SHORTENING THE PATH TO ENERGY INDEPENDENCE: A POLICY AGENDA TO COMMERCIALIZE BATTERY-ELECTRIC VEHICLES

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I. INTRODUCTION

Battery electric vehicles ("BEVs")—highway vehicles primarily powered by electricity stored in a battery—present the best near term solution to reduce America's dependence on petroleum and to curb carbon dioxide ("CO_2") emissions, the primary pollutant contributing to climate change. Our nation's almost total dependence on petroleum to power our cars and trucks is dragging-down our economy, entangling our military in foreign conflicts, and saddling our children with an ecological disaster.

Only ten years ago, the technical consensus was that BEVs suffered from an "insurmountable handicap" because their lead acid and nickel metal-hydride batteries were prohibitively expensive, had limited calendar and cycle lives, required replacement during vehicle lifetime, and could not be recharged in less than 12 hours.[1] Then, BEVs were regarded as little more than a quixotic dream of the environmental community.

Now, new lithium-ion ("LI-ion") batteries are changing the game. The batteries are more powerful, lighter and longer-lived than their lead-acid and nickel metal-hydride predecessors. In fact, the technology has come so far that BEVs are approaching the performance of internal combustion ("IC") vehicles with the introduction of fast charge technology that enables ten-minute battery recharging.

A shift to BEVs would have a profound impact on our petroleum dependency and mobile source air pollution. BEVs have a petroleum-equivalent fuel economy of between 200 and 300 miles per gallon,[2] *roughly five to seven times the fuel economy of a Toyota Prius, the most fuel-efficient gasoline vehicle on the road today.*[3] Gasoline consumption would drop by up to 6.5 MMB per day (52% of total petroleum imports). CO_2 emissions would be cut by 47% (based on the national average CO_2 output rate for electricity generation)[4] and smog emissions by 90%. CO_2 emissions are directly linked to fuel consumption because CO_2 is the ultimate end-product of burning gasoline. The more fuel a vehicle burns, the more CO_2 it emits. Since the CO_2 emissions are essentially constant per gallon of fuel combusted, the amount of fuel consumption per mile is directly related to the amount of CO_2 emissions per mile. Also, by completely shifting pollution from hundreds of millions of small sources to a few thousand central electrical generation plants, air quality in urban areas would improve dramatically. The cost-effectiveness of emission-reduction and carbon-sequestration technologies also would be much better if they are installed at central power plants rather than in motor vehicles. Costs can be spread over forty or fifty year operating lives and billions of kilowatt hours rather than over ten or fifteen years and 150,000 to 200,000 miles. Also, as CO_2 emissions from central electricity generation are reduced over time with increasing penetration of renewable energy and other CO_2 controls, BEVs will become even cleaner. Finally, because electricity is heavily regulated by federal and state energy commissions its price is far more stable than petroleum which is unregulated and subject to speculative trading, price gouging, and other predatory practices.

Notwithstanding their promise, without aggressive government policies, it may be decades before BEVs can meaningfully penetrate the vehicle market. The history of technology adoption in the automotive industry suggests that new technologies take 20 to 30 years to penetrate even 50% of the vehicle population.[5] BEVs are still 25% to 50% more expensive than their IC counterparts. The relatively high cost of Li-ion batteries is the principal reason. Rapid adoption of BEVs is more difficult also because a variety of current federal government policies discriminate against BEVs in relation to other alternative fuel vehicles ("AFVs").

Unfortunately, we do not have the luxury of 20 to 30 years before taking serious action to substantially reduce dependence on petroleum and CO_2 tailpipe emissions. The nation's economy and global climate change impels government intervention to accelerate the uptake of BEVs, the most viable near-term vehicle propulsion technology to eliminate dependence on fossil fuel.

This paper proposes the adoption of six federal policies designed to level the playing field for BEVs with the aim of reducing incremental cost and accelerating the commercialization and deployment of this vital technology. Part II discusses the importance of finding a solution to transportation-related CO_2 emissions in the context of the global climate change problem. Part III provides relevant background information on BEV technology. Part IV discusses the market barriers that must be overcome. Part V describes six specific changes in federal policy to lower incremental cost and accelerate the commercialization of BEVs, namely:

1. Award of Lifetime CO_2 Set-Aside Allowances in the Cap & Trade Program
2. Creation of a Battery Guarantee Program
3. Inclusion of Electricity In the Clean Air Act ("CAA") Renewable Fuels Standard
4. Enhanced vehicle tax credits: provide investment tax credits exceeding those for hybrid and alternative fuel vehicles
5. Fueling Infrastructure Tax Credits: Equal Federal Investment Tax Credit Treatment As Alternative Fuel Vehicle Refueling Infrastructure Ethanol, CNG, and Hydrogen
6. A 1.2 MPG CAFE Incentive Credit to Match Ethanol, CNG, and Hydrogen.

II. PETROLEUM USE AND CLIMATE CHANGE

The U.S. transportation sector currently accounts for approximately two-thirds of our petroleum use and roughly one-quarter of our total energy consumption. We are completely dependent on petroleum to fuel our cars and trucks, which emit about one-third of our CO_2, the principal greenhouse gas ("GHG") pollutant contributing to global warming. In some heavily-traveled states, such as in California and New Jersey, cars and light trucks account for nearly one-half of all CO_2 released to the atmosphere. CO_2 emissions from the transportation sector are growing faster than from any other sector. From 1990 to 2005, emissions from cars and trucks grew 25% as total vehicle-miles-traveled ("VMT") are increasing each year an average of 1.9%.

The two primary federal programs regulating OEMs—the Corporate Average Fuel Economy ("CAFE") standards and the CAA Title II mobile source emissions program—rely upon a command and control approach. While these programs have vastly improved tailpipe emissions of criteria pollutants they only marginally have improved fuel economy and will not force the necessary technological changes needed to dramatically improve CO_2 reductions from automobiles and trucks. With VMT increasing roughly 2% per year in the U.S. and IC automobiles propagating rapidly in the developing world a revolutionary improvement in fuel economy and/or CO_2 destruction technology is needed quickly. While conventional pollutants can be reduced in automobile exhaust with sophisticated emission control systems, such as catalytic converters, on-board computers, and oxygen sensors, no viable technology has yet been developed to practically remove CO_2 from vehicles, which is produced directly from the combustion of the fuel itself.

A. CO_2: A Compounding Problem

The unchecked growth in transportation sector CO_2 emissions presents a thorny problem for policy-makers. Because CO_2 resides in the stratosphere for more than 100 years it accumulates over time. For centuries, the CO_2 level was relatively stable at about 270 parts per million ("ppm"). As the combustion of fossil fuels grew, however, the CO_2 level gradually increased so that by 1950 the level reached 320 ppm. By 2007, the CO_2 level reached 380 ppm, the highest level since humans first walked the Earth.[6] Ambient CO_2 levels continue annually to increase on average 2 ppm. Recent evidence suggests that the rate of CO_2 build-up is accelerating with population expansion and economic development that is tied to increased use of energy. Similar to compounding interest on credit card debt, each year of "business-as-usual" adds to our CO_2 deficit reduction burden. If we are to avoid a catastrophic temperature increase of more than 1.9°C—which could melt the Greenland icecap and raise sea level by 23 feet—most scientists say we need to keep the ambient CO_2 level from exceeding 490 ppm.[7] Most scientists also say that stabilization of CO_2 concentrations below the 490 ppm target level will require CO_2 emissions to peak during the period 2000–2015 and then to decline thereafter.[8] We therefore have a very short window of time to bring about a reduction in global emissions if we wish to limit temperature increase to only 1.9°C. The sooner we find alternatives to fossil fuel vehicles the lower the cost to society of meeting the target ambient CO_2 concentration below 490 ppm, since vehicle emissions are the fastest-growing source of CO_2.[9]

B. Surging Transportation Emissions in the Developing World: A Huge Market Opportunity

As incomes rise in India, China and the rest of the developing world through globalization more people are purchasing gasoline-powered automobiles, much as has occurred over the past 100 years in the United

States where 800 in 1,000 people now own an automobile. For the first time in history, automobile ownership is possible for millions of Indian families, where only 12 in 1,000 people now own an automobile. Recently, New Delhi-based Tata Motors (which recently purchased Ford Motor Company's Jaguar and Land Rover units) introduced the world's cheapest automobile, the "Nano," a $2,500 40- horsepower gasoline-powered vehicle.[10] Within just a few decades the automobile fleet in India could approach 864 million cars, 3.5 times the number today in the United States. The same phenomenon is occurring in China. While only 20 in 1,000 Chinese now own an automobile, by 2035 China is expected to surpass the United States in the number of highway vehicles, with the number exceeding 662 million by 2050.[11] The Chinese government reports that on average 1,060 new automobiles per day are being registered in Beijing alone.[12]

The threat of global climate change impels federal government action to help commercialize and export BEVs on a global scale. The prospect of inefficient, petroleum-based transport taking root in the developing world presents an enormous risk and therefore a market opportunity for American technology. Stopping and eventually reversing the huge quantity of CO_2 emitted to the Earth's atmosphere demands that we solve the problem of tailpipe emissions. Preventing an exponential proliferation of low-cost gasoline-powered automobiles in India, China and other rapidly developing nations will help to lower the cost of achieving the 480 ppm target. In so doing, America could ultimately reduce its own costs of emissions reductions under the international climate change treaty to be negotiated by the end of 2009 under the auspices of the United Nations Framework Convention on Climate Change.[13] If we fail to act, billions of tons of CO_2 from new mobile sources in the developing world will be released over the coming decades, overwhelming any reductions achieved here in the U.S.

A near-term opportunity is emerging to commercialize and deploy BEV technology here in America—still the world's largest automobile market—and across the globe.[14] Decisive action by the federal government to create market demand for BEVs will enable America to seize the opportunity. By nurturing a domestic BEV industry, the U.S. can accelerate the deployment of this crucial technology across the globe and restore American automobile technology to a position of leadership. The window of opportunity to launch developing nations on the path of sustainable transportation, however, is closing fast.

C. The National Response (To Date)

In 1997, the United States signed the Kyoto Protocol, a global treaty under which developed countries agreed to binding cuts in their greenhouse gas emissions relative to 1990 levels while developing countries, including India and China, agreed to non-binding measures that permitted continued economic growth. Under the Protocol, the U.S. was to reduce its national emissions from 1990 levels by 7% during the first compliance period from 2008 to 2012. In 2001, however, the U.S. withdrew from the agreement arguing that the binding emissions cuts required under the Protocol would harm the U.S. economy, especially since India and China were unwilling to amend the Protocol to accept binding emission reduction commitments.[15] Upon withdrawal from the Protocol the U.S. no longer was a participant in the global carbon emissions trading program, soon to be the largest commodities market ever created.

The Kyoto Protocol relies upon a market-based approach patterned on EPA's NOx Budget and Acid Rain cap and trade programs. Under the cap and trade approach, emissions of CO_2 from large sources are allocated "allowances"—the right to emit one ton of CO_2–-to cover their emissions over the course of a year. Gradually, the overall cap is reduced so that covered sources must either reduce their emissions to stay within their individual cap or buy allowances from other sources that have over-controlled emissions and therefore have excess emissions to sell. The program also typically allows sources outside of the cap—so called "non-covered sources"—to voluntarily reduce their emissions in a manner that is permanent and enforceable and to sell these "offset" allowances to covered sources. By monetizing the value of a ton of CO_2 avoided the cap and trade approach harnesses the profit motive to ferret-out and secure the least-cost opportunities for CO_2 reductions. One way the Kyoto Protocol does this is to enable developed nations, who are subject to the cap, to sponsor emissions reduction offset projects in developing nations, who are not subject to the cap. This is known as the Kyoto Protocol's Clean Development Mechanism ("CDM"). Because the impact of CO_2 emissions is dispersed evenly across the global, the location of emission reductions is immaterial. A ton of CO_2 avoided in Shanghai is just as valuable to the climate as a ton avoided in Scranton.

Since the United States withdrew from the Kyoto Protocol in 2001, American climate change policy has consisted of a series of voluntary reduction programs sponsored by the EPA (which has sought to block mandatory controls) and a patchwork of regional, state, and local initiatives.[16] In the absence of a mandatory national program the states have stepped to the fore. At last count, twenty-seven states had passed renewable portfolio standards requiring electricity providers to supply an increasing percentage of electricity derived from renewable sources sush as solar, wind, and biomass power.[17] Also, in 2006, the northeastern states formed an interstate compact, the Regional Greenhouse Gas Initiative ("RGGI"), a mandatory regional program that will cap and trade CO_2 emissions from some 758 fossil fuel-fired electrical generation of 25 megawatts or larger.[18] Fossil fuel power plants in New Jersey, New York, Connecticut, Rhode Island, Massachusetts, New Hampshire, Vermont, Maine, Maryland and Delaware will be required to reduce their CO_2 emissions by 10% by 2019. In 2007, the western states of Arizona, California, New Mexico, Oregon, Utah, and Washington, plus the Canadian provinces of Manitoba and British Columbia, followed with their own Western Climate Initiative ("WCI") the goal of which is collectively to reduce GHG emissions by 15% below 2005 levels by 2020.[19]

While state efforts mostly are focused on stationary sources, in April 2007, a coalition of states won the right to force the EPA to regulate GHG emissions from new motor vehicles. The U.S. Supreme Court ruled in the much-anticipated decision, *Massachusetts v. Environmental Protection Agency,*[20] that CO_2 is a "pollutant" within the meaning of the Clean Air Act and that EPA needed a scientific basis to refuse to regulate vehicle tailpipe emissions. Also, by 2006, twelve states had adopted California's Low Emission Vehicle Program ("LEV"), which for the first time sought to impose CO_2 tailpipe standards on cars and light-duty trucks. A number of automobile manufacturers opposed states' adoption of the standards and sued to block implementation of the LEV program.[21] While the manufacturers' challenge failed in the courts, at the end of 2007, the EPA denied California (and the 12 states that had adopted the California program) the right to regulate GHG emissions from mobile sources. The EPA claimed that the LEV standards were unnecessary since the Energy Independence and Security Act of 2007 ("EPAct 2007") increased CAFE standards for light duty vehicles sold in 2020 to 35 miles per gallon (mpg). EPA claimed that the CO_2 reductions achieved by the revised CAFE standards resulted in greater CO_2 reductions than the California standards of 33.8 mpg. Thus, according to the EPA, a separate California CO_2 tailpipe program was unnecessary.

A recent California Air Resources Board analysis of the relative effectiveness of the California GHG LEV program and the revised CAFE standards, however, finds that the California GHG program would eliminate about twice the quantity of CO_2 over the revised CAFE standards by 2020.[22] EPA's rejection of the GHG portion of California's LEV program therefore eliminated the states' principal policy option to reduce GHG emissions from the transportation sector. However, even if CARB's tailpipe standards are eventually adopted, it appears they will not achieve the needed cuts in CO_2 tailpipe emissions to stabilize the climate. Analysis by the Center for Clean Air Policy ("CCAP") finds that the seemingly inalterable growth in VMT will overwhelm the CO_2 reductions associated with the 30% improvement in fuel economy mandated under the revised CAFÉ standards by 2030. CCAP's analysis concludes based on Energy Information Administration forecasts, that driving will increase 60 percent between 2005 and 2030, leading to a 30% increase in CO_2 despite the CAFE improvements and a lowering of the carbon content of fuel. CCAP's analysis predicts that even with CAFE improvements CO_2 emissions will be 12 percent higher than the 2005 level and 40 percent higher than the 1990 level, thereby missing by a wide margin the target for climate stabilization of 15 to 30 percent *below* 1990 levels by 2020.[23] Therefore, while the California standards are more stringent than revised CAFE standards, as discussed above, it appears that VMT would also overwhelm any CO_2 reductions even if the California standards are adopted nationwide.

Most recently, in response to the Supreme Court's April 2007 finding that CO_2 is a pollutant that EPA must regulate under the Clean Air Act if it finds that it threatens public health and welfare, the EPA published an Advanced Notice of Proposed Rulemaking ("ANPR"). The ANPR solicited public comments on various options to regulate CO_2 emissions and essentially defers any decision to the next Presidential Administration.[24]

In the absence of a mandatory federal regulatory program to address CO_2 emissions, the Congress has pursued a number of legislative proposals. The principal climate change bill under consideration is the Lieberman-Warner Climate Security Act ("Lieberman-Warner").[25] The stated purpose of the bill is to create the core of a federal program to reduce U.S. greenhouse gas emissions substantially enough between 2012 and 2050 to avert the catastrophic impacts of global climate change, while preserving economic growth. The bill would create a national CO_2 cap and trade program applicable to specified "covered facilities" responsible collectively for more than 80% of U.S. greenhouse gas emissions including most notably large users of coal, natural gas processing plants, and petroleum refiners. Under the proposed bill covered facilities must annually submit to EPA a sufficient number of emission allowances to account for all of their CO_2 emitted in that year. While loosely patterned on the successful acid rain trading program under Title IV of the federal CAA Amendments of 1990 and the Nitrogen Oxide ("NOx") Budget Trading Program under Title I of the CAA, the Lieberman-Warner bill is vastly more complex. Following is a summary of the vehicle-related provisions of the substitute bill proposed on June 4, 2008 by Senator Boxer, Chairwoman of the Senate Environment and Public Works Committee, which has jurisdiction over the legislation.

1. **Emissions Trading**

   The proposed bill contains extensive provisions designed to reduce costs, including a program for trading CO_2 allowances and a robust "offset allowance" program that encourages non-covered facilities (i.e. facilities not subject to the cap) to generate allowances from greenhouse gas emissions reductions. Anyone can buy, hold, sell, and retire allowances. Covered facilities can satisfy up to 15% of their annual CO_2 cap obligation by purchasing offset allowances. Offset allowances must be certified by EPA based on a determination that offsets are real, verifiable, additional, permanent, and enforceable. "Additional" means the emission reduction or sequestration of CO_2 is incremental to "business-as-usual" as measured by the difference between baseline GHG emissions as compared to such emissions with the offset project.

2. **International Linkage**

   Importantly, the bill links emissions trading with international emissions trading programs and acknowledges that reductions in CO_2 emissions in developing countries serves to reduce the compliance costs for covered entities here in the U.S.[26] A covered facility can import international allowances to satisfy up to 15% of its compliance obligation. "International allowances" are those generated under a foreign greenhouse gas emissions trading market that the EPA certifies as having comparable integrity to the U.S. market, and that exists by virtue of national emissions caps that the EPA finds to be of comparable stringency to the caps established by Lieberman-Warner.

3. **Transportation CO2 Measures**

   The bill attempts to address transportation-related CO_2 emissions through several indirect measures. First, it caps CO_2 emissions from petroleum refiners using an "upstream" approach that requires refiners to purchase a sufficient number of CO_2 emission allowances to cover downstream emissions from the vehicles that burn the fuels.

Second, the bill attempts to promote the early deployment of clean technologies by creating a two year EPA grant program, funded out of the annual appropriations process, to help entities purchase medium- and heavy-duty fuel efficient commercial vehicles. Then, for the years 2012 and 2017, the bill would allocate 0.5 percent of the annual cap (roughly $550 million per year at a $20/ton allowance price) to an EPA program (basically a grant program) that would distribute the allowances to entities purchasing advanced medium- and heavy-duty hybrid commercial vehicles. Light-duty vehicles, which comprise roughly 75% of all highway vehicle CO_2 emissions,[27] are not included in the EPA grant program.

Third, the bill creates a $40 billion grant program to help automobile manufacturers pay for up to 30% of the cost to engineer and to produce "qualifying advanced technology vehicles" and "qualifying components" thereof. These are vehicles powered by electricity, fuel cells, hybrid gasoline or hybrid plug-in gasoline, advanced diesel, or hydrogen that achieve a fuel economy at least 25% better than standard IC vehicles. The fund would be capitalized by the allocation of 1% of annual total cap allowances for the years 2012 to 2050 (roughly $1 billion per year in 2012 at a $20/ton allowance price and declining to $346 million per year by 2050). The manufacturer conversion grant program requires grant recipients to maintain domestic employment levels for 7 years following receipt of the grant.

Fourth, the bill establishes a low-carbon fuel ("LCF") standard that would require transportation fuel providers, namely refiners, blenders and importers of gasoline to reduce the life-cycle carbon content of gasoline by 5% by 2015 and by 10% by 2020. Electric utilities can participate in the LCF program if they provide for and separately track electricity for transportation through a meter that measures the electricity used for transportation separately from electricity used for other purposes and that allows for load management and time-of-use rates.

As is discussed in Part IV, below, Lieberman-Warner's provisions to address CO_2 emissions from vehicles will not produce the necessary market incentives to move manufacturers to mass produce BEVs in the near-term. More will be required.

III. EMERGENCE OF BEV TECHNOLOGY

BEVs present the most viable near term solution to reduce our dependence on fossil fuels and associated CO_2 emissions. Research and development of advanced batteries in recent years has improved battery performance and cost. Advancements in battery technologies have produced a Li-ion battery possessing the requisite durability and energy density to enable vehicle performance approaching that of IC vehicles. The latest generation of batteries are safe, long-lived and powerful—hurdles that until now prevented BEVs from being commercially successful. For example, while General Motor's mid-1990's BEV, the EV1, had a range of 60 miles, three new start-up manufacturers, Phoenix Motorcars, Miles Electric Vehicles, and Tesla Motors are rolling-out BEVs with driving ranges between 100 and 267 miles per charge, depending on driving conditions.[28] GM also will be offering its own BEV in 2010, the Chevrolet Volt, a "series hybrid"[29] BEV with an all-electric range of 40 miles and an extended range of 400 miles using a small internal combustion engine to recharge the batteries. The Volt will have an overall fuel economy of 150 miles-per-gallon.[30]

Li-ion batteries also last longer, a hurdle that prevented lead-acid BEVs from being commercially successful. Testing shows that Li-ion batteries have calendar and cycle lives exceeding the lifetime of other components of the vehicle. For example, after 4000 deep discharge duty cycles (more than 10 years of calendar life) the iron-phosphate chemistry used in A123's Li-ion battery (one of two Li-ion battery chemistries supporting GM's Volt program) still retains almost 90% of its capacity.[31] New nano-structured chemistries, such as iron phosphate and titanate, are also safer, eliminating uncontrolled thermal runaway, a fatal flaw that caused some computer laptop and cell phone batteries to ignite. Finally, the technology is improving continuously. Energy efficiency has improved between 5-10% per year since Li-ion batteries were introduced in 1991, a trend expected to continue.

A. Battery Fast-Charging a Game Changer

A critically important feature of several types of Li-ion batteries on the market today is their capacity to accept high voltage charging without sacrificing cycle or calendar life. This break-through enables "fast-charging" BEVs in 10 to 20 minutes, nearly the same time needed to refill the petroleum tank on an IC vehicle. The ability to accept a "fast charge" effectively extends the range of BEVs, overcoming the perception that BEVs lack the convenience of IC vehicles because of limited range. So-called "range anxiety"—fear of running out of fuel—is seen as a barrier to consumer acceptance of BEVs.[32]

In September 2007, a BEV using an 18 kWh Li-ion battery traveled 186 miles in an urban delivery circuit through Oslo, Norway using a high voltage, 125kW rated rapid charging system developed by California-based AeroVironment, Inc. The battery charger fast-charged the vehicle in less than 10 minutes three separate times during normal break-times throughout the day, thereby enabling a vehicle duty cycle comparable to an IC engine but with no emissions. The ability to recharge BEVs in the time needed to fill the petroleum fuel tank of a conventional IC vehicle enables widespread consumer acceptance of BEVs.

B. Superior Life-Cycle Costs

With far cheaper life-cycle costs BEVs are becoming more competitive with IC vehicles, even ignoring their pollution reduction advantages which are compelling. BEVs have a petroleum-equivalent fuel economy of 200 – 300 miles per gallon—roughly 5 times the fuel economy of even the most fuel-efficient hybrid gasoline-electric vehicles on the road today.[33] To calculate the gasoline fuel economy of BEVs for purposes of the EPA Fuel Economy Guide energy consumption by electric vehicles is reported in terms of kilowatt-hours per 100 miles. Fuel economy of BEVs is measured pursuant to the Department of Energy Petroleum Equivalent Factor analysis which considers the relative efficiency of the electricity production and distribution infrastructure, the energy content of the electricity, and a fuel content factor. For purposes of CAFE, a petroleum-equivalent fuel economy is calculated using a petroleum equivalence factor of 82,049 Watt-hours per gallon. A 35 kWh BEV with a range of 130 miles costs just $5.25 to fuel with electricity. Assuming a retail electricity cost at the high-end of 15 cents kWh, BEVs have a fuel cost of just 4 cents/mile compared to 20 cents/mile for an ICE vehicle fueled with $4.00/gallon gasoline.

Maintenance costs of BEVs also are far cheaper. A typical four-cylinder IC engine has over a hundred moving parts. BEVs have one: the rotor. And, unlike IC vehicles, BEVs need no lubricating oils, filters, coolants, clutches, spark plugs, wires, PCV valves, oxygen sensors, timing belts, fan belts, water pumps and hoses, catalytic converters, or mufflers—all vehicle components requiring regular maintenance, service and repair.

C. Superior Energy and Environmental Benefits

BEVs drastically reduce CO_2 emissions and other criteria air pollutants compared to the cleanest IC vehicles, even when the pollution associated with the power plants generating the electricity for the vehicles is considered. Based on the Argonne National Laboratory's GREET model, which considers the entire fuel lifecycle impacts from fossil fuel extraction or feedstock growth, fuel production, distribution, and combustion, the EPA finds that electric vehicles have a much higher fuel efficiency and therefore a superior lifecycle greenhouse profile than other alternative fuels, even considering that 50% of the nation's electricity is supplied by coal.[34] A shift to electric-drive vehicles would increase fuel economy by 390%, reduce CO_2 emissions by 47%, and reduce smog emissions by 90%.[35] EPA finds that BEVs would reduce CO_2 emissions by 47% based on today's national average CO_2 output from electric generation. This is twice the percentage reduction achieved by corn-based ethanol and LNG and nearly twice the percentage reduction from CNG vehicles. In some areas of the country, where nuclear, natural gas, and renewable energy are a higher percentage of the electricity mix, the CO_2 reductions from BEVs will be even greater. And, as the CO_2 emissions from the grid improve with time under various renewable portfolio standards in 27 states and under the future cap and trade program, the CO_2 impacts from BEV will be even lower. As the electricity portfolio decarbonizes so too will the vehicle population.

Moreover, our nation's existing electricity infrastructure has sufficient available capacity to fuel up to 84% of our nation's cars, pickup trucks, and SUVs (198 million vehicles) for a daily drive of 33 miles per day, the average daily driving distance of Americans. According to the U.S. Department of Energy's National Renewable Energy Laboratory, the large-scale deployment of plug-in hybrid vehicles will have limited, if any, negative impacts on the electric power system in terms of additional generation requirements.[36]

The abundance of electric fueling infrastructure distinguishes BEVs from other alternative fueled vehicles. The conversion of cars and trucks to alternative fuels long has been the policy objective of federal and state governments but these efforts have failed in part because of the great expense to develop alternative fuel infrastructure.[37] Of the millions of ethanol flexible-fueled vehicles on the road today only a tiny fraction actually run on ethanol because ethanol supply infrastructure does not exist in most metropolitan areas. The delivery of ethanol to vehicles requires a whole new infrastructure because ethanol corrodes traditional distribution and storage systems (it is incompatible with most gasoline storage tanks and other ancillary equipment). Similar efforts to convert vehicles to compressed natural gas ("CNG") fuel also have failed because the necessary CNG fueling infrastructure is too expensive. Of the 1,692 propane, or natural gas/gasoline bi-fuel vehicles purchased by the State of New Jersey, for example, 96% never have even used CNG because of a lack of fueling infrastructure.[38]

The challenge of creating a market for all other types of alternative fuel vehicles and a network of fueling stations is too expensive.[39] BEVs, however, require no new fueling infrastructure as most vehicles will be charged overnight in the home. For the comparatively few charged at roadside charging stations the fueling infrastructure costs will be much less than for petroleum, ethanol, or CNG. The electrical grid largely is coextensive with the road network.

D. Benefits to the Grid

Our electric infrastructure has ample capacity to handle BEVs. Studies show that with no additional investment 84% of our cars, pickup trucks, and SUVs—198 million vehicles—could be supplied with electricity to power the average American's 33 mile daily driving range. The Li-ion batteries in today's BEVs also provide 35 or more kWh hours of mobile electric storage capacity, making them available to supply temporary back-up power and electric grid regulation services, referred to as "vehicle-to-grid" ("V2G") service. Even at modest penetration levels BEVs can provide valuable V2G services that can significantly reduce the need to construct additional electrical generation and transmission capacity by increasing the utilization of existing base load electrical generation assets.

Also, BEVs enhance the efficiency and cost-effectiveness of wind energy investments by providing off-peak electric load which coincides with the period of maximum wind energy output (nighttime). The variability in wind output means limited predictability, high natural ramp rates, and limited coincidence with peak demand. These factors restrain meaningful penetration of wind power into traditional electric power systems. According to the National Renewable Energy Laboratory, however, the conversion of 40% of the light-duty vehicle fleet to vehicles having an all-electric battery range of 60 miles (i.e. 17.7 kWh battery packs) would more than double wind energy development while increasing total load by only 7.3% and actually *decreasing* CO_2 emissions from the electrical sector by 1%.[40] This is because most BEVs will be recharged during nighttime hours when wind energy is at its maximum output. Thus, BEVs are a synergistic technology because they significantly enhance the value of wind energy investments.

IV. BARRIERS TO MARKET PENETRATION

Cost is the principal barrier to rapid adoption of BEVs. The vehicles have an incremental cost of $12,000 to $15,000 (about 50% higher than IC vehicles),[41] largely because economies of production scale have not been achieved. Since cost is the primary factor in consumer purchasing decisions this high incremental cost is a major barrier-to-entry.[42] Data on consumer purchasing behavior shows that the fuel and other lifecycle cost savings must exceed the incremental purchase cost within 2.5 years to be attractive to consumers.[43] The pay-back must be relatively immediate or they simply will not pay the higher price. This means that BEVs and other AFVs with incremental costs upwards of $15,000 will not sell without deep below-cost discounts.

It seems clear that rapid market penetration of BEVs will occur only if existing original equipment manufacturers ("OEMs")—which have the mass production capacity and expertise to produce large quantities of BEVs at the lowest-cost in the near term—embrace the new technology. However, OEMs are reluctant to migrate to new technology, particularly when it has the potential to disrupt their core business. The history of technological evolution in the automobile industry suggests that new technologies require 10 to 30 years before they penetrate 50% of the vehicle population.[44] For example, the automatic transmission reached 50% of the U.S. automobile market by 1950 but did not penetrate 90% of the U.S. vehicle fleet until 1970. Even very cost-effective new technologies, such as variable valve timing, took 10 to 15 years to penetrate 50% of the vehicle population.[45]

Virtually all prior efforts to regulate automotive emissions and fuel economy have relied upon command and control approaches to force technology improvements, which consistently met with resistance from the automotive industry. Even as far back as 1955, the four U.S. OEMs agreed to not install smog control equipment without unanimous agreement.[46] This prompted Congress eventually to pass the CAA of 1970, which imposed clear deadlines and technology-forcing mandates on the industry.[47] More recently, the industry blocked California,[48] Vermont,[49] and twelve other states from regulating tailpipe emissions of CO_2—the so-called California LEV Program. In rejecting the manufacturer's challenge to the regulations, the federal court in Vermont detailed the industry's consistent opposition to all prior efforts to force migration to cleaner vehicle technology. Most recently, the industry opposed the National Highway Traffic Safety Administration proposal to increase CAFE standards for model years 2012 to 2015.[50]

Some OEMs may view BEVs as a disruptive technology because they replace IC engines and transmissions, two of the primary business units of the automobile industry.[51] The primary expertise of automobile OEMs is the low-cost design and manufacture of combustion technology and transmissions which they have been producing for over 100 years.[52] Integrated OEMs have entire manufacturing plants dedicated to the production of IC engines and transmissions. However, most OEMs have limited expertise and intellectual property in the key technology components of BEVs, namely electrochemistry and power electronics. Some OEMs therefore may see little profit to be made in migrating to electric power trains. The lower life cycle maintenance costs of BEVs also means that automobile dealerships, which derive substantial profit from maintenance and repair of IC vehicles and wield economic clout, may also oppose migration to the new technology. For these reasons, absent governmental inducements, manufacturers may have little incentive to migrate to this technology.[53]

The Li-ion technology also is relatively unproven for larger-scale applications, such as BEVs. Even small Li-ion batteries used in consumer electronics for over a decade have been the subject of product recalls and/or production shutdowns due to reliability and safety problems, even though they operate in a much more forgiving environment than that experienced by highway vehicles, which are subject to extremes of temperature, moisture, and vibration.[54] This suggests that scaling-up the production of Li-ion cells for larger BEV applications, which involve thinner electrodes, will be a slow and costly proposition. The price of GM's Volt, for example, reportedly is climbing toward $40,000 because the unproven Li-ion battery pack still must be warranted under California's zero emission vehicle program for 10 years/150,000 miles. With the Volts' battery pack expected to cost at least $10,000, GM's warranty exposure will be substantial.[55]

For all of these reasons, if left to the market, the commercialization and widespread deployment of BEVs could take many years. Unfortunately, the world does not have the luxury of many years to make substantial reductions in tailpipe CO_2 emissions. Government policy intervention is vital.

V. MEASURES TO ACCELERATE TECHNOLOGY ADOPTION

A key to accelerating the adoption of BEVs is to reduce their incremental cost by (i) monetizing their lifetime CO_2 reduction benefits, (ii) spreading the risk of technology failure efficiently, and (iii) treating them equally with other alternative fuels in the existing fuel diversification federal policy framework. To help propel the rapid adoption of BEVs the federal government should consider six policy changes that would reduce incremental cost, the most significant barrier-of-entry for this technology.

Policy Change 1: *BEVs Should Receive Set-Aside CO2 Allowances Under Cap & Trade*

The future cap and trade program should make BEVs eligible for a lifetime award of CO_2 emission allowances through an allowance set-aside program within the CO_2 cap and trade system at a bonus ratio of 4:1. The concept of bonus allowances (i.e. allocation of allowances at a ratio greater than one allowance to one ton of CO_2 reduced or sequestered) is consistent with other provisions of Lieberman-Warner in which certain, financially risky activities are regarded as so beneficial that they are allocated bonus allowances to incent early adoption. For example, Subtitle F of Lieberman-Warner, titled "*Bonus allowances for carbon capture and geological sequestration,*" would award carbon sequestration projects 4.5 allowances for every ton of sequestered CO_2 between 2012 and 2017, sliding down to a ratio of 1:1 by the year 2030.[56] According to the Senate Environment and Public Works Chairwoman's Report accompanying the bill, the bonus allowance system for carbon sequestration is necessary to allow for scale issues to be resolved, costs to be reduced, and the groundwork laid for massive deployment of carbon capture and sequestration ("CCS") plants either as new facilities or as retrofits. The lack of market certainty has prevented significant investment in either new pulverized coal or new CCS coal plants. Bonus allowances offer further assurance that CCS is a good investment because it offers early adopters assurance of a stream of allowance value once they commence sequestering CO_2. Modeling by the EPA shows that CCS bonus allowances can speed the deployment of CCS technology by roughly 5 years.[57]

As in the case of CCS coal technology, to meaningfully induce rapid technological innovation to address CO_2 tailpipe emissions, OEMs must have the ability to make a profit within a relatively short time horizon by selling automobiles. However, the incremental cost of this radical new technology, as in the case of CCS, is too high for OEMs to have market certainty that they will be able to sell these vehicles at a profit. Data on consumer purchasing behavior shows clearly that the fuel and other lifecycle cost savings must exceed the incremental purchase cost within 2.5 years to be attractive to consumers.[58] This means that BEVs with incremental costs upwards of $15,000 are unlikely to sell in sufficient numbers to justify OEM investment.

The same approach used to incent CCS could be applied to BEVs through the award of bonus lifetime allowances at a ratio of 4:1. This is a revenue-neutral mechanism to reduce incremental cost by monetizing CO_2 reduction benefits and thereby conferring a direct and meaningful incentive to produce BEVs. A bonus allowance set-aside for BEVs would align OEM profit motives with the public policy goal of reducing tailpipe emissions for the first time in the history of automotive regulation.[59]

Absent a lifetime bonus allowance program for BEVs, Lieberman-Warner is unlikely to create the necessary economic incentives for OEM's to convert to this technology. The bill would rely on a massive grant program to help OEMs convert their manufacturing facilities to produce advanced technology vehicles, an upstream cap on CO_2 emissions from petroleum refiners, and a carbon fuel standard. While these are laudable ideas they will not directly incent OEMs to produce BEVs and therefore will not appreciably accelerate the commercialization of this technology.

The advanced technology conversion grant program is a misplaced incentive because the barrier to mass production of BEVs is not the cost of retooling but rather the uncertainty of the market given the high incremental cost over which OEMs have little control. As previously discussed, the new technology components for BEVs—the battery pack and the electric motor—will not be produced by the OEMs. The batteries and electric motors will be supplied by outside vendors and assembled and integrated by the OEMs at existing assembly lines that will require little retooling. For example, GM's Volt will be assembled at the company's Hamtramck, Michigan plant where 1,847 workers are currently producing the Buick Lucerne and Cadillac DTS. Accordingly, it is questionable whether a massive government grant program to pay OEMs to retool their plants to manufacture BEVs will be a meaningful inducement.

The net result of the "upstream" cap on refinery emissions and the low-carbon fuels standard will be to increase the cost of transportation fuels as refiners will pass along to consumers the cost of purchasing allowances covering consumers' vehicle emissions. By increasing the cost of petroleum fuel, in essence through what is a tax, the upstream cap may prompt consumers to move toward more fuel efficient or even electric vehicles, but only if there is a short pay-back period. OEMs, knowing this fact, may be unwilling to bear this risk.

Making BEVs eligible for lifetime CO_2 bonus allowance set-asides within the CO_2 cap and trade system—at least until economies of production scale are achieved—would create a direct incentive for OEMs to produce BEVs and would reduce incremental cost by monetizing their CO_2 reduction benefits. If the discounted value of the total amount of avoided CO_2 emissions over the lifetime of a BEV could be captured at the point-of-sale and monetized in the form of CO_2 allowances, the incremental cost of BEVs could be reduced and the technology could enter the market more quickly. This could be accomplished by estimating the total tons of CO_2 avoided over the 150,000 mile warranty period of the BEV, with an appropriate discount for uncertainty in the carbon content of the electricity used to fuel the BEV. Using EPA data, a BEV replacing an average gasoline-powered light duty vehicle getting 20 miles per gallon[60] eliminates roughly 35 tons of CO_2 over its 150,000 mile warranty period as compared to an average light-duty IC vehicle, assuming a CO_2 emissions rate of 19.4 pounds/gallon and the national average CO2 content of the electric grid.[61] At a projected allowance price ranging between $22 and $61 per ton in the year 2020 under various future cap and trade scenarios,[62] monetizing the lifetime CO2 reductions of BEVs under a bonus allocation of 4:1 would reduce incremental cost by roughly $3,000 to $8,500.

The lifetime CO_2 reduction benefits could be monetized through a prepaid forward contract approach, whereby a buyer of a commodity stream over time prepays the seller for the entire stream up front. The approach is commonly used in energy markets, such as natural gas volumetric production payment contracts, which enable energy traders to hedge price risk. As applied to BEVs the prepaid forward contract approach would enable the estimated income stream from the CO_2 allowances generated each year over the warranty period of the vehicle to be monetized, discounted to present value, and transferred at the vehicle point-of-sale.

Front-loading the offset allowances at the point of sale would have several benefits. First, it would eliminate the administrative challenge of individual BEV owners having annually to account for and make application for issuance of CO_2 offset allowances generated in the prior year by driving an electric vehicle instead of a gasoline, diesel, or ethanol vehicle. Second, it would monetize the lifetime CO_2 reduction benefits of each BEV, thereby creating greater cost-reduction opportunity than under an annual allocation approach. Finally, a ten year prepaid forward contract for the offset allowances would provide a hedge for the buyer against future increases in CO_2 allowance prices, the cost range of which is highly uncertain.

Neither Lieberman-Warner or RGGI directly include mobile sources in the cap and trade program. However, mobile sources are included in several other cap and trade programs which could serve as a model. The first is found in California's Mobile Source Emission Reduction Program and in Ohio's NOx Budget Trading Program for nitrogen oxides ("NOx"). Under both programs automobile technologies that reduce NOx can generate allowances that can be purchased by stationary sources to satisfy their NOx budgets.[63] Under EPA's NOx Budget Trading Program, Ohio and 21 other states allocate allowances to NOx sources. States may choose also to reserve (i.e., "set-aside") allowances to provide incentives for new sources and/or for certain activities, such as energy efficiency and renewable energy ("EE/RE"). Under the EE/RE Set-Aside, a state awards NOx allowances to eligible EE/RE projects. Awardees can either sell these allowances to help finance their projects or retire the allowances and thereby account for the emissions reductions associated with the project. Ohio issues NOx EE/RE Set-Aside allowances to any project utilizing technology that has not been adequately demonstrated in practice, but that has a substantial likelihood of reducing NOx emissions compared to current practices, including the use of fuel additives that reduce the NOx emissions from automobiles, trucks, buses or off-road vehicles. Thus, in Ohio, reductions of NOx from mobile sources qualify for NOx allowances under the NOx Budget cap and trade program.

The UN Clean Development Mechanism ("CDM") also issues allowances to fleet owners of electric, CNG, liquid petroleum gas fleet trucks and passenger buses deployed in developing countries, like India, China, and Mexico. Interestingly, as previously discussed, Lieberman-Warner will link to the CDM program by allowing covered facilities in the U.S. to satisfy a portion of their compliance obligation by purchasing CO2 allowances issued by the UN.[64] Paradoxically, the exclusion of mobile sources from the cap and trade program under Lieberman-Warner means that covered facilities in the U.S. will be able to satisfy a portion of their cap obligations using allowances purchased from the CDM's BEV fleet program yet they would not be able to buy allowances from domestic BEV fleet projects.

The future cap and trade system should establish a bonus allowance set-aside program for BEVs, until such time that sufficient economies-of-scale are achieved, at which point BEVs no longer would be considered "additional." For example, the RGGI offset rules authorize offsets for projects that reduce or avoid CO2 emissions from natural gas, oil, or propane end use combustion due to end use energy efficiency, but only if the project meets the requirement of "additionality," generally meaning that a measure can not be well-established in the market, required by any other regulatory requirement or funded by grants or other system benefit funding source. Energy efficiency measures are not considered "additional" once they achieve a market penetration of 5%.[65] In the case of BEVs, a cap on the number of units qualifying for allowances could be set at a threshold that is determined based on the anticipated commercialization pathway, for example, 1,000,000 units per OEM.

Policy Change 2*: Li-ion Batteries in BEVs Should Receive Government-Sponsored Warranty Insurance*

The unproven long-term performance of Li-ion batteries used in electric vehicles heightens the importance of a robust vehicle warranty to persuade consumers to embrace the new technology. Warranties are a principal means to overcome the information imbalance regarding product quality between an informed manufacturer and an uninformed customer.[66]

However, the cost of warranting BEVs will be several thousand dollars per unit. Accounting rules require manufacturers who provide product warranties to their customers to record an accrued warranty expense at the time of sale. Accrued warranty expenses are estimated based on company's projections of future claims. These warranty expenses are an important component of a manufacturer's selling expenses and can be substantial. According to one recent analysis, the average warranty expense constitutes about one percent of sales and about eleven percent of operating income.[67]

The ability to spread efficiently the risk attendant to battery failure would reduce the cost of BEVs and accelerate their commercialization. The federal government is uniquely positioned along with the insurance sector to provide financial support to the fledgling BEV industry by backstopping manufacturer warranties to help contain risk and reduce cost. A federal battery guarantee corporation proposed by David Sandalow of the Brookings Institution in his book, *Freedom from Oil*,[68] would help OEMs provide 10-year/150,000 mile battery warranties for the first million BEVs.

A template for the BEV insurance program is the Price-Anderson Act,[69] which served as a catalyst for commercializing nuclear power at time when the technology was unproven and considered risky. Following the Second World War, the federal government sought to privatize nuclear energy electricity production. However, it soon became apparent that profits from nuclear energy were uncertain and the risks were substantial. The federal government offered incentives to encourage private investment but the risk of potentially vast liability in the event of a nuclear accident discouraged investment. The uniqueness of nuclear energy made it impossible to rule out the risk of a major nuclear accident resulting in extensive damage. The potential liability dwarfed the ability of the industry and private insurance companies to absorb the risk.[70] In 1957, Congress responded with the Price-Anderson Act, which required the industry to purchase the maximum available amount of privately underwritten public liability insurance ($60 million in 1957) and provided for the federal government to indemnify the licensee and other "persons indemnified" for amounts above the private insurance coverage, not to exceed $500 million. Since its enactment, Price-Anderson Act has been amended multiple times to extend the program.

The battery guarantee program proposed by Sandalow could be structured in a manner similar to Price-Anderson by spreading the risk of battery-pack failures between OEMs, the private insurance sector, and the federal government. OEMs could pick-up the first layer of risk up to a specified maximum, with the insurance sector picking up the next layer, and the federal battery guarantee corporation picking-up the excess layer.

A possible source of revenue to fund the premiums for the private insurance component are allowance revenues from the vehicles, if authorized under the cap and trade program. The battery warranty insurance premium payments to private insurers could be structured within the prepaid forward contract for the monetized value of the CO2 reductions over the vehicle lifetime. The period of eligibility for allowance set-asides would correspond with the period needed to backstop the battery warranty, estimated to be 10 years.

Policy Change 3: *Renewable Electricity Should Be Included In Renewable Fuels Standard*

BEVs receive no Renewable Fuels Standard ("RFS") credits under Clean Air Act Section 211(o) even when they are charged with renewable electricity such as solar and wind power. The Energy Independence and Security Act of 2007 amended the RFS, signed into law in 2005, by requiring refiners to ramp-up production of ethanol to 36 billion gallons by 2022. The current RFS program, which was developed by EPA in collaboration with petroleum refiners and renewable fuel producers, provides for credit trading between refiners subject to the RFS standard. Certain other fuels that are not even blended into gasoline also qualify for credits, including biodiesel and biogas. However, renewable electricity used to fuel BEVs currently is not included in the RFS.

If electricity generated from renewable energy were included in the RFS renewable energy developers would have an additional revenue stream which would synergistically drive the market for BEVs and renewable energy. As previously discussed, BEVs significantly enhance the penetration rate of wind energy because most BEVs will be recharged during nighttime hours when wind energy is at its maximum output.[71]

Making renewable electricity eligible under the RFS also would provide an alternative compliance option for refiners subject to the mandate, thereby alleviating economic pressure to divert corn crops to the production of ethanol. The diversion of 25-35% of the domestic corn crop to ethanol production is a prime factor in the recent increase in global food prices, prompting twenty three U.S. Senators to ask U.S. EPA to waive the RFS mandate. It is important also to note that E85 and other alcohol-based alternative fuels are not without environmental impacts. Ethanol vehicles emit greater quantities of carcinogenic formaldehyde and acetaldehyde[72] and have higher "well-to-wheels" CO_2 emissions than their IC counterparts, according to recent analysis.[73]

Policy Change 4: *BEVs Should Receive Enhanced Federal Investment Tax Credits Exceeding Those for Hybrid and Alternative Fuel Vehicles Under IRC §30B*

BEVs currently receive no investment tax credit under Section 30B of the Internal Revenue Code ("IRC"), unlike new qualified hybrid light duty motor vehicles and alternative fuel vehicles. IRC Section 30B provides a $3,400 tax credit for new qualified hybrid light duty vehicles but and excludes BEVs by limiting the definition of "new qualified hybrid motor vehicles" to parallel hybrids (i.e. vehicles that draw *propulsion* energy from onboard sources of stored energy which are *both* an internal combustion or heat engine using consumable fuel, and a rechargeable energy storage system). A separate BEV tax credit equaling 10% of the cost of the vehicle up to $4,000 expired at the end of 2007. Making BEVs eligible for enhanced tax credits exceeding those for hybrid vehicles would recognize their vastly superior environmental benefits and would help eliminate their incremental cost.

Policy Change 5*: BEVs Should Receive the Same $30,000 Federal Alternative Fuel Vehicle Refueling Infrastructure Investment Tax Credit §30C as Ethanol, CNG, and Hydrogen*

Investments in BEV charging infrastructure currently receive no investment tax credit under Section 30C of the IRC, unlike fueling infrastructure for ethanol, natural gas, CNG, LNG, liquefied petroleum gas, and hydrogen, all of which receive a credit of up to $30,000. While Section 179 of the IRC allowed a business expense deduction to companies and individuals buying electric vehicle recharging equipment, the deduction expired in 2005. Making BEV charging infrastructure eligible for the same tax credit provided to ethanol, natural gas, CNG, LNG, liquefied petroleum gas, and hydrogen infrastructure under §30C would facilitate investment in fast-charging infrastructure, a catalyst for consumer acceptance.

Policy Change 6: *BEVs Should Receive the Same 1.2 MPG CAFE Incentive Credit as Other Alternative Fuel Vehicles*

BEVs receive no alternative fuel credits under the federal government's CAFE regulations, which provide vehicle manufacturers with extra credit toward their CAFE mandate of up to 1.2 mpg for AFVs. This is why "flex fuel" vehicles capable of running on E85 (85% ethanol) fuel are produced in large volumes by American manufacturers despite the fact that there is no ethanol infrastructure and less than 1% of flex fuel vehicle owners actually use E85 fuel . Because BEVs presently do not qualify for alternative fuel credits under the CAFE regulations, OEMs have little incentive under the CAFE regulations to produce them. If BEVs were included in the CAFÉ alternative fuel program, and credits could be traded between manufacturers, fledgling BEV manufacturers could sell their CAFE credits to large OEMs, thereby reducing barriers-to-entry.

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