USC University of Southern California

DEPARTMENT OF PREVENTIVE MEDICINE

University of Southern California
2001 N Soto Street, M/C 9237
Los Angeles, CA 90089-9237
Tel: (323) 442-1096
Fax: (323) 442-3272

Dr. Chairwoman Mary Nichols:

We would like to concur fully with the attached comment from the Clinton Global Initiative EV School Bus Commitment Team regarding the FY16/17 AQIP investment plan.

In addition, we believe that reducing children's exposure to harmful traffic-related air pollutants in general and diesel-related air pollutants from school buses would result in significant improvements in their health, especially for children with asthma.

Studies have shown that switching school buses from diesel to improved, clean technology, and especially zero emissions technology, decreases particulate and gaseous air pollutant and toxics emissions during transit, pick-up and drop-off, and idling and results in significant reductions in children's exposures (Zhu et al 2014, Ryan 2013, Hochstetler 2011; Li et al 2009, Adar 2008, Behrentz el al 2005, Sabin 2005). Reduced exposures in turn have been shown to be associated with improvements in respiratory health, including decreased pulmonary inflammation as measured by exhaled nitric oxide, improved lung function and decreased school absenteeism, especially in asthmatic children who are at a greater risk (Adar et al, 2015; Mazer 2014; Beatty 2011, Yamazaki 2014).

Signed:

Frank Gilliland M.D., Ph.D.
Director, Southern California Environmental Health Sciences Center
and Hastings Professor
Department of Preventive Medicine
Keck School of Medicine
University of Southern California
2001 N. Soto St.
MC9237
Los Angeles, CA 90089
office 323-442-1096

Rima Habre, ScD
Assistant Professor of Clinical Preventive Medicine
Division of Environmental Health
Keck School of Medicine of USC
University of Southern California
2001 N Soto St, Rm 225D, MC 9237
Los Angeles, CA 90089 (FedEx 90032)
Tel. 323.442.8283

USC University of Southern California

DEPARTMENT OF PREVENTIVE MEDICINE

University of Southern California
2001 N Soto Street, M/C 9237
Los Angeles, CA 90089-9237
Tel: (323) 442-1096
Fax: (323) 442-3272

Andrea M. Hricko
Professor of Preventive Medicine
Keck School of Medicine, USC &
Co-director, Community Outreach and Engagement
Southern CA Environmental Health Sciences Center
2001 N. Soto Street
L.A. CA 90089
323-442-3077

Jiu-Chiuan (JC) Chen, MD., MPH, Sc.D.
Associate Professor, Division of Environmental Health, Department of Preventive Medicine, University of Southern California Keck School of Medicine,
2001 N. Soto Street, MC 9237
Los Angeles, CA 90089
(90032 for FedEx and for map directions)
Tel: (323) 442-2949; Fax:(323) 442-3272

Shohreh F. Farzan, PhD
Assistant Professor of Preventive Medicine
Division of Environmental Health
Keck School of Medicine of USC
University of Southern California
2001 N Soto St, Rm 225B, MC 9237
Los Angeles, CA 90089 (FedEx 90032)
Tel: (323) 442-5101

Hooman Allayee, PhD, FAHA
Associate Professor
Institute for Genetic Medicine &
Department of Preventive Medicine
USC Keck School of Medicine
2250 Alcazar St., CSC202
Los Angeles, CA 90033
Phone: (323) 442-1736
Fax: (323) 442-2764
Email: hallayee@usc.edu

USC University of Southern California

DEPARTMENT OF PREVENTIVE MEDICINE

University of Southern California
2001 N Soto Street, M/C 9237
Los Angeles, CA 90089-9237
Tel: (323) 442-1096
Fax: (323) 442-3272

Scott Fruin, PhD, MS
Assistant Professor
Division of Environmental Health
Keck School of Medicine
University of Southern California
2001 North Soto Street, Rm 225, MC 9237
Los Angeles, CA 90032
323-442-2870
fruin@usc.edu

Rob McConnell MD
Professor of Preventive Medicine
Keck School of Medicine
University of Southern California
rmcconne@usc.edu
323-442-1593

Jill Johnston, PhD
Assistant Professor of Preventive Medicine
Director of Community Outreach & Engagement
Division of Environmental Health
Keck School of Medicine
University of Southern California
jillj@usc.edu
323-442-1099

Tracy Bastain, PhD, MPH
Assistant Professor
Division of Environmental Health
Department of Preventive Medicine
University of Southern California
2001 N. Soto Street, Suite 230F, MC 9237
Los Angeles, CA 90089
For FedEx deliveries, please use 90032

USC University of Southern California

DEPARTMENT OF PREVENTIVE MEDICINE

University of Southern California
2001 N Soto Street, M/C 9237
Los Angeles, CA 90089-9237
Tel: (323) 442-1096
Fax: (323) 442-3272

Meredith Franklin
Assistant Professor
Division of Biostatistics
Department of Preventive Medicine
USC Keck School of Medicine
2001 N Soto St. SSB 202A, Los Angeles, CA 90089
(323) 442-2703

Duncan C. Thomas
Professor, Division of Biostatistics
Verna Richter Chair in Cancer Research
SSB-202F
323-442-1218
Dthomas@ usc.edu

Jun Wu, PhD
Associate Professor
Program in Public Health
University of California, Irvine
949-824-0548

References:

1. Am J Respir Crit Care Med. 2015 Jun 15;191(12):1413-21. doi: 10.1164/rccm.201410-1924OC. **Adopting Clean Fuels and Technologies on School Buses. Pollution and Health Impacts in Children.** Adar SD[1], D'Souza J[1], Sheppard L[2,3], Kaufman JD[2,4,5], Hallstrand TS[4], Davey ME[6], Sullivan JR[2],Jahnke J[7], Koenig J[2], Larson TV[2,8], Liu LJ[2,6].
2. Res Rep Health Eff Inst. 2014 Mar;(180):3-37.. **Characterizing ultrafine particles and other air pollutants in and around school buses.** Zhu Y, Zhang Q; HEI Health Review Committee.
3. Environ Sci Process Impacts. 2013 Oct;15(11):2030-7. doi: 10.1039/c3em00377a. **The impact of an anti-idling campaign on outdoor air quality at four urban schools.** Ryan PH[1], Reponen T, Simmons M, Yermakov M, Sharkey K, Garland-Porter D, Eghbalnia C, Grinshpun SA.

USC University of Southern California

DEPARTMENT OF PREVENTIVE MEDICINE

University of Southern California
2001 N Soto Street, M/C 9237
Los Angeles, CA 90089-9237
Tel: (323) 442-1096
Fax: (323) 442-3272

4. J Sch Nurs. 2014 Apr;30(2):88-96. doi: 10.1177/1059840513496429. Epub 2013 Jul 13. **Reducing children's exposure to school bus diesel exhaust in one school district in North Carolina.** Mazer ME[1], Vann JC, Lamanna BF, Davison J.
5. J Health Econ. 2011 Sep;30(5):987-99. doi: 10.1016/j.jhealeco.2011.05.017. Epub 2011 Jun 21. **School buses, diesel emissions, and respiratory health.** Beatty TK[1], Shimshack JP.
6. Atmos Environ (1994). 2011 Mar 1;45(7):1444-1453. **Aerosol particles generated by diesel-powered school buses at urban schools as a source of children's exposure.** Hochstetler HA[1], Yermakov M[1], Reponen T[1], Ryan PH[1], Grinshpun SA[1].
7. J Environ Monit. 2009 May;11(5):1037-42. doi: 10.1039/b819458k. Epub 2009 Feb 27. **School bus pollution and changes in the air quality at schools: a case study.** Li C[1], Nguyen Q, Ryan PH, Lemasters GK, Spitz H, Lobaugh M, Glover S, Grinshpun SA.
8. Atmos Environ (1994). 2008 Oct;42(33):7590-7599. **Predicting Airborne Particle Levels Aboard Washington State School Buses.** Adar SD[1], Davey M, Sullivan JR, Compher M, Szpiro A, Liu LJ.
9. J Air Waste Manag Assoc. 2005 Oct;55(10):1418-30. **Relative importance of school bus-related microenvironments to children's pollutant exposure.** Behrentz E[1], Sabin LD, Winer AM, Fitz DR, Pankratz DV, Colome SD, Fruin SA.
10. J Expo Anal Environ Epidemiol. 2005 Sep;15(5):377-87.**Characterizing the range of children's air pollutant exposure during school bus commutes.** Sabin LD[1], Behrentz E, Winer AM, Jeong S, Fitz DR, Pankratz DV, Colome SD, Fruin SA.
11. J Expo Sci Environ Epidemiol. 2014 Jul;24(4):372-9. doi: 10.1038/jes.2014.15. Epub 2014 Mar 12. **Association between traffic-related air pollution and development of asthma in school children: cohort study in Japan.** Yamazaki S[1], Shima M[2], Nakadate T[3], Ohara T[4], Omori T[5], Ono M[6], Sato T[7], Nitta H[6].

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 Zero-Emission Bus Pilot Commercial Deployment Project as described in the April 4, 2016 Discussion Document

Comment Submitted by the Clinton Global Initiative Vehicle-to-Grid EV School Bus Commitment Team May 13, 2016

The Clinton Global Initiative Vehicle-to-Grid EV School Bus Commitment Team supports CARB's investment plan to accelerate the commercialization of ZEV trucks and buses. The primary focus of the CGI Commitment is to achieve a commercially viable ZEV school bus that can be economically competitive with fossil fuel school buses in California and the other 49 states and DC. The goal of the CGI commitment is to also achieve this result without relying on governmental subsidies in order to assist in making the ZEV school bus economically competitive with traditional school buses.

While we fully appreciate CARB allotting $42 million toward the "Zero-Emission Bus Pilot Commercial Deployment Project" for FY 2016-17, we believe further refinements need to be made to this allocation. Within the $42M we believe a further allocation should be made between transit and shuttle buses and school buses. This will remove the unintended but unfavorable consequences of grouping school buses with transit buses in a single funding category. We recommend that CARB allocate $21M of the $42M specifically to fund ZE school bus demonstration projects and that CARB fund at least one school bus demonstration program that contains a significant "vehicle-to-grid (V2G)" component.

Our primary reason for proposing funding for school buses that is distinct from that of transit buses rests on the fact that the bus types are distinct in their health impacts and in their conventional funding mechanisms. In the 2014-15 Zero-Emission Truck & Bus solicitation, fully one quarter of a project's score is based on these scoring criteria:

- Emissions reduction benefits: 10 percent
- Cost effectiveness: 5 percent
- Budget and match funding: 10 percent

It is close to inevitable that school bus projects will receive lower scores than transit buses on each of these criteria.

In the case of the first two, lower scores are driven by the fact that transit buses normally cover three times the distance per year as school buses, with generally lower fuel economy.[1] Converting a transit bus to zero-emission technology therefore reduces the mass of emitted criteria pollutants much more than conversion of a school bus, and the cost-effectiveness of the investment in ZE technology will be correspondingly higher.

The systematically higher scores that accrue to transit buses are technically correct but do not go far enough toward the ultimate goal of enhancing the health and welfare of the people of California. On the contrary, this goal would be better served by recognizing that not all emitted pollutants have equal

[1] U.S Department of Energy Alternative Fuels Data Center. http://www.afdc.energy.gov/data/10309

impacts. Gram for gram, pollutants emitted by diesel school buses have more serious impacts than those of transit buses. This is because these pollutants tend to become concentrated in the interiors of school buses and to be inhaled by a population whose maturing lungs are particularly susceptible to the insults inflicted by the pollutants.

This effect has been studied and documented for the last 15 years, including by scientists commissioned by CARB itself.[2] Concern spawned by these studies has led to efforts in California to replace conventional diesel buses with a variety of alternatives including "clean-diesel" measures such as direct oxidation catalysts (DOCs), and alternative fuels including compressed natural gas, propane, and gasoline. Given the broad penetration of at least the clean-diesel measures, it was reasonable to hope that the problem of compromised health for school bus riders would be on its way out.

Unfortunately, the results in this regard are less favorable than one might hope. A landmark study on the impact of pollution-reduction measures in school buses was published last year in the American Journal of Respiratory and Critical Care Medicine. It showed that the most widely adopted clean-diesel measures have reduced fine and ultra-fine particulate matter on buses by as little as 10 percent (for the impact of ultra-low-sulfur diesel fuel on the concentration of PM 2.5) and as much as 42 percent (for the impact of diesel oxidation catalysts on the concentration of ultra-fine particles). From the "glass half-full" perspective, the authors conclude that these reductions have led to a decrease in the rate of pupil absenteeism of about eight percent. From the "glass half-empty" perspective, the study showed that clean-diesel measures generally failed to bring on-board pollutant concentrations down to even those levels present on the sides of busy roads. These outcomes were no doubt behind the decision of the American Journal of Respiratory and Critical Care Medicine to publish an editorial calling attention to the importance of the problem of air pollution on board school buses. The editorial opens as follows:

> For more than a decade, elevated air pollution levels inside school buses have been recognized as an insidious hazard that may affect the health of 25 million U.S. children who commute to school in diesel powered school buses each day. Concentrations of traffic-related air pollutants (TRAP) reported inside school buses are up to several-fold higher than ambient background levels. What are the health effects of these short-term, but relatively intense, exposures to children? This question is amplified by concerns that children are likely to be especially susceptible to the health effects of air pollution. Emissions from diesel engines are a major source of the complex mixtures of fine and ultrafine particulate and gas-phase compounds that make up TRAP. In numerous studies, TRAP has been associated with a growing list of acute and chronic adverse health effects. Of particular importance to children is the established association between short-term exposure to TRAP and exacerbation of asthma, as well as emerging evidence linking long-term exposures to reduced lung growth, incident asthma, obesity, and neurocognitive deficits. [3]

The editorial concludes with these words: "Efforts to clean up diesel engine emissions from school buses are likely to have tremendous societal benefits." [4] The editorial shines a light on the fact that the societal impact of a microgram of PM 2.5 is more severe when that microgram is present on board a school bus than in almost any

---

[2] "Characterizing the Range of Children's Pollutant Exposure during School Bus Commutes", Final Report. Prepared for the California Air Resources Board, Contract No. 00-322. Principal Investigator Dennis R. Fitz, College of Engineering, Center for Environmental Research and Technology, University of California Riverside. October 10, 2003.

[3] S. D. Adar et al. "Adopting Clean Fuels and Technologies on School Buses". American Journal of Respiratory and Critical Care Medicine. Vol. 191, no. 12, June 15, 2015. Pp. 1413-1421.

[4] Op. cit. American Journal of Respiratory and Critical Care Medicine. Pp. 1350-1351.

other setting. From this it follows that using the same yardstick to measure the cost-effectiveness of an investment in cleaner air for school buses and for transit buses is unlikely to maximize the actual societal health benefit generated by the invested dollars.

The perverseness of the situation is sharpened when the resources available for pollution-reduction are compared between transit buses and school buses. Reduced-emission transit buses are supported by a variety of public-sector programs, led by but not limited to the Low or No Emission Vehicle Deployment Program sponsored by the Federal Transportation Administration. In 2016, this program features a national budget of $211 million. The program covers up to 80 percent of the cost of low- and no-emission buses. By contrast, with the exception of the Lower-Emission School Bus programs sponsored by certain California air districts, there are no subsidy programs of any kind for school buses.

Using a one-size-fits-all yardstick to judge the richness of match funding contributions under such disparity will obviously lead to systematic exclusion of the vehicle type whose funding environment is relatively impoverished.

The disparity in these criteria between transit buses and school buses is so extreme that a scoring dynamic is likely wherein a relatively weak transit bus application can rank higher than a strong school bus application. Under this circumstance, school buses will remain an orphaned class of vehicle, and opportunities that exist today to move zero-emission school buses to mainstream, subsidy-free commercialization will go untapped.

This is the main argument for creating a separate funding category for school buses. Four other arguments also apply:

1) One of CARB's goals for this program is to achieve commercialization of ZEVs. ZEV school buses are much closer to full commercialization (i.e., a competitive price with little or no public sector subsidy) than transit buses. This stems from several variables, but mainly center around the unique usage patterns of school buses and their ability to participate in revenue generating programs through V2G operations. Our studies indicate that combining the reduced operating and maintenance costs of ZEV school buses with V2G revenues will allow a commercially viable ZEV school bus to be introduced in the mid-term in all 50 states with minimal or no public subsidies. By dedicating a specific set of funds to ZEV school buses, CARB can accelerate this goal and thereby free up future public subsidies for transit buses and other less economically competitive vehicles. A specific ZEV school bus investment now will pay significant dividends to all ZEV vehicles in the future and enable CARB to reach its ZEV goals.
2) Opinions vary on how soon, but most experts agree that vehicle-grid integration (VGI) will be an important phenomenon at the intersection of two key economic sectors: energy and transportation. Navigant Research projects that North American plug-in electric vehicle sales will reach a million units per year in the early 2020s, with a small (7%) but growing percentage of those vehicles being placed "in VGI service".[5] [6] VGI can thus be seen as a major opportunity for economic development for trail-blazing jurisdictions that pioneer relevant technologies. California is arguably in the best position to capitalize on this

[5] Navigant Research. "Electric Vehicle Geographic Forecasts Plug-In Electric Vehicle Sales Forecasts for North America by State/Province, Metropolitan Area, City, and Selected Utility Service Territory". 2Q 2015.
[6] Navigant Research. "Vehicle Grid Integration VGI Applications for Demand Response, Frequency Regulation, Microgrids, Virtual Power Plants, and Renewable Energy Integration". 1Q 2015.

opportunity. The state currently has a small number of V2G projects including the U.S. Department of Defense V2G project at Los Angeles Air Force Base (LAAFB)[7] and the CGI V2G school bus demonstration; a collection of active research institutions including Lawrence Berkeley National Laboratory, the Electric Power Research Institute, and the University of California San Diego; policy leadership from the Governor's Office, California Energy Commission, Public Utilities Commission (PUC), and the California Independent System Operator (CAISO); participation from the state's investor-owned utilities; and technology development programs at a variety of vehicle, component, and systems producers. Other regions have their own webs of VGI activity, however, including the Mid-Atlantic in the U.S. and Germany. It is important, therefore, for California's political and business leaders to encourage and support efforts that can establish the state as the unequivocal global leader in VGI hardware, software, and services. The time is ripe for a major next-generation vehicle deployment project to build on the success of the LAAFB and V2G school bus efforts. Creating a dedicated fund for ZEV school buses would be one way to lay the foundation for such a project.

3) By supporting ZEV V2G school buses with a dedicated funding amount, CARB will make a great step forward toward its ZEV deployment goals. Currently there are 24,000 school buses operating in the state of California. Through a strategic investment in ZEV V2G school buses, CARB could assist with moving over 2/3 of these to ZEV within 10 years, thereby placing a significant number of ZEVs on California roads with little or no public sector subsidy.
4) As California moves toward its 2030 goal of deriving 50% of its electricity from renewable resources, it is clear that a massive investment in energy storage resources will be needed. The PUC, CAISO, and California-based utilities all recognize and are mobilizing around this fact. Given that the cost of energy storage will be borne by the state's electric rate-payers, it is essential to prioritize the most cost-effective investments. High on this list are dual-use assets such as vehicle batteries that can both power propulsion systems when vehicles are in motion and support the grid when they are parked. Due to their usage pattern (they sit idle up to 85% of the hours of a year), school buses with ZEV V2G technology have the very best investment case of any vehicle type. By supporting ZEV V2G school bus technology, CARB can also assist the state of California in managing its day-to-day energy load and use of energy resources.

Based on these reason, the CGI ZEV V2G School Bus Commitment team, strongly encourages CARB to allocate $21M of the FY16-17 funds to ZEV school bus programs and that CARB commit to funding no less than one ZEV V2G school bus demonstration program.

[7] See, for example, "Air Force Nails Biggest V2G Fleet in the World". Clean Technica. November 24, 2014. http://cleantechnica.com/2014/11/24/keystone-schmeystone-part-ii-air-force-nails-biggest-v2g-fleet-world/