenue sharing for owners and consequent equity value enhancement as payments for solar electricity are integrated into the rental payment (thereby increasing overall uptake of EVSE in MUDs); and 2) enabling EV purchases by far more households vs. EVSE deployed at individual deeded spaces, which are subject to under-utilization and "asset-stranding" due to tenant churn

1.7. Shared Use is Economically Essential in Most MUD Properties: Even after installation in a MUD property, a charger can quickly become a stranded asset if attached to just one specific dwelling unit, due to high turnover among residents. As shown in the following table, based on industry data from Marcus & Millichap commercial brokerage (specializing in MUDs), *a fixed assignment of an EVSE to a single apartment carries a 96% risk of being stranded in as little as 3 to 5 years*. By contrast, an urban shared used system that is accessible to all residents

[1] Data for costs of SCE and PG&E programs taken from quarterly program reports filed by respective Utilities with CPUC under the AFV Program A.15-02-009 and SCE A1806XXX . NOTE – Utility costs do NOT include additional capital or operational costs borne by the site host or EVSP. Further, the utility figures do not include program administration costs (over $12M for PG&E) which are excluded from their construction cost reporting, but would likely boost per port reported costs by well over 50% if included. Also, utility service upgrades are provided at low cost for utility-sponsored installations, but at very high cost for non-utility EVSPs. Powertree costs (as in the case of other non-utility EVSPs) reflect higher per port costs due to paying "full retail" electrical capacity upgrade costs which are up to 10X higher than internal utility cost allocation for ratepayer funded internal EVSE program fulfillment. In addition, Powertree per port costs include costs of solar and storage as resilience and revenue producing features. However, inclusion of solar and storage enables more rapid deployment and more cost-efficient operations and supports larger-scale capacity expansion, thus enabling (with the shared approach) a more cost-efficient overall program when considered on a "per EV-enabled apartment" basis.

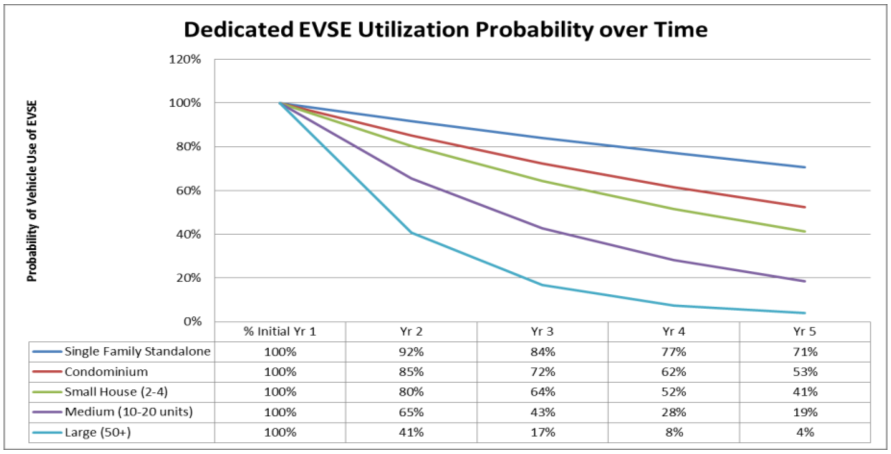
The projected 17% rate of EV penetration in MUDs is based on statewide achievement of the 2030 goal of 5 million EVs, given a 28 million total residential vehicle fleet in CA. Powertree costs are based on a "per EV enabled apartment" in San Francisco with vehicle populations adjusted per US Census projections and the 17% penetration for enabled apartments. Example: $690/enabled-apartment * 11 apartments enabled within 1 block radius * (5 million vehicle target / 28 million residential fleet) * 1.595 vehicles registered per apartment (DMV) = $2058 per enabled vehicle. Note that the Powertree model includes PV-powered resiliency, building access management, and energy storage support.

of a larger MUD building – and to "next-door neighbors" within a one-block radius – would achieve close to 100% utilization as EVs are increasingly adopted by residents with guaranteed access to secure and convenient home charging.

Likely Churn by Category of MUD		**Utilization Probability of dedicated EVSE at Initial Location**				
	Churn	% Initial Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Single Family Standalone	8% (12 years)	100.0%	91.7%	84.0%	77.0%	70.6%
Adjusted for CARB EV penetration		**100.0%**	**91.8%**	**84.2%**	**77.2%**	**70.8%**
Condominium	14% (7 years)	100.0%	85.7%	73.5%	63.0%	54.0%
Adjusted for CARB EV penetration		**100.0%**	**85.9%**	**73.7%**	**63.2%**	**54.3%**
Small House (2-4)	20% (5 years)	100.0%	80.0%	64.0%	51.2%	41.0%
Adjusted for CARB EV penetration		**100.0%**	**80.2%**	**64.3%**	**51.6%**	**41.4%**
Medium (10-20 units)	35% (3 years)	100.0%	65.0%	42.3%	27.5%	17.9%
Adjusted for CARB EV penetration		**100.0%**	**65.4%**	**42.8%**	**28.1%**	**18.7%**
Large (50+)	60% (2 years)	100.0%	40.0%	16.0%	6.4%	2.6%
Adjusted for CARB EV penetration		**100.0%**	**40.7%**	**16.9%**	**7.5%**	**3.9%**

Churn is based on average duration tenants residing at given class of property. Utilization % figures are adjusted from baseline 2017. The CARB minimum % of new vehicle sales is adjusted to cumulative full California light duty vehicle fleet %. I.e., probability of new tenant having a Plugin Vehicle. Churn % from Commercial real estate trade data for MUD. [Marcus & Millichap]

Shared Use Utilization probability		(> 100% indicates multiple use/need for multiple chargers)				
	Density Factor (per census)	% Initial Yr 1	Yr 2	Yr 3	Yr 4	Yr 5
Rural	26	3%	3%	4%	5%	6%
take rate	10%					
Suburban	70	14%	17%	21%	26%	32%
take rate	20%					
Urban	1,078	582%	716%	881%	1083%	1332%
take rate	54%					
Density Factor is Population per 1 Block radius Block (appx 1/16 square mile)						
http://en.wikipedia.org/wiki/List_of_United_States_cities_by_population_density#Population_densities						
https://www.census.gov/prod/cen2000/phc3-us-pt1.pdf#page=44						
Take rate is % of location that utilizes shared service. (% in MUD as proxy)						
100% = Certain Usage						
< 100% less certain to be used						
> 100% demand in excess of single use						



This chart shows % probability of utilization for a charger if the EVSE is dedicated to a single apartment.

1.8. Impact of EVSE Sharing in Diverse Market Segments: The table below shows the impact of sharing in different market segments. The property size churn constraint is eliminated as EV adoption increases. Figures above 100% show expected level of multiple vehicles per multi-family residential charging location, e.g., 582% = 5.82 vehicles using a single EVSE as their home base for charging.

This chart shows impact of sharing in different market segments. Property size churn constraint is eliminated as full area market factors take control. Figures above 100% show expected level of multiple "primary" vehicles per charging location. I.e., 582% = 5.82 vehicles using single location as primary base for charging.

It is clear that properties with high churn and a low number of total EV drivers *will very quickly be faced with stranded assets if the EVSE are dedicated to a single drive*r. By sharing the EVSE both within the building and with nearby neighbors, the negative impact of churn is mitigated.

1.9. Proposed CEC Funding Design to Encourage Shared Charging in MUD Settings: As noted above, shared charging is substantially more economical as a strategy to enable and sustain more EV purchases in the MUD segment. However, there remain several key challenges to operationalizing this strategy, each of which could be mitigated by appropriate program design by the CEC (and allied utilities). These include:

- **Adequate financial support for site recruitment and technical assistance:** The availability of free installation and free equipment has not provided sufficient incentive for meaningful rates of EVSE uptake by MUD owners. Most MUD property owners are either: a) unaware of available incentive programs, b) Intimidated by the complexity and hassle of EVSE deployment; or, c) Unimpressed with the ROI on charging vs. other property investments. Gaining full property owner commitments in larger properties with complex ownership structures (REITs, etc.) for an emerging market is very time-consuming and costly, as is the site survey process to establish accurate costs and timelines for EVSE deployment and electrical upgrades at scale and often requires the existing of a legal mandate before they are allowed to proceed. *An effective programmatic approach to MUD charging must acknowledge the significant costs of site host recruitment and technical assistance.* Based on recent experience in the greater Bay Area tracked by EV Alliance, we estimate that the one-time cost of site host identification, site qualification, engineering, permitting, and initial on-site promotion of the EV ownership opportunity is between $4000 and $8000 per charge port. *The cost of installation and equipment is above and beyond these foundational costs.*

- **Adequate operating support for EVSE following initial deployment:** The shared approach to EVSE reflects a full embrace of the "built it and they will come" model of EV adoption and EVSE utilization. While this approach may appear riskier or more costly at first glance than the dedicated approach based on a known EV driver, it: a) solves the "chicken vs. egg" problem; b) it mitigates the longer-term risk of stranded assets due to tenant churn, and; c) it will result in far lower cost per household (and per vehicle) enabled for charging. However, to make the shared EV viable, the CEC must provide operating support for the early years of lower EV utilization. The precedent for providing this operating support has already been created by the CEC in the case of hydrogen vehicle fueling stations, which bundle capital and operating support for the first several years of operation – on the theory that growing demand will ultimately enable profitable operations. While EV uptake in buildings newly provided with EV charging will vary according to consumer preference, we also recommend funding a robust program of targeted outreach, Ride and Drives, and discounts coordinated with the local utilities and other funding partners, such as Air Quality Management Districts.

1.10. Proposed CEC MUD Program Design

To achieve truly broad-scale charging access for MUD residents, we propose that the CEC utilize its resources to address the front-end financing problem with resources scaled to the challenge. A large-scale state investment that enables efficient and attractive charging business models will in turn unlock and leverage even larger private finance – once there is sufficient demonstration of EVSE business model performance over time. Specifically, we propose that the CEC fund a commercial scale demonstration program that would create significant impact in key metro areas with substantial MUD property concentrations. Rather than funding smaller piece-meal efforts, we propose that the program be configured to encourage respondents to propose tranches of ~7,500 apartments enabled for EV adoption, for a total program size of 75,000 apartments enabled for charging. This would go a significant distance toward closing the "charger gap" of 89,000 EVSE identified in the recent 2019-20 Investment Plan. Proposers would be encouraged to develop larger projects spanning multiple properties and ownership groups in geographies well aligned with current and emerging EV purchase demographics. While the 7500 apartment minimum is an illustrative number which could be modified in any direction, we believe that this represents the right order of magnitude to demonstrate the scalability and viability of MUD charging for follow-on private financiers. For an initial statewide program, reaching 75,000 buildings would represent at least a "down payment" on a scalable program that could attract significant private finance as economic sustainability is demonstrated. The program structure would optimally reflect these parameters.

- **Provide finance on a milestone basis for tranches of ~1,000 apartments "enabled for EV."[2]** Qualifying projects could be comprised of multiple buildings with at least 1000+ apartments total and space available for shared EVSE. (It should be noted that many garden apartments have a parking space to unit ratio of 2-1 or better, which is ideal for enabling shared charging.) It is recommended that the EVSE have at least 70 amps of 2xx Volts AC capacity to enable fast throughput of vehicles equipped with higher-rate L2 charging capability. Initial milestone funding would be associated with completed MUD site agreements[3] and relevant EVSE deployment planning and engineering, followed by construction and operational milestones.
- **Encourage projects which provide shared access for nearby apartments:** Given the potentially slow ramp-up of EV procurement within a particular building, shared chargers coupled with appropriate access controls could be made available to neighboring buildings within a short walking radius. For example, a complex with 1000 apartments could be configured to serve as many as 6000 nearby apartments given consistent density in the neighborhood. This would enable a total of ~7,000+ apartments per project.
- **Provide finance for EVSE construction, commissioning, and operations** following the development of site agreements and surveys[4]. Operating support would be provided for an appropriate period of time – likely 2-3 years – to enable EV procurement and EVSE utilization to ramp up sufficiently to achieve economically sustainable operations. The provision of operational support for MUD-focused EV charging networks is consistent with existing CEC practice in the hydrogen fueling space and reflects a serious response to the current market failure in MUD charging (experienced by both IOUs and EV Service Providers).[5]
- **Encourage business model innovation:** The projects would be evaluated in part on the basis of business model innovation and scalability to reach large numbers of potential EV drivers in key metro markets. Examples of business model innovation include: 1) integration of EVSE with solar and stationary storage deployment at MUDs to enhance revenue streams to property owners, benefits to the grid, and local resilience; 2) Developing shared use protocols that can serve both in-building EV drivers and "near-neighbors" to enhance project efficiency and enable robust revenue sharing for site hosts.

[2] Apartment-enabled = an apartment now having access to an EVSE charger in the same building or within a ~1 block radius

[3] An optimal MUD Site Agreement is a long term (10+ year) agreement with the property owner sufficient to provide ongoing access and control of parking stalls, placement of EVSE and associated equipment, and signage, easements, rights and liability provisions sufficient to ensure operations and liability control for the parties involved.

[4] Survey is a physical count of living units (apartments, etc) in and within a 1 block radius of the EVSE Host address listing type of building (#units), host site and type of property, etc.

[5] In the case of Fuel Cell Vehicle infrastructure, persistent market barriers and "chicken and egg" problems with fueling infrastructure are being surmounted by comprehensive state funding – with private sector partners taking on the full burden of infrastructure development and operation only as the requisite scale economies are achieved.

- **Focus on scale based on apartments enabled for EV charging:** Project size minimums would be designed to enable network effects in the target region sufficient to attract meaningful new PEV adoption growth as the projects come online. For example, an initial program funding level sufficient to enable ~10 to 12 projects of ~7000 - 7500 apartments each would reach 75,000 apartments enabled for EV charging (including in-building apartments and near-neighbors.)

1.11. Proposed CEC MUD Program Funding Parameters

To achieve scaled impact, these funding levels and program requirements are recommended for CEC consideration:

- **Pre-construction funding:**
  - Up to $12,000 per building address in site acquisition costs
  - $400 per enabled apartment for construction
  - $300 per month per stall in operating costs per building address for up to 24 months (based on a single site address of at least 8 apartment units or more.)
- **Site Control Agreements** -- meeting the size parameters above would be required with long-term contract with the building owner guaranteeing EV Charging service access for all building residents and neighboring drivers during that period. Note that longer contract terms are crucial for securing private financing and developing a sustaining business model for the EVSP.
- **Reimbursement framework:** Reimbursements could be paid as follows:
  - **Site Acquisition at up to $12,000 per contracted building:**
    - (a) 25% on grant award and the balance provided per (b) below:
    - (b) upon achievement of necessary number of Site Agreements meeting the program criteria and individual grant agreement terms and conditions. Payable in group of at least 10 buildings contracted.
  - **Site Construction Cost contribution per enabled apartment**:
    - A total of $400 per apartment enabled for EV charging, based on:

      (a) 25% upon delivery of area survey confirming the number of apartments in-building and within a 1 block radius of contracted properties

      (b) 40% upon presentation of permits and plans (if required by local AHJ) and ordering of material required within 30 days.

      (c) 25% upon completion of construction and final permit signoff by local AHJ

      (d) 10% after commencement of operations
  - **Site Operation Support**
    - $300 per month per stall for up to 24 months
    - Paid starting the first month following the completion of Site Construction for the site
    - Proposers could propose a schedule of reduced payments as charging revenues ramp up (allowing for payment of costs of energy and equipment and a variety of business models).

- **Eligible costs would include:**
  - Site host outreach and sales costs
  - Legal fees, study fees, permit fees, certification costs (if required) and contract development
  - Site survey and preliminary engineering -- including any data collection, analysis, and electrical/construction estimates
  - Reservation and finance security costs (letters of credit, rebate reservation deposits, credit checks, etc. – differentiated from construction financing itself)
  - Relevant administrative overhead (accounting, rent, staff, travel, lodging, etc.)
  - Equipment, Labor and materials including resiliency, energy storage for grid mitigation and/or demand charge reduction, renewable energy generation and control equipment
  - Construction management costs
  - Local permit and utility chargesReal estate rental charges, insurance, management and maintenance

1.12. Proposed MUD Program Budget

The following budget reflects a program goal of enabling 75,000 apartments for charging, at a cost of $38.7 million over three to four years.

Summary Budget		
Phase 1 - Site Acquisition	$	5,113,636
Phase 2 - Construction	$	30,000,000
Phase 3 - Operational Support	$	3,630,362
Grand Total	$	38,743,999
Payback period to State from new Sales tax revenues from EV fuel shift to Electricity:		9 years
[Payback period = Total Budget / Sales Tax generated per year]		
Effective $/tonne of GHG avoided (10 year basis):	**$**	**(0.91)**
Levelized Cost per Apartment:	**$**	**516.59**
Cost Effectiveness Score:		**18.50**
Comparison Score for Cost Effectiveness:		
Single Family		1.00
DCFC Charger (dual format and assuming Tesla adapters)		2.10

The State of California will enjoy a net positive fiscal impact from shifting transportation fuel procurement from gasoline to electricity. The effective sales tax revenue boost related to the EV shift amounts to approximately $495 per vehicle per year (per Strategen Consulting and Powertree Services analysis[6]).

1.13. MUD Program Evaluation Criteria

[6] "Impact Analysis: Governor Brown's 2030 Energy Goals", Strategen Consulting LLC [https://www.dropbox.com/s/disn2wvxfrvv1kw/Strategen_2030_Governor_Goals.pdf?dl=0]

- **Demonstration of value for property hosts and savings for renters and drivers.** Proposer must show clear path on how value is provided to each key stakeholder in the project effort, including prospective and existing EV drivers, other tenants, the building owner and manager, immediate neighbors, and the community at large.
- **Geographic density.** Sites should be close enough to one another (e.g., ~1 – 5 miles) to achieve a "cluster effect" wherein the relatively high visibility of new EV deployments and personal interactions and referrals will magnify EV awareness and grow EV sales and electric VMT.
- **Clean energy sourcing.** Applicants should identify the carbon intensity and renewable content of the energy delivered to the vehicles. Lower carbon intensity should be weighted more favorably.
- **Outreach plan for boosting EV adoption.** Applicants should develop a local outreach and marketing plan to boost EV purchases and charger utilization once the project is built.
- **Cost effectiveness.** Projects should be assessed against cost effectiveness criteria and match level (among other attributes). The application of available incentives from utilities, AQMDs, etc. should be encouraged to enhance cost effectiveness
- **Demonstration of sustainable operations to enable expansion:** Proposers would be required to demonstrate an economic and technical pathway "EV-enable" all the apartments in a given project, showing that expanded operations beyond the first tranche of EVSE can be profitable.
- **Timeframe.** Given the scale proposed, a 24-month period for site acquisition is suggested, with construction and commissioning to be completed within an additional 18 months for installation and construction (dependent on the local utility's ability to deliver required upgrades and permits with utility delays being accepted as an extension of this time) followed by up to 24 months of operation.

1.14. Proposed Cost Effectiveness Metrics

- **Cost per EV opportunity enabled**: Calculate the number of annual vehicle purchases that can now consider an EV. For example: At 1.1 vehicles/apartment (per US Census) and a 6 year vehicle turnover (Motor industry average), 1000 apartments enabled will demonstrate an EV purchase opportunity of 1000 * 1.4 / 6 = 233 vehicles per year.
- **Cost per Apartment Enabled:** Calculate the final cost upon commencement of operation of the apartments enabled by the project. Sum total allowable costs and associated overhead to point of operation and divide by the count of previously surveyed apartments within the 1 block operational radius of the project buildings where EVSE has been installed. Note buildings hosting EVSE without shared access should not count for this apartment count.

1.15. Proposed Operational Effectiveness Metrics

- **Number of buildings in Site Agreements.**
- **Number of buildings in which EVSE are actually installed** (reimbursement rates would be adjusted based on installation levels if building owners drop out of their agreements).
- **Number of charge ports & charge rate capacity in KW**

- **Operational data** on usage over time in # sessions, KWH delivered, hours of charging and time of day of charging
- **EV adoption.** Awardees should baseline the number of registered EVs in project zip codes and track annually. A survey would be used to determine if the MUD infrastructure was influential in EV purchase decisions.
- **Local economic & environmental impact**. Awardees should estimate the sales tax value, avoided fuel costs, and GHG impacts from newly registered EVs.

Summary

It is urgent that California achieve scale in EV adoption in multi-family properties if it is to keep pace with state goals for EV and EVSE adoption, GHG and petroleum reduction, air quality improvement, and equitable economic development. A MUD-focused EV charging pilot program of the type described above will address key barriers to large-scale enablement of EV charging in urban areas -- and do so for a fraction of the cost per new EV enabled vs. other strategies.

SECTION 2: Program Design for Accelerating Deployment of V2G Enabled School Buses

2.1. Moving from Pilot Projects to Commercial Scale: The California Energy Commission and CARB have acknowledged the importance of accelerated development of the commercial Vehicle-Grid-Integration (VGI) ecosystem, as articulated in the first VGI Roadmap, now being updated through the VGI Working Group. Analyses by NREL and LBNL presented at recent VGI workshops sponsored by the CEC have illustrated the very substantial grid benefit provided not only by managed charging, but specifically by V2G enabled vehicles capable of discharging stored energy from batteries back to the grid. However, until very recently, few EVs have been factory-enabled for V2G operation, and the numerous V2G pilot projects sponsored by the CEC have focused on customized and/or very low-volume niche vehicles, as in the case of the Los Angeles Air Force Base project. Because of the customization involved, many of these projects did not demonstrate commercial scalability. Clearly, the next phase of CEC investment should be focused on ensuring that the lessons learned from VGI projects to date are leveraged to enable rapid commercial scaling of viable V2G use cases.

2.2. Focusing on Electric School Buses as the Best Initial V2G Use Case: V2G enabled school buses have long been considered the best use case for initial V2G deployment, owing to the long depot dwell times of school buses and the fact that most buses are entirely out of passenger service on weekends and in the summer. EV Alliance advocated strongly with the CEC Prop 39 electric school bus program team to ensure that all buses supported with CEC funds would be V2G enabled at reasonable cost. It now appears that the incremental cost of the V2G enabled buses appears to be well within the cost parameters required to provide a net economic benefit to school bus operators and Load Serving Entities.

2.3. Program Design Suggestions to Ensure Market Scalability: Over the past year, EV Alliance has been assessing key barriers to and opportunities for rapid development of the V2G electric school bus ecosystem. We have been in dialogue with a number of relevant stakeholders, including school bus OEMs (e.g., Bluebird, Thomas/Proterra, etc.), school bus dealers (A-Z, Creative Bus Sales, etc.) infrastructure as a service providers (Amply, InCharge, Highland Electric Transportation), School Districts (Twin Rivers et. al.), project developers (Clinton Global Initiative V2G School Bus Project, Terra Verde Energy), V2G systems integrators (Nuuve, Kisensum / Chargepoint), research institutions (LBNL, EPRI, E3), and e-fleet analytics companies (eletriphi and others). Our takeaway is that the following key challenges must be met to effectively accelerate the VGI ecosystem for E-School Buses. Further, we belive that CEC could be instrumental in developing relevant solutions to these barriers, through an integrated set of market acceleration initiatives, summarized below.

Challenge	Proposed CEC Program Strategy
V2G Capable EVSE – Only a small number of EVSE manufacturers have dedicated the time and resources to develop affordable, bi-directional charging stations, required for V2G operations. Most OEMs in this sector are very open to adding V2G enabled EVSE to their product roadmap, but are not very interested in prioritizing this feature unless they have growing demand from the market, or achieve some cost recovery for product development. Notably, both higher-rate AC and DC approaches to V2G can be viable, and different charging speeds are likely to be needed over time as batteries and related systems evolve.	**EVSE OEM Support for V2G Enabled Charger Development:** Appropriate funding levels for this program would need to be further assessed, but could perhaps be in the $200K range per OEM x 5 OEMs = $1 million in total program cost.

V2G Fleet & VGI Management Software – Software providers selling into the EV market have focused primarily on charging management, integration of vehicle and charging systems, vehicle fault detection, and other layers of management and control. With a few exceptions (e.g., Enel X), there has not been an equivalent focus on the necessary communication and control infrastructure between the charger, the vehicle battery, and the grid. Relevant grid layers include the distribution operator, local Load Serving Entity (utility/CCA), ISO, microgrid, and other behind-the-meter applications. The software layer is critical to deploying commercial V2G services, as the vehicle battery value depends on its ability to respond to a request from the grid partner, and to economically optimize among uses of solar and stationary storage assets to firm the dispatchable resources provided by the fleet itself.	**Support for V2G Fleet and VGI Management Software:** Ensuring that stakeholders have access to robust V2G Fleet and VGI Management software that is well-integrated with existing EVSE and DER Management Systems will be important to give fleet managers and LSEs confidence in integrating V2G fleets into the grid. A program of perhaps four $250K grants could support work by leading providers to solve ground-level software integration challenges, for a total program investment of ~$1 million.
V2G Contract & Program Templates – The ability to integrate EVs as DERs to provide V2G services will depend on developing robust contractual frameworks to streamline the process of executing commercial transactions between the electric fleet asset owner, relevant energy service provider(s), and the LSE. These frameworks should include: **Performance Profiles for E-Buses and Energy Service Providers:** Energy service providers need a variety of documents that clearly profile the performance characteristics and expectations for integration of a school bus (and complementary stationary storage) as a grid asset. The profile would need to address the bus duty cycles, charging requirements, operating schedule, performance capabilities as a grid asset, and commercial considerations such as warranties, as well as operational control and dispatch functions and parameters. A similar performance profile is needed to define expectations and requirements for each potential energy service partner, including (but not limited to) the LSE, a DER Aggregator, a microgrid or VPP operator, and the CAISO. **Standard Practice Manual for V2G Operations:** A “standard practice manual” for V2G operations is needed to define how V2G enabled school buses can take advantage of program designs available today for DERs as well as program designs now in development. This manual should identify market pricing, value, avoided cost, integration feasibility, and policy considerations for value optimization. These two profiles (V2G School Buses as DER assets and the performance requirements of LSEs and Energy Service Providers) should be matched up to guide the development of new commercial programs, and to quantify the opportunity on both sides of the market.	**V2G Contract and Program Development Templates:** The proposed Performance Profiles, contract templates, Standard Practice Manual should be developed in an iterative and collaborative manner with input of all relevant stakeholders. The cost would likely be in the range of $250,000 - $300,000 for a well-structured development process and fully vetted contracts and guidance documents.

V2G School Bus Market Acceleration Initiative: Too often, the complex process of accelerating market uptake of advanced technologies is left to "market forces." Yet these advanced technologies – including V2G buses – typically require strategic alignment and integration of multiple stakeholders and systems, utilizing novel business models and commercial arrangements. To prevent market failure in the crucial V2G space, it is essential that there be a highly visible, focused, and effective effort to launch and sustain this integrated V2G commercial marketplace. To that end, we propose a *V2G Market Acceleration Initiative* that educates and engages School Districts, fleet owners, vehicle and EVSE OEMs, Energy Service Providers, utilities of all types, the ISO, all other relevant stakeholders based on a compelling "end state vision" for California's V2G ecosystem -- with V2G School Buses as the vanguard application. This initiative will utilize the outputs of the V2G contract and program templates defined above, along with relevant hardware and software tools, to support development of the commercial V2G marketplace, with defined goals for participation and commercial activity.	**The Market Acceleration Initiative** would include: a) Development of an "end-state vision" for V2G School Bus deployment and grid integration (aligned with the California VGI Roadmap); b) Goals for participation by vehicle OEMs and School Districts; c) Education and outreach to School Districts and other market participants to ensure awareness – and scaled procurement – of V2G School Buses based on an understanding of their benefits, business models, use cases, and technical requirements; d) Integration and optimization of available financing and incentives by: engaging key stakeholders to map out the financial and underwriting needs of each market participant, and pro-actively engaging funding institutions to ensure that market needs are met. This initiative could be sustained for a 36 month period for a cost of perhaps ~$500,000 - $600,000.
V2G School Bus Deployment Grants to Address Incremental Costs and System Integration Requirements: The first tranche of V2G school bus deployments will likely be complex and require incremental investment in systems integration and early-stage V2G hardware and software solutions, including first-generation V2G enabled EV chargers, interconnect processes, and DER management systems. A proposed V2G Deployment Grant program will address these initial project development challenges for a time limited period (e.g. three years.)	**V2G School Bus Deployment Grants** would be provided to School Districts in collaboration with V2G partners to provide the incremental resources needed for procurement and integration of V2G enabled hardware and software, interconnection, charging management, and project coordination. Grants of ~$400,000 to $1.5 million depending on District and fleet size would enable ~20 leadership Districts to demonstrate replicable approaches that overcome initial technical and market barriers to successful V2G deployment. Total program cost over three years to support 20-25 districts would be ~$15 million.

Summary: The California Energy Commission and its sister agencies have been pioneering V2G technical advancements for many years. However, it is only now that economically viable V2G enabled vehicles are being prepared for commercial-scale production. To capture the full value of prior investments, it is essential that the CEC directly address remaining barriers to the development of a robust V2G ecosystem, beginning with the exceptionally well-suited electric school bus use case. Accelerated deployment of V2G school buses will in turn encourage V2G enablement and grid integration of other medium- and heavy duty vehicles, and ultimately light duty vehicles. The cumulative value of enabling EVs as a grid asset can soon reach into the billions of dollars, as projected by NREL and LBNL. However, to realize these values in the near-term, a robust market transformation initiative of the scale described herein is essential.

Contacts

For more information on these concepts, please contact:

Richard Schorske, Executive Director, EV Alliance and ZNE Alliance, richards@znealliance.net, 415 310-2407 (overall program concept)

Stacey Reineccius, CEO, Powertree Services Inc., ceo@electrictrees.com, 415-235-5094 (MUD focus)

Duncan McIntyre, CEO, Highland Electric Transportation, dmcintyre@highlandet.com (V2G School Bus focus)

Appendix 1: Cost Effectiveness Metrics for MUD Program Development

New cost effectiveness metrics have been referenced in the Clean Transportation Plan and other CEC reports, and we would like to add some detail on suggestions regarding the ongoing refinement of these metrics. Currently the EV industry and policymakers are generally measuring EV infrastructure in terms of cost per port deployed. However, that is a misleading measure and ultimately can lead to wasteful investments. Measuring ports alone assumes a one car to one charger linkage, which does not reflect the real potential for sharing of scarce charging resources. One port, if managed correctly, can serve multiple vehicles, as in the case of DC chargers, and many workplace and commercial chargers, as well as shared MUD chargers. This can have an impact on the anticipated costs and related infrastructure budget needed.

A better metric to target is *EVs enabled for charging* – which is based on the number of vehicles that could use a single port as their PRIMARY charging location (for 75% of their charging or more). This would be adjusted by the % of the general fleet that can be supported by a given charger. This assessment approach would enhance investment allocation efficiency. For example: A single family home "port" supporting a single car would have a Cost Effectiveness of 1:1

A single DC Fast Charger with CHAdeMO only might service 20 vehicles as their primary point of charging and with an adjustment for vehicle fleet coverage as follows:

DC	Mkt Share of DC**
1 - CCS	7.13%
2- TSLA	20.9%
3- CHAdeMO	2.4%
TOTAL DC MKT SHARE	30.36%

**Data here is based on CA EV population market share of vehicle capabilities per manufacturer monthly sales reports cumulative since 2011.

The CHAdeMO DCF would thus be 20 vehicles * 2.4% market share = 0.48 cost effectiveness score.

A dual format DCF (CCS + CHAdeMO) would be 20 vehicles * (7.13% +2.4%) market shares = 1.906 cost effectiveness score.

As AC is present on EVERY vehicle this would have a market share adjustment of 100% adjusted by rate of charge.

A Shared access AC charger serving 6 vehicles would be represented as: 6 * 100% = 6.0 cost effectiveness rating. This could be enhanced by the speed rating of the vehicles capable of being served. An example being this table from current market data:

KW	Mkt Share KW AC**
under 3.4	33%
6.6 to 11.5	46%
Over 11.5	21%
	100.00%

For example, a 3.4 KW would be a factor of 33%. A 9.6KW would be (46%+33%) = 79% and a over 11.5KW would be 100%.

So we see a ranking as follows assuming max 19.2KW for AC with 6 vehicles per stall and a single stall:

Category	Cost effectiveness Ranking (higher is better)
DC CHAdeMO	0.47
Single Family/Non-Shared MUD	1.00
DC CH+CCS	1.90
DC TSLA SC	4.17
MUD Shared	6.00

The formula for cost effectiveness is:

Number of Vehicles per Stall x Number of Stalls x (market share of DC charger type or rate of charge adjusted AC market share) = Cost Effectiveness Score

We recommend that investments be guided toward locations that yield the ***most vehicles enabled*** *instead of just the most ports* – thereby achieving greater cost-effectiveness in terms of enabling EV utilization and eVMT.

** Data is gathered from cross tabulation of Vehicle model manufacturer specifications and manufacturer reported vehicle sales data across all PHEV, FCEV and BEVs since 2011 through July 2018.