**California Air Resources Board “Development of the FY 2016-17 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program”**

**Comment on the April 4, 2016 Discussion Document**

**Comment Submitted by the Clinton Global Initiative Vehicle-to-Grid EV School Bus Commitment Team**

**May 6, 2016**

This comment pertains to the On-Road Trucks Project Category of the Advanced Technology Demonstration Projects under the Heavy-Duty Vehicle and Off-Road Equipment Investments section of the Air Resources Board’s April 4, 2016 “Discussion Document for the 2016-17 Air Quality Improvement Program (AQIP) Funding Plan”. The Clinton Global Initiative Vehicle-to-Grid EV School Bus Commitment Team respectfully suggests that the scope of the On-Road Trucks category be expanded to include both school buses and vehicle-to-grid (V2G) technologies. Due to the unique characteristics of school buses, we believe their inclusion can lead to rapid development of V2G that can then be deployed in trucks and other vehicles across the spectrum. We believe that limiting the current investment plan to exclude school buses could actually retard the trend of electrification in trucks.

Our suggestion springs directly from the articulated rationale for the Advanced Technology Demonstration Projects:

Advanced Technology Demonstration Projects are intended to accelerate into the California marketplace the introduction of advanced emission reducing technologies on the cusp of commercialization. A public investment in these technologies helps to achieve GHG reductions, as well as criteria pollutant and toxic air contaminant reductions, sooner than would be possible otherwise. This commitment from the State encourages industry to expeditiously invent, develop, test, and introduce cutting edge emission reducing technologies.[[1]](#footnote-1)

No technology is better aligned with these goals than vehicle electrification. As it is put in the state’s ZEV Action Plan, “Achieving [the state’s climate goals] will require broad electrification of the transportation sector, and efforts will need to be sustained far beyond transitioning light-duty passenger vehicles to ZEV technologies. Freight, rail and other medium- and heavy-duty applications are central to goods and passenger movement in California and advancing zero-emission technologies in these areas will help to meet the Governor’s petroleum reduction goal, as well as reducing localized pollution and greenhouse gas emissions.” [[2]](#footnote-2)

However, substantial truck electrification faces an uphill journey. The challenge is not technical but economic. The problem is that the cost of the on-board energy storage needed to cover the duty cycle of the typical medium- or heavy-duty vehicle (M/HDV) is so substantial that it cannot be recovered just from the fuel and maintenance savings typical of electric vehicles. This reality will pertain even with foreseeable decreases in energy storage costs.

Extensive study of the electrification challenge by a variety of parties indicates that the best option to fill the economic gap between conventional and electric M/HDVs is vehicle-grid integration (VGI) [[3]](#footnote-3). VGI allows the costly asset represented by the vehicle battery to be given a second value-creating role as a distributed energy storage resource. The resource can be used to generate revenues in a variety of power markets that exist to ensure the performance and robustness of the electric grid. VGI also enhances alternatives for bus financing by positioning the battery as a distinct value-generating asset that can have ownership that is separate from that of the bus. This concept lends itself both to battery leasing at the front end of a bus-purchase transaction and to second-life battery applications once the battery can no longer support a bus’s minimum range requirements.

Detailed economic modeling by PJM Interconnection (the country’s largest regional transmission organization) indicates that annual revenues in the thousands of dollars are a realistic possibility for V2G-enabled M/HDVs[[4]](#footnote-4). Accrued year in and year out over the life of a vehicle, these revenues can make the difference between economic viability and non-viability for electric M/HDVs. The ZEV Action Plan is implicitly aligned with this view via its inclusion of several discrete action steps aimed at developing V2G technology, and its call for inter-agency cooperation in support of such development[[5]](#footnote-5).

V2G appears to be a natural and seamless fit with the program parameters articulated for the Advanced Technology Demonstration Program in the April 4 Discussion Draft:

* It is “on the cusp of commercialization”, with a successful history of technical demonstration
* It will have a direct positive impact on California businesses and the California marketplace by virtue of the state’s current position of leadership in the emerging V2G industry
* It needs one – and only one -- round of public investment to consolidate the business case that will allow the private sector to take the concept forward

V2G technology also fits easily within each of the specific areas of investigation targeted by the On-Road Trucks part of the Advanced Technology Program:

* Intelligent Truck Systems. The theme of this module is capturing and communicating intelligence from the operating environment to increase trucking efficiency. The technologies called out in the Discussion Document all have promise, but we would argue that V2G is the ultimate embodiment of a “networked vehicle” strategy. The key to this premise is that V2G links energy-producing and energy-consuming activities in a way that is unimaginable with the use of liquid or gaseous fuels. The resulting integration allows energy to be moved within the system according to real-time considerations in a way that enhances the efficiency of both freight movement and electricity generation.
* Advanced Engines and Powertrains. One of the focuses of this module is electrification of on-board auxiliary systems. Assuming such systems are supported with on-board batteries, they are just as relevant for V2G integration as batteries used for propulsion. Here, no less than in the propulsion case, the ability to generate ancillary grid service revenues may make the difference between a commercializable technology and one that is fatally handicapped by poor economics. To our awareness, no one is looking at this idea currently. The Advanced Technology Program may be the best way to spark interest in it.
* Zero-Emission Short and Regional Haul Trucks. The stated scope of this module includes battery-electric vehicles. We would suggest that the door should be explicitly opened to V2G technology. After school buses, medium-duty delivery fleets are arguably the best candidates for vehicle-grid integration since the vehicles are often clustered in fleets, are parked in the same place every night, and are often operated on a single shift. Including V2G in this module can define the entrée point and downstream path for V2G penetration into the trucking sector.

If it is accepted that V2G technology could further the objectives of the On-Road Trucks Project Category, we would argue that the Category definition should be expanded to include school buses. Because school bus fleets have the attributes listed above for delivery truck fleets, and are parked for as many as 85 percent of the hours in a year, they represent the best use-case for V2G commercialization – across all vehicle segments, both light- and heavy-duty.

The modeling conducted by our proposal team for the ARB’s recent Zero-Emission Truck & Bus solicitation showed that a commercial price for a V2G school bus of $200,000 could be arrived at through the cumulative production by a qualified manufacturer of approximately 300 buses[[6]](#footnote-6). (It should be noted that the Lower Emissions School Bus Programs operated over the last 15 years by the state’s air districts typically supported the sale of this number of CNG buses in just 1-2 years.) PJM Interconnection’s economic modeling of V2G school buses vs. those of conventional school buses indicates that a price of $200,000 is where total-cost-of-ownership parity is achieved between electric and conventional. In short, commercialization of V2G school buses is a highly realistic goal that could be achieved beneficially within the context of the ARB’s 2016-17 Advanced Technology Program.

Our final argument is a counterintuitive one. Common sense would say that allowing school buses into the scope of the On-Road Trucks Project Category would divert resources from trucks and detract from truck-oriented program results. We would say that the opposite effect is more likely. The impact of including school buses, and letting them pave the way for near-term migration of V2G technology into the truck sector, will arguably do more to reduce truck-generated GHG and criteria pollutant emissions than any other single measure.

1. California Air Resources Board, “Discussion Document” for Public Workshop on the Development of the Fiscal Year (FY) 2016-17 Funding Plan for Low Carbon Transportation and Fuels Investments and the Air Quality Improvement Program (AQIP)”. April 4, 2016, p 31. [↑](#footnote-ref-1)
2. Governor’s Interagency Working Group on Zero-Emission Vehicles, “2015 ZEV Action Plan. An Updated Roadmap toward 1.5 Million Zero-Emission Vehicles on California Roadways by 2025”. April 2015, p 2. [↑](#footnote-ref-2)
3. See, for example, J. Tomic and J-B. Gallo, “Using Commercial Vehicles for Vehicle to Grid”. Paper presented at EVS26, Los Angeles, California. May 6-9, 2012; and L. Noel and R. McCormack, “A cost benefit analysis of a V2G-capable electric school bus compared to a traditional diesel school bus”. Applied Energy 126 (2014), pp 246-255. [↑](#footnote-ref-3)
4. Unpublished data from PJCDOCS-#713620 [↑](#footnote-ref-4)
5. Governor’s Interagency Working Group on Zero-Emission Vehicles, “ZEV Action Plan. A roadmap toward 1.5 million zero-emission vehicles on California roadways by 2025”. February 2013 p 13. [↑](#footnote-ref-5)
6. South Coast Air Quality Management District proposal to the California Air Resources Board, “Battery Electric School Bus with V2G Technology Commercialization Project”. January 29, 2016. Attachment 3: Project Narrative p 13. [↑](#footnote-ref-6)