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Clerk of the Board  
California Air Resources Board  
1001 I Street  
Sacramento, CA 95814

January 23, 2012

**Re: 2012 AMENDMENTS TO THE CALIFORNIA ZERO EMISSION VEHICLE (ZEV) REGULATION,  
AND THE "LEV III" ADVANCED CLEAN CARS REGULATION - Being Considered January 26, 2012**

Dear Chairman Nichols and Members of the Air Resources Board:

I am writing to express my strong support for the proposed amendments to the Zero Emission Vehicle (ZEV) regulation and the LEV III Advanced Clean Cars regulations being considered at the Board's January 26, 2012 hearing. I urge you to approve the strongest possible amendments to expedite the production and adoption of zero emission (and very low emission) vehicles in California. I urge you to continue to strengthen California's vital work in advancing ZEV and Transitional ZEV (TZEV) technology, in the most expedited possible timeframes.

I am a Professor of biology and ecology at California State University Sacramento, and have conducted research in various areas of marine and terrestrial biology and ecology. I am also a highly satisfied owner of an all-electric 2011 Nissan LEAF car. I have driven 3,500 miles in my LEAF since last May, and I find it to be the best car I have ever owned, in performance, safety, comfort, driving costs, negligible maintenance, low carbon footprint, and zero tailpipe emissions. The Nissan LEAF is a "real" car, and an excellent one. I have even made extended trips (over 200 miles round trip at highway speeds) from Sacramento to the coast using the LEAF, by using charging infrastructure that currently exists. As a frequent bicycle commuter, I strongly value the growth in zero emission vehicles as a vital improvement to local air quality and health. In my professional evaluations of our planet's ecosystems, I am very concerned about the role that combustion-based transportation (including fuel production) has as one of the single biggest impacts on our environment. In my role as an educator, I am committed to educating students and the public about the importance of cleaner transportation choices to a sustainable future.

In order to provide quality information to people and help dispel unfounded myths and criticism of electric vehicles (such as on internet blogs), I have prepared an informal, 2-page summary of key findings and analysis of some of the major benefits of electric cars. My hope is that this may serve as a useful tool in discussions. I have attached this summary here. I would like to highlight these points:

- Climate change is unfolding and poses unprecedented risks to our ecosystems and societal well-being.
- Contrary to some bloggers' claims, battery electric vehicles do provide a significant emission reduction compared with conventional cars, even when the electricity to recharge the electric vehicle comes from the U.S. grid mix of fuels -- using an electric car will result in a 47-100% reduction in CO2 emissions compared to a conventional car. The comparison is favorable even when using most-conservative assumptions for worst-case power-generation fuel sources (e.g., the analysis considers grid mixes of 100% coal, 100% fuel oil, and of 75% coal and 25% natural gas). Electric cars make good sense in ALL states. Plug-in hybrids with 40-mile electric range also compare well. In California -- where the grid mix is cleaner than the U.S. average and

growing in the use of renewables – electric cars have the potential to move toward an almost-negligible carbon footprint in their driving operation.

- Zero emission vehicles have many accompanying benefits:
  - o reduced smog-forming criteria air pollutants and toxic air pollutants;
  - o reduced ocean and other water pollution: consider that there are an estimated 171 million gallons annually of oil spills from petroleum industry/consumption sources worldwide;
  - o Avoidance of the many hidden costs of our dependence on foreign oil, such as these estimates by the Rocky Mountain Institute:
    - \$2.95/gal gasoline cost to the U.S. economy due to price volatility;
    - \$5.67/gal indirect cost to U.S. taxpayers for military protection of oil interests;
    - \$1.5 trillion per year (12% of our GDP) for U.S. military expenditures in the

Persian Gulf and various estimates of trade deficit impacts, such as an estimated \$500 million per day increase in national debt due to oil interests alone, and the national security concerns linked to terrorism, considering that 80-95% of Middle East countries' export revenues come from oil (making up 40-50% of their GDP).

I appreciate and applaud the Air Resources Board's strong leadership in expanding zero (and near zero) emission vehicle technology. I urge you to adopt the proposed amendments, with the strongest possible provisions and timing, for both the ZEV and the LEV III advanced clean car regulations.

Sincerely,

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Professor of Biological Sciences, CSUS  
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In order to provide quality information to people and help dispel unfounded myths and rumors of electric vehicles (such as an internet "hoax" I have reported in informal 3-page summaries of my findings and analysis of some of the major benefits of electric cars. My hope is that this may serve as a useful tool in discussions. I have attached this summary here. I would like to highlight these points:

- Climate change is undebatable and poses unprecedented risks to our ecosystems and societal well-being.
- Contrary to some bloggers' claims, battery electric vehicles do provide a significant emission reduction compared with conventional cars, even when the electricity to run the electric vehicle comes from the U.S. grid mix of fuels -- using an electric car will result in a 43-51% reduction in CO2 emissions compared to a conventional car. The comparison is in terms of even when using most-conservative assumptions for worst case power-generation fuel sources (e.g. the analysis considers grid mixes of 300% coal, 200% fuel oil, and 0% natural gas). Electric cars are good news in ALL states. Plug-in hybrids with 40-mile electric range also compare well. In California -- where the grid mix is cleaner than the U.S. average and

## Electric Cars Can Reduce Global Warming, Air and Water Pollution, Trade Deficit, Terrorism



### Global Warming:

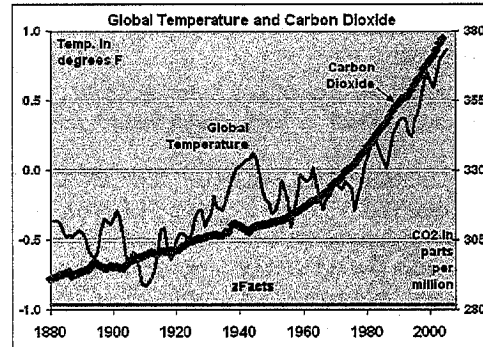
~1.4 degree F increase over last 100 years;  
 ~2 - 11.5 degree F increase over next century (IPPC, 2007).

### Consequences:

- Climate change
- Sea Ice and Polar Ice Cap Melting
- Sea-level Rise, Coastal Flooding
- Extreme Weather Events
- Reduced Ocean Productivity
- Species Extinctions
- Massive Economic and International Security Costs

### Primary Cause

CO<sub>2</sub> increase: 280-380 ppm over last century,  
 23% increase attributable to transportation (IEA, 2009),  
 33% of U.S. greenhouse gasses from transportation (EPA, 2011).  
 Annually Americans burn 138.6 billion gallons of gasoline producing 1.4 billion tons of CO<sub>2</sub> (Sierra Club, 2010).



Energy Footprints:	Energy Source	Footprint (Amount CO <sub>2</sub> released; EIA, 2010)
Conventional Car:	1 gallon gasoline	19.4 lbs directly by combustion 6.0 lbs indirectly by energy used in refining*
Battery Electric Vehicle (BEV):	<u>Electricity in kilowatt hours (kWh)</u> <u>Used to Charge Electric Vehicle - If Derived from Different Fuels</u>	
	1 kWh from fuel oil	2.0 lbs
	1 kWh from coal	2.1 lbs
	1 kWh from natural gas	1.3 lbs
	1 kWh from renewable	0 lbs

\*Refining one gallon of gasoline requires 3 (range 3-12) kWh equivalent of electricity.  
 Determining the CO<sub>2</sub> footprint of this depends on source of electricity, fuel oil assumed here.  
 Assumes 4 miles/kWh for Battery Electric Vehicle (typical for Nissan LEAF)

Factoids: BEV can travel 12 (12 - 48) miles on the energy used to refine a single gallon of gasoline.  
 Oil refining is the greatest consumer of electricity in CA's manufacturing sector.

**Electric cars reduce transport CO<sub>2</sub> emissions from 47% to 100% depending on source of electricity.\***

### DOE Well-to-Wheel Analysis for Vehicles (for U.S. Grid Mix)\*\*

Vehicle Type	CO <sub>2</sub> g/mi	CO <sub>2</sub> lbs per 100 mi driving	Fraction EV CO <sub>2</sub> vs. Gasoline ICE CO <sub>2</sub>	DOE assumptions**
Conventional Car 25 mpg	450	99	1.00	25 mpg
Future Conventional Car 34 mpg (DOE Range)	340 (320-360)	74.8 (70.4-79.2)	0.76 (0.71-0.8)	34 mpg
Plug-in Hybrid (40 mi electric range) (DOE Range)	270 (180-280)	59.4 (39.6-61.6)	0.60 (0.40-0.62)	
Electric BEV - U.S. Grid Mix (DOE Range)	230 (110-240)	50.6 (24.2-52.8)	0.51 (0.24-0.53)	102 mpg equiv
Electric BEV - Ultra-Low CO <sub>2</sub> /Renewable	0	0	0.00	102 mpg equiv

\*\* Department of Energy (Title: Well-to-Wheels Greenhouse Gas Emissions and Petroleum Use for Mid-Size Light-Duty Vehicles; Originator: Tien Nguyen & Jake Ward; Oct 5, 2010). EIA's 2009 Reference Case for U.S. Grid Mix: 47.8% coal, 18.4% natural gas, 21.8% nuclear, 1% fuel oil, 10.2% renewables including hydropower - from EIA Annual Energy Outlook 2011.

## Conservative Comparison Based on Individual Fuel Type (for 100 miles and 100,000 miles of driving):

Vehicle	Energy Source	100mile CO <sub>2</sub>	100,000mi CO <sub>2</sub>	Reduction	Cost***
Conventional 25 mpg	Gasoline	101.6 lbs	50.8 tons	----	\$16,000
Battery Electric (BEV)	Coal	52.5 lbs	26.3 tons	48%	
"	Fuel Oil	50.0 lbs	25.0 tons	51%	
"	75%Coal/25% NG	47.5 lbs	23.8 tons	53%	
"	Renewable	0 lbs	zero!	100%	\$ 2,000
				Savings =	\$14,000

\*\*\*Cost to owner based on \$4.00/gallon gas; \$0.08 per kWh electricity; 100,000 miles of driving; 4 miles/kWh BEV.

### **Air Pollution**

Transportation is the largest single source of air pollution in the United States. It causes over half of the carbon monoxide, over a third of the nitrogen oxides, and almost a quarter of the hydrocarbons. (EPA)

**Particulate matter (PM)** Penetrates deep into lungs.

**Hydrocarbons (HC)** Produces ground-level ozone which irritates the respiratory system, causing coughing, choking, and reduced lung capacity.

**Nitrogen oxides (NOx)** Causes lung irritation and weaken the body's defenses against respiratory infections such as pneumonia and influenza.

**Carbon monoxide (CO)** Blocks transport of oxygen to the brain, heart, and other vital organs in the body especially in fetuses, newborn children, and people with chronic illnesses.

**Sulfur dioxide (SO<sub>2</sub>)** Produced especially by burning diesel. Sulfur dioxide can react in the atmosphere to form fine particles and poses the largest health risk to young children and asthmatics.

**Hazardous air pollutants (toxics)** e.g., Benzene, acetaldehyde, and 1,3-butadiene, etc - account for half of all cancers caused by air pollution.

\$180 billion annually - hidden health costs related to these pollutants (RMI 2011).

### **Water Pollution - Oil Spills**

**171 million gallons** - annual spills from petroleum industry/consumption sources worldwide (NRC, 2002)

**210 million gallons** - amount spilled in Deepwater Horizon disaster April-July 2010

### **Economics**

#### Direct

\$0.35 - 0.72/gallon gas (\$15-\$30 /bbl) Federal subsidy for oil and gas (CSM, 2011)

\$2100-\$4300 federal fuel subsidy for 25 mpg car for 150,000 mi (\$3500-\$7200 for a 15 mpg car, 150,000 mi)

#### Hidden

\$2.95/gallon gas (\$40/bbl) Cost to U.S. economy of price volatility (RMI 2011)

\$5.67/gallon gas (\$77/bbl) Indirect Cost to U.S. Taxpayers for military protecting oil interests (RMI)

\$1.5 trillion dollars per year (12% GDP) - U.S. military expenditures in Persian Gulf (RMI 2011)

\$500 million per day increase in national debt due to oil interests alone (Sierra Club Fact Sheet)

### **Terrorism**

80 to 95% of Middle East countries' export revenues come from oil making up 40-50% of their GDP.

America's best weapon against terrorism is to decrease its dependency on foreign oil by increasing its fuel efficiency and introducing next-generation fuels (Data for Iran and Saudi Arabia, IAGS, 2003).

#### SOURCES

CSM - Christian Science Monitor (March 9, 2011 based on Earth Track 2007)

DOE - U.S. Department of Energy (Well-to-Wheels Greenhouse Gas Emissions and Petroleum Use for Mid-Size Light-Duty Vehicles;

T Nguyen & J Ward; Oct 5, 2010)

EIA - U.S. Energy Information Administration

(Carbon Dioxide Emissions from the Generation of Electric Power in the United States, July 2000; EIA Annual Energy Outlook 2011)

EPA - U.S. Environmental Protection Agency (<http://www.epa.gov/olimatechange/fq/emissions.html>)

IAGS - Institute for the Analysis of Global Security (<http://www.iags.org/fuelingterror.html>)

IEA - International Energy Agency (CO<sub>2</sub> Emissions from Fuel Combustion Highlights, 2011)

IPPC - Intergovernmental Panel on Climate Change

NRC - National Research Council (National Academy of Sciences)

RMI - Rocky Mountain Institute (Reinventing Fire, 2011)

Sierra Club - Electric Vehicle Fact Sheet