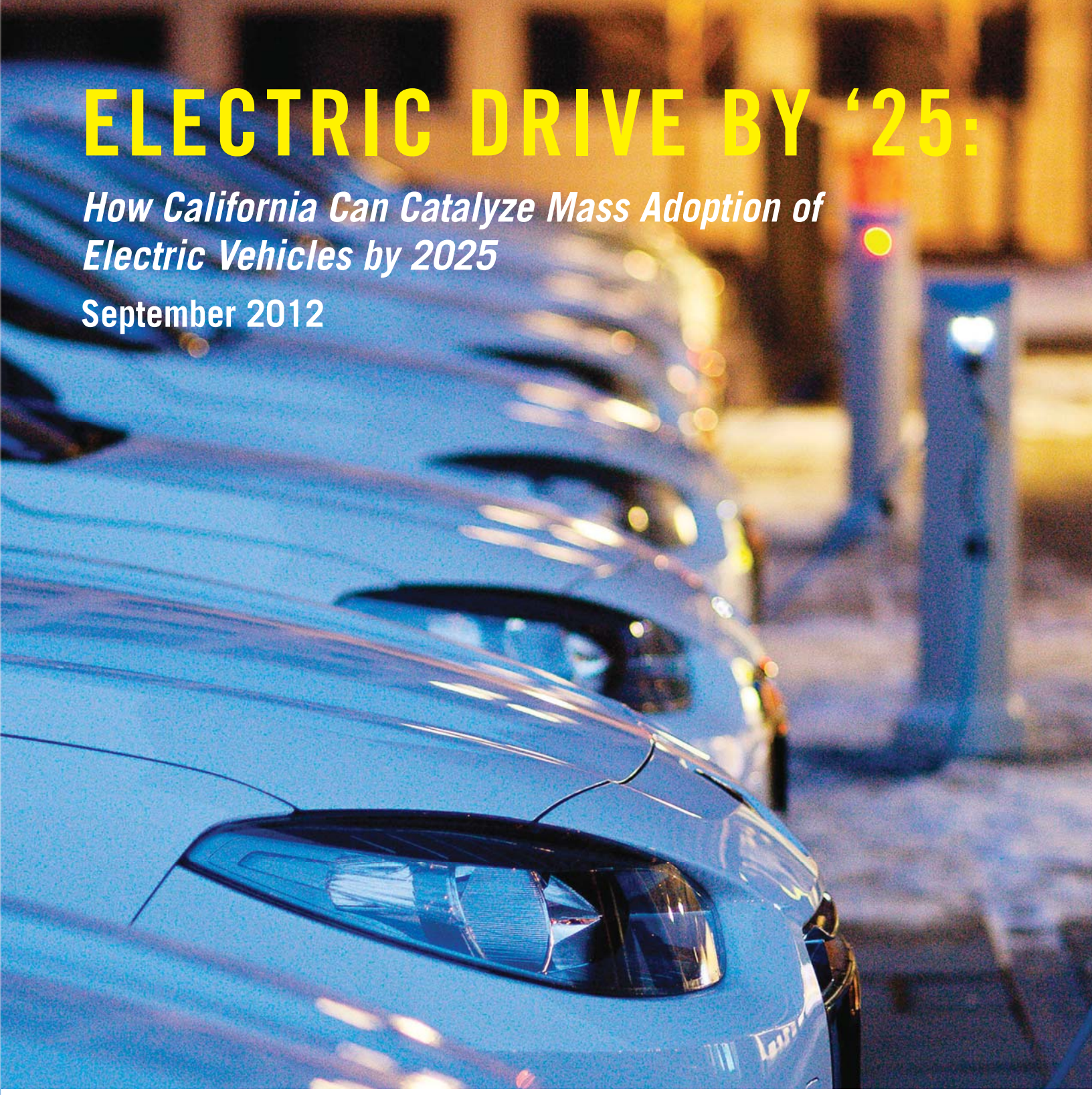


ELECTRIC DRIVE BY '25:

How California Can Catalyze Mass Adoption of Electric Vehicles by 2025

September 2012

Bank of America

BerkeleyLaw
UNIVERSITY OF CALIFORNIA
Center for Law Energy & the Environment

UCLA LAW
UCLA ENVIRONMENTAL LAW CENTER
EMMETT CENTER ON CLIMATE CHANGE AND THE ENVIRONMENT

About this Report

This policy paper is the tenth in a series of reports on how climate change will create opportunities for specific sectors of the business community and how policy-makers can facilitate those opportunities. Each paper results from one-day workshop discussions that include representatives from key business, academic, and policy sectors of the targeted industries. The workshops and resulting policy papers are sponsored by Bank of America and produced by a partnership of the UCLA School of Law's Environmental Law Center & Emmett Center on Climate Change and the Environment and UC Berkeley School of Law's Center for Law, Energy & the Environment.

Authorship

The author of this policy paper is Ethan N. Elkind, Bank of America Climate Policy Associate for UCLA School of Law's Environmental Law Center & Emmett Center on Climate Change and the Environment and UC Berkeley School of Law's Center for Law, Energy & the Environment (CLEE).

Additional contributions to the report were made by Sean Hecht and Cara Horowitz of the UCLA School of Law and Steven Weissman of the UC Berkeley School of Law.

Acknowledgments

The author and organizers are grateful to Bank of America for its generous sponsorship of the workshop series and input into the formulation of both the workshops and the policy paper. We would specifically like to thank Anne Finucane, Global Chief Strategy and Marketing Officer, and Chair of the Bank of America Environmental Council, for her commitment to this work.

We thank Steve Weissman for facilitating the workshop. Additional information and policy paper review provided by Max Baumhefner, Anne Ku, and Rafael Reyes.

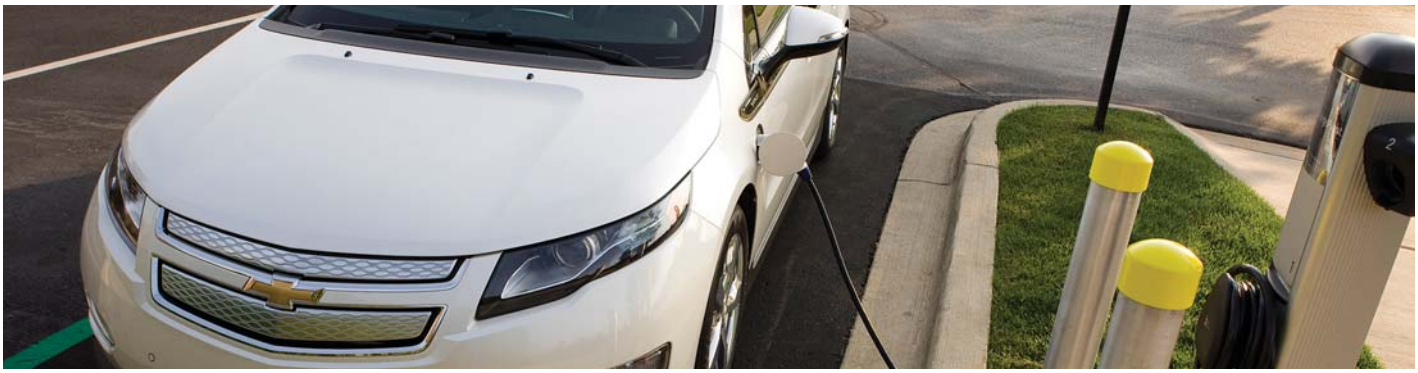
Finally, the UC organizers gratefully acknowledge Leslie Baroody, Jay Friedland, Greg Haddow, Sandra Itkoff, Alexander (Alex) Keros, Adam Langton, Michael Lord, Ryan McCarthy, Ryan Popple, Colleen Quinn, Matt Sloustcher, Eileen Wenger Tutt, Diane Wittenberg, Jason Wolf, Tracy Woodard, and Eric C. Woychik for their insight and commentary at the May 22, 2012 Climate Change Workshop that informed this analysis.

For more information, contact Ethan Elkind at Elkind@law.ucla.edu or Eelkind@law.berkeley.edu.

Bank of America

BerkeleyLaw
UNIVERSITY OF CALIFORNIA
Center for Law Energy & the Environment

UCLA LAW
UCLA ENVIRONMENTAL LAW CENTER
EMMETT CENTER ON CLIMATE CHANGE AND THE ENVIRONMENT



Executive Summary: The Importance of Electrifying Vehicles

California will need mass consumer adoption of electric vehicles to meet its long-term energy and environmental goals and to improve its economy. In the past few years, major automakers have begun marketing electric vehicles, introducing a range of cars and trucks that can "plug in" to the grid for electricity to power the engine, either wholly or in part. Meanwhile, new car companies, some of which are based in California, have focused exclusively on all-electric and plug-in hybrid models. Today, all major automakers have plans to introduce electric vehicles by 2015, with some already on the market, like the Nissan LEAF, Chevy Volt, Tesla Model S Sedan, Fisker Karma, Toyota Prius Plug-In Hybrid, CODA Sedan, and Ford Focus Electric. Many of these vehicles are designed or manufactured locally in California, including Tesla, Fisker, and CODA.

California's electric vehicle industry and its state and local policy makers should continue to create the market and policy conditions necessary to catalyze this mass adoption by 2025, a benchmark year for measuring long-term goals. The state has vital interests at stake. First, electric vehicle deployment and the resulting reduction in air pollution from decreased petroleum usage can save the state significant health care costs and lives. Premature deaths from particulate matter alone are comparable to deaths from traffic accidents and second-hand smoke. Second, Californians have the opportunity to save fuel costs with the cheaper price of electricity per mile compared to gasoline per mile (estimated to be between one-half and one-quarter the price). These savings will be even greater as electric vehicle prices likely decrease with battery improvements and the advent of more efficient, large-scale manufacturing. Third, electric vehicle deployment can help the state meet its goal to integrate more variable renewable energy from the sun and wind into the grid by potentially using vehicle batteries to regulate (and in the long term possibly store) electricity. Finally, electric vehicle purchases benefit the domestic economy through the growth of California-based electric vehicle automakers and component suppliers and by ensuring that fuel for the vehicles (in the form of electricity) comes from local sources.

Early results from the introduction of new electric vehicles to the U.S. market have been promising, with sales of both Nissan LEAFs and Chevy Volts outselling the popular hybrid Toyota Prius in its first year of sales, 9,674 (LEAF) and 7,671 (Volt) to 5,562 (first-year Prius sales). As of May 2012, plug-in electric vehicles comprised approximately 30,000 of the cars in the United States, more than four times as many as the year before.

Yet significant challenges remain to reach mass adoption. At a workshop at the UCLA School of Law in May 2012, key stakeholders, including auto manufacturers, charging company representatives, electric vehicle advocates, electric utilities, and public agency leaders, gathered to discuss solutions to the major challenges. They identified the following obstacles as among the most significant.

Top Three Barriers to Mass Consumer Adoption of Electric Vehicles in California by 2025

1) Lack of Consumer Awareness and Information: many consumers are unfamiliar with electric vehicles and their performance, while at the same time they may harbor common misperceptions about vehicle types, safety, range, impact on their electricity bills, and other facets of electric vehicle ownership.

2) Lack of Appeal to Broader Market: the higher initial costs and limited battery range of some electric vehicles may make them less attractive to a broader market segment beyond a specific group of early adopters.

3) Lack of Access to Charging Infrastructure Outside of the Home: potential electric vehicle customers may be deterred by a public or non-home charging station infrastructure that seems inadequate, difficult to navigate, and unpredictable in its pricing.

Summary of Solutions to Overcome the Long-Term Challenges to Mass Consumer Adoption of Electric Vehicles

Based on the workshop discussion, this paper identifies the actions that electric vehicle manufacturers, stakeholders, advocates, and government leaders can take to ensure that California catalyzes mass adoption of electric vehicles by 2025. Policy-makers, industry leaders, and advocates will need to:

- Educate consumers, the media, and elected officials through a simple and effective outreach campaign about the benefits and joy of driving electric vehicles;
- Reduce fees, taxes, and upfront costs for electric vehicle owners and invest in battery research; and
- Plan for and facilitate deployment of a well-planned and easy-to-use charging infrastructure network.

At stake is the future of the electric vehicle market. California accounts for 11 percent of the national market for annual new car sales, as well as more than 20 percent of non-plug-in hybrid vehicle sales in the United States. With such a significant market share and volume of cars, California can help launch a sustainable and more robust electric vehicle market, with the country and world benefitting as a result.

The section below summarizes the solutions listed previously, as well as others identified by workshop participants.

SOLUTION #1 SUMMARY: Develop a Consistent and Pervasive Outreach Campaign

The electric vehicle industry and advocates could develop consistent use of terms and create a simple message promoting electric vehicles.

The industry and other stakeholders could launch a communications and outreach campaign and target members of the media, public leaders, and consumers, such as through the Electric Drive Transportation Association and Plug In America.

The industry could identify key stakeholders and partners to raise funds to implement the outreach campaign.

Auto manufacturers could continue to offer opportunities for test driving the vehicles and educate their car dealers about them in order to inform potential buyers.

Industry and advocates could encourage high-profile adoption of the vehicles by celebrities and political leaders and placement in key products and entertainment programs.

Federal, state, and local officials could hold media events featuring electric vehicles and motivate public officials to drive them as a showcase for constituents.

State and local officials could designate a single point of contact in government for electric vehicle communication and outreach efforts to assist stakeholders, vehicle and charging companies, and interested consumers.

SOLUTION #2 SUMMARY: Develop and Promote Incentives for the Purchase of Electric Vehicles

State leaders could extend the AB 118 electric vehicle rebate program beyond 2015 to provide greater certainty and continued incentives during the nascent stage of the market.

Federal and state leaders could create tax incentives and lower fees and insurance payments for electric vehicle owners to promote vehicle purchases.

State leaders and utilities could better promote existing, separate electric vehicle charging rates to reduce monthly charging costs for vehicle owners.

State leaders could facilitate the distribution of revenues from the sale of low carbon fuel standard credits to electric vehicle owners to provide them a revenue stream from the regulated entities under the state program.

State leaders, utilities, automakers, and grid operators could develop battery financing programs such as on-bill or separate financing to reduce the upfront cost of the vehicle by removing the battery cost from the initial purchase price.

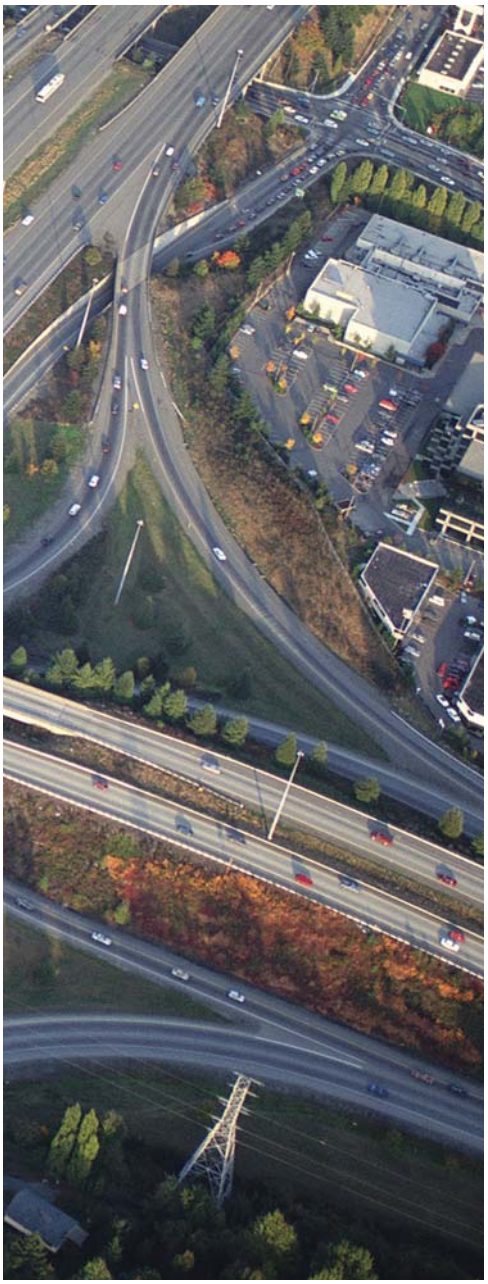
Federal and state leaders could strengthen funding for electric vehicle battery research and development to help reduce the long-term cost of the batteries for electric vehicle owners (as well as for broader energy storage needs for the grid).

State leaders could develop alternatives to the gas tax to fund infrastructure investments to remove a disincentive for electric vehicle adoption by governments hesitant to lose gas tax dollars with more efficient vehicles.

The electric vehicle industry could develop consumer financing packages to facilitate electric vehicle purchases, such as providing the first set of miles free to charge or developing incentives that increase with the cost of the vehicles and the range of the batteries.

Federal and state leaders could clarify the technical and cost requirements necessary to enable "vehicle-to-grid" services for electric vehicle owners who allow utilities to use the charging connection to provide grid services, which can reduce the monthly cost of ownership.

Utilities and other entities could purchase used electric vehicle batteries for grid operations and other applications and provide advance payment to reduce upfront vehicle costs.



SOLUTION #3 SUMMARY: Coordinate and Promote the Deployment of Comprehensive Charging Infrastructure

Federal and state leaders could develop favorable tax policies for businesses that install workplace and multi-tenant charging stations, such as tax credits and clarification that charging is not a taxable benefit for employees.

Federal and state leaders could work with industry groups to promote uniform installation rules and open standards related to charging infrastructure to facilitate their deployment by reducing costs and improving interoperability of various charging technologies.

Federal leaders could encourage lenders to finance electric vehicle infrastructure deployment at low-cost rates to enhance the existing charging infrastructure.

State leaders could work with stakeholders to develop a statewide guidance document on charging infrastructure priorities to help local governments and other permitting authorities to focus charging companies on deploying technologies in the most optimal areas of the state.

State leaders could work with local governments to streamline and standardize permitting for charging infrastructure in areas identified by state and local officials and charging companies as optimal for placement.

State leaders and charging companies could continue to collect and analyze data on charging patterns and impacts to improve siting criteria and selection.

State leaders could consider developing targets for parking lot owners to install a minimum number of charging stations when tax incentives and market forces do not motivate action.

State leaders could ensure that new homes and business are eligible for pre-wiring for electric vehicle charging given the higher cost of retrofitting homes and business that do not already have the wiring in place.

Charging companies could coordinate ongoing maintenance and operation of charging infrastructure and provide a database for electric vehicle users to help them find charging stations when they need them.

Charging companies could develop common standard and communications protocols for their technologies to ensure interoperability and more seamlessness and price consistency among diverse technologies.

Charging companies could ensure that consumers have transparent fueling prices to make the charging process easier to navigate and to provide more certainty regarding the long-term cost of vehicle ownership.

The Current State of Electric Vehicles and Charging Infrastructure

Electric vehicles description and deployment status

Electric vehicles include a range of cars and trucks that can "plug in" to the grid for electricity to power the engine, either wholly or in part. These plug-in electric vehicles (PEVs) experience improved efficiency and performance as a result of the electric power. They come in three forms:

1) All-battery electric vehicles (abbreviated as BEV), such as the Nissan LEAF or Tesla Model S Sedan.
2) Plug-in hybrid electric vehicles (PHEV), which can have either a series configuration, where the gas engine serves only to generate electricity to recharge the battery, or a parallel configuration, where the gasoline engine can directly power the car independently or in parallel with the electric drive.[1] Automakers use the parallel configuration in models such as the Toyota Prius, Honda Insight, and Ford Escape Hybrid.[2]
3) Extended Range Electric Vehicle (EREV), in which a gasoline engine only powers the engine once the driver has depleted the battery. Examples include the Chevy Volt, Fisker Karma, and BMW i3.[3]

California first's regulations on electric vehicles in the early 1990s prompted a wave of new electric vehicle models, such as the General Motors EV1. However, the state failed to meet its goals and scaled back the program, leaving only a few models on the road from the 1990s and early 2000s. In the last few years, however, major automakers have begun introducing plug-in technologies, while some new companies have developed electric models exclusively. Today, all major automakers have plans to introduce electric vehicles by 2015, with some already on the market, like the Nissan LEAF, Chevy Volt, Tesla Model S Sedan, Fisker Karma, Toyota Prius Plug-In Hybrid, CODA Sedan, and Ford Focus Electric.[4]

Early results from the introduction of these newer electric vehicles to the U.S. market have been promising, with sales of both Nissan LEAFs and GM Volts outselling the popular, non-plug-in hybrid Toyota Prius in its first year of sales, 9,674 (LEAF) and 7,671 (Volt) to 5,562 (first-year sales of non-plug-in Prius).[5] As of May 2012, Plug-in electric vehicles comprised approximately 30,000 of the cars in the United States, more than four times as many as the year before.[6]

Charging options

Electric vehicle owners have four options for charging, or refueling, their batteries. Three of the four charging options involve increasing levels of power and quickness:

- Level 1 denotes 110 to 120 volt alternating current power found in most household outlets, which can power small batteries or hybrids overnight. Level 1 can sufficiently refuel a hybrid or plug-in hybrid electric vehicle with an overnight charge, although the technology may not be sufficient for a larger battery pack after a longer drive. Many electric vehicle owners use Level 1 charging today at home because the technology does not require installing new charging infrastructure. Level 1 also has less impact on the grid than more intensive charging processes due to the typically off-peak nature of its use and its reduced intensity of energy demand.

- Level 2 charging entails 220 to 240 volt alternating current that can fully recharge a battery overnight at as little as a third of the charging time as Level 1. Most homes and businesses require new wiring to enable Level 2 charging.

- DC (direct current) or Fast Charging with today's technology involves charging a typical battery to 80 percent capacity in just 30 minutes. The technology requires dedicated charging infrastructure, typically located in public access areas for drivers on extended trips.[7]

- Battery switching represents the fourth and final option, in which vehicle owners swap a depleted battery for a fully charged one at a designated location.[8] The electric vehicle industry has not yet offered this option in the United States.

The Current State of Electric Vehicles and Charging Infrastructure, *continued*

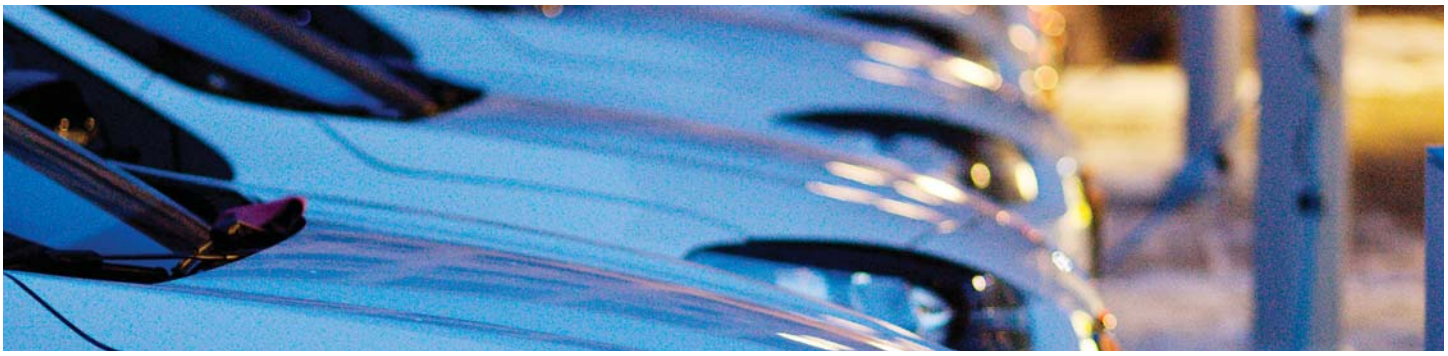
The increased speeds from Level 1 to DC charging carry trade-offs: Level 1 takes longer to charge, Level 2 usually requires the purchase of a new home or business charging unit and sometimes upgrades to electrical panels and a dedicated circuit for charging, and both Level 2 and DC charging have the potential to produce more stress on the local electricity distribution infrastructure and increase the customer's utility bills (Level 1 charging tends to have less impact on bills).

Current state of charging infrastructure

Electric vehicle owners need convenient options for recharging in order to feel comfortable purchasing the vehicles. For many electric vehicle owners,[9] Level 1 charging at home may meet their needs and offer the convenience of home refueling relative to conventional vehicles. Workplace charging will likely be the second most utilized location for charging, requiring companies and multi-tenant office buildings to provide charging infrastructure. Public access charging will be necessary to alleviate battery range anxiety as electric vehicle users, particularly with all-battery power, plan extended trips.

Public charging stations will not have a market without more electric vehicles on the road. According to the U.S. Department of Energy, the United States currently has 4,153 electric vehicle public charging stations,[10] likely not enough to meet future demand and adequately address some consumers' range anxiety. To address this challenge, public sector entities have facilitated the funding and siting of public access charging stations. For example, the California Energy Commission, with help from the United States Department of Energy, has helped fund over 4,000 residential and public charging stations in mostly urban areas using revenue from AB 118 (Nuñez, 2007), a state law that created a dedicated revenue stream for clean air investments like electric vehicles from increased fees on smog abatement and vehicle and vessel registration.[11] The Department of Energy also funded approximately 600 charging stations in Los Angeles, while the Bay Area Air Quality Management District offered incentives[12] for the installation of up to 3,000 residential Level 2 charging stations and funding for a network of 50 fast charging stations.[13]

California may be poised for a sizeable increase in public access charging stations. In April 2012, the California Public Utilities Commission (CPUC) reached a settlement with Dynegy Power Marketing, LLC over claims related to the California electricity market abuses in 2000 and 2001. The terms required Dynegy affiliate NRG Energy, Inc. (NRG) to spend over $100 million on new charging infrastructure. According to the settlement, this infrastructure includes 200 fast charging stations for public use at reasonable rates for five years, support for 10,000 "make-readies" (retrofitted with wiring to accommodate future charging) for 10,000 dedicated parking spaces at approximately 1,000 multifamily, workplace and public interest sites like universities, and separate investments in electric vehicle technology and car sharing pilot programs.[14] At the national level, charging company ECOtality received almost $115 million in grant funding from the Department of Energy to launch the "EV Project" in 2009 and 2010, which in part will help bring charging stations to metropolitan areas throughout the United States. Partner matches have raised the total value of the EV Project to approximately $230 million.[15]



Increased Adoption of Electric Vehicles Will Improve California's Environment and Economy

California has committed to promoting electric vehicles both for environmental and economic benefits. By drawing on domestically generated electricity, which will increasingly come from renewable sources under state law, Californians who drive electric vehicles will be simultaneously reducing air pollution, including the greenhouse gases that cause climate change, and investing in the local economy for fuel sources. Reports from scientists, economists, and energy experts have also found that electrifying transportation will be central to meeting the state's long-term greenhouse gas reduction goals.[16]

Burning fossil fuels to power vehicles contributes to harmful air pollution and exacerbates climate change

Californians suffer from some of the most toxic air pollution in the country. Over 90 percent of Californians breathe unhealthy levels of one or more air pollutants during some part of the year,[17] while the San Joaquin Valley has one of the worst levels of ozone pollution in the United States (ozone pollution leads to asthma, reduced lung capacity, and increased susceptibility to respiratory illnesses).[18] Fossil-fuel burning on-road vehicles contribute roughly 32 percent of this statewide air pollution,[19] including emissions of carbon monoxide, sulfur dioxide, and particulate matter pollution, among other pollutants.[20] In addition, the state's transportation sector accounts for almost 40 percent of the greenhouse gas emissions that cause climate change, making it the single largest source,[21] compared to 33 percent nationwide[22] (see Figure 1).

Pollution from fossil fuel-powered driving will only worsen as the population increases and land use patterns become more diffuse. The Urban Land Institute projected a 48 percent increase in driving between 2005 and 2030, compared to a projected 23 percent increase in population.[23] In California, the Department of Transportation estimated an increase in vehicle miles traveled of 61 percent from 2007 to 2030 under the business-as-usual scenario.[24]

Converting these vehicles to electric power will reduce this air pollution by using cleaner sources of fuel. Even though electricity often comes from generators that rely on fossil fuels, such as coal and natural gas, electric vehicles still result in

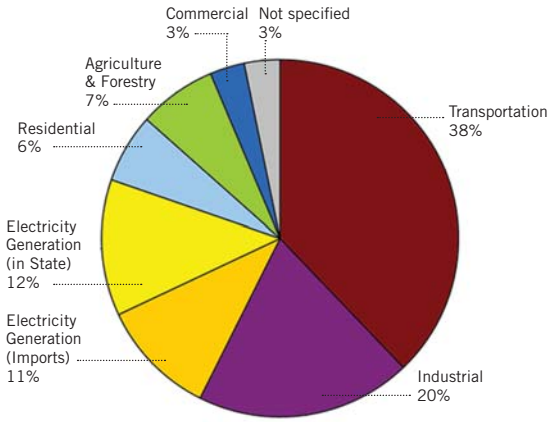


Figure 1. California's Greenhouse Gas Emissions (2000-2009 Average)

Source: California Air Resources Board

significant net emissions reductions compared to fossil-fuel based vehicles over the long term. Conventional, centralized power plants are more efficient than the millions of dispersed internal combustion engines, while reducing petroleum consumption avoids upstream emissions from refining operations.[25] In addition, a 2007 study by the Electric Power Research Institute (EPRI) and Natural Resources Defense Council (NRDC) documented that even under a range of electric vehicle adoption forecasts and electricity generation portfolios, long-term electric vehicle deployment will lead to significant greenhouse gas and petroleum fuels reductions across the nationwide electricity and transportation sectors compared to non-plug-in vehicles.[26] And as California increases its deployment of renewable energy sources to 33 percent of its generation mix by 2020 and reduces the carbon emissions from existing power plants, these emissions will only decrease further with electric vehicle usage.[27] According to the United States Environmental Protection Agency, electric vehicle usage in California emits only a quarter of the pollutants as the average new car.[28]

Electric vehicles can improve California's economy

Electric vehicles can help the California economy in key ways. First, their deployment and resulting reduction in air pollution can save the state lives and significant health care costs. Premature deaths from particulate matter alone are comparable to deaths from traffic accidents and second-hand smoke.[29] Second, Californians have the opportunity to save fuel costs with the cheaper price of electricity per mile compared to gasoline per mile (between one-half to one-quarter the price[30]) and reduced maintenance costs. These savings will be even greater if electric vehicle prices decrease with continued reductions in battery costs and more efficient, large-scale manufacturing and if the long-term trend of increasing gasoline prices continues. Finally, electric vehicle purchases benefit the domestic economy through the growth of new California-based electric vehicle automakers and component suppliers and by ensuring that fuel for the vehicles (in the form of electricity) comes from local sources.

Electric vehicle adoption in California offers significant benefits to the national auto market as well and can help stimulate electric vehicle production worldwide. California accounts for 11 percent of the national market for annual new car sales, as well as more than 20 percent of hybrid vehicle sales in the United States. These percentages translate to more than 1.1 million cars per year, with projected growth to 1.7 million cars by 2020. By 2020, the number of registered automobiles in California will likely increase to 25 million to 30 million vehicles from 22 million in 2010.[31] With such a significant market share and volume of cars, California can help launch a sustainable and more robust electric vehicle market, with the country and world benefitting as a result.[32]

Electric vehicles help California meet its clean energy goals

Electric vehicle deployment promises to help California achieve its renewable energy generation goals (which are central to the state's greenhouse gas reduction targets) in a cost-effective and efficient manner. Governor Jerry Brown signed legislation on April 12, 2011 to increase the state's "renewable portfolio standards" (RPS), which require retail electricity sellers to procure a percentage of their electricity from eligible renewable energy resources, to 33 percent by 2020.[33] The state has ambitions to exceed this target and become a global leader in generating renewable energy. In his signing statement for the 33 percent legislation, Governor Brown expressed a belief that reaching 40 percent renewable energy in the near future could be achievable and cost-effective.[34]

Integrating this variable renewable energy (as the sun does not always shine and the wind does not always blow) while minimizing greenhouse gas emissions requires a variety of techniques and technologies, including energy storage technologies like batteries. As electric vehicle owners connect their vehicles to the grid, they may be able to provide grid services that balance the intermittent energy supply through real-time, variable charging levels (and possibly in the long term by feeding electricity from the battery into the grid and even the driver's home, assuming vehicle manufacturers eventually allow for this technology). These grid services, sometimes described as "smart charging" and "vehicle-to-grid" (V2G), could allow vehicle owners to receive monetary compensation from utilities, thereby decreasing the cost of ownership.

In addition, electric vehicle deployment may stimulate further research and breakthroughs in battery technology, which could potentially create opportunities for grid-scale battery deployment to integrate variable renewables at a large scale. Vehicle owners may also be able to sell their used batteries to utilities for grid services or other applications, such as home energy storage combined with solar systems, thereby recouping some of their initial investment in the vehicles.

Increased electric vehicle adoption will place additional demands on the electric grid, particularly if charging occurs during "on-peak" hours in the early evening or noon through 9pm during summer days. However, the extent of the impacts is unclear and dependent on upgrades to the electricity distribution system, the future generation mix of each utility, and the ability to integrate the demand increase with new smart grid technologies. As a result, in order to reduce greenhouse gas emissions with the adoption of electric vehicles, policy makers have an incentive to use electric vehicle deployment to enhance and further the state's clean energy goals.

California Has Committed Itself to Promoting Electric Vehicles

California has taken a number of legislative and regulatory steps to promote electric vehicle deployment and adoption, such as the Zero Emission Vehicle and Low Carbon Fuel Standard regulatory programs and rebates for purchasing electric vehicles. These actions both stem from and inform the state's landmark commitment to reduce greenhouse gas emissions through the California Global Warming Solutions Act of 2006 (AB 32, Nuñez).[35] AB 32 mandates that the state roll back its greenhouse gas emissions to 1990 levels by the year 2020, equivalent to a 30 percent cutback from the business-as-usual scenario projected for 2020.[36] In addition, former California Governor Arnold Schwarzenegger's Executive Order S-3-05 calls for an eighty percent reduction from 1990 levels by 2050,[37] while current Governor Jerry Brown's Executive Order B-16-12 calls for an 80 percent reduction by 2050 in the transportation sector specifically.[38] In the AB 32 Scoping Plan, the California Air Resources Board, the agency responsible for implementing AB 32, noted that its "the Zero Emission Vehicle (ZEV) program will play an important role in helping California meet its 2020 and 2050 greenhouse gas emissions reduction requirements."[39]

The ZEV program represents one of the state's most important regulatory efforts to promote electric vehicles. The California Air Resources Board created the program in 1990 under its Clean Air Act authority to reduce pollution from passenger vehicles and improve air quality across the state. The program included a sales mandate for automakers in California to include ZEVs in their market fleets. At the time, however, the only technology available that could meet the zero emissions goal was the battery-electric vehicle (BEV). Policy makers soon concluded that the technology was too expensive, so the Air Resources Board modified and delayed the ZEV goals to include new types of clean but conventional vehicles, including "partial" zero emissions vehicle options.[40]

The Air Resources Board recently bolstered its vehicle emissions program by creating the Advanced Clean Cars program in 2012. The Board predicted that the new program and ZEV regulations would result in over 1.4 million ZEVs on the road by 2025, comprising over 15 percent of vehicles sales that year. Under the program, car manufacturers with sales over 60,000 vehicles annually must produce and sell in California a minimum percentage of ZEVs for each model year. Updates to the program that the Air Resources Board adopted as part of its Advanced Clean Cars rulemaking will increase requirements beginning in 2018, eventually resulting in approximately 15 percent of new vehicle sales in 2025 to be from plug-in hybrid electric vehicles, battery electric vehicles, or fuel cells.[41]

California's Low Carbon Fuel Standard could provide revenue for consumers who purchase electric vehicles. The program is a major part of the Air Resources Board's regulatory effort to reduce greenhouse gas emissions under AB 32 (although industry groups have challenged it in ongoing court proceedings). The Low Carbon Fuel Standard program regulates producers of transportation fuels by requiring them to reduce the carbon intensity of their product. In order to demonstrate compliance, regulated entities must make annual showings that they meet the carbon intensity target for their fuel pool. If they have not sufficiently reduced the carbon content through their manufacturing processes, they can purchase off-market "credits" from other sources. Electric utilities, charging station operators, and other entities that support electric vehicle deployment are therefore eligible to sell credits for the carbon fuel reductions to the regulated entities. Under California Air Resources Board regulations, the utilities (in the case of residential charging) and charging station operators must provide the revenue to plug-in electric vehicle owners. Revenue from low carbon fuel standard credits earned from fleet and workplace charging must return to the owners of those properties.[42]

California has also set goals to promote electric vehicle deployment through planning and non-financial incentive programs. For example, AB 1007, the State Alternative Fuels Plan, directed the California Energy Commission and Air Resources Board to develop a state plan to increase the use of alternative fuels, including biofuels, hydrogen, electricity, and others.[43] The plan under AB 1007 determined the feasibility of meeting petroleum reduction goals adopted by the California Energy Commission in response to AB 2076 (Shelley) in 2000.[44] In addition, California allows zero-emission vehicle owners with single occupants unlimited use of carpool lanes by offering a white sticker that the drivers can place on their cars. Similarly, a few plug-in hybrid electric vehicle owners are eligible for green stickers to access carpool lanes with a single occupant. This program will remain in effect under state law at least through the end of 2014.[45]

California and national leaders offer significant financial incentives for electric vehicle research and purchases

To stimulate electric vehicle production and demand, California has instituted some vital financial support programs. AB 118 (Nuñez, 2007) created the Alternative and Renewable Fuel and Vehicle Technology Program and the Air Quality Improvement Program to support electric vehicle purchases.[46] The Energy Commission, Air Resources Board, and Bureau of Automotive Repair jointly administer the programs, which have funding through 2015 via increases to the smog abatement, equipment registration, vessel registration, and special identification plate service fees.[47] Through Air Resources Board regulations, $26.1 million of these dollars helped fund the Clean Vehicle Rebate Project from 2009 to 2012, which provides purchasers of electric vehicles with up to $2500 in state rebates.[48] In addition, under AB 118, the Energy Commission dedicated additional revenue for electric vehicle infrastructure investments, while the state's investor-owned utilities can dedicate ratepayer funds for electric vehicle investments as well.[49]

At the national level, the 2009 American Recovery and Reinvestment Act (ARRA) provided substantial funding for electric vehicle production and battery research, as well as consumer incentives. The law invested more than $14.4 billion in loan guarantee programs, advanced battery manufacturing grants, plug-in vehicle tax credits, advanced energy manufacturing tax credits, automobile purchase sales tax credits, infrastructure/vehicle deployment, federal purchases of high-efficiency vehicles, Clean Cities grant program, alternative refueling property tax credits, and the advanced technology vehicles manufacturer loan program. The program also provided a tax credit to reduce vehicle costs for consumers between $2500 and $7500 for up to 200,000 vehicles sold per manufacturer after December 31, 2009.[50]

These incentive programs and other efforts to boost the electric vehicle market constitute a strong foundation to develop and enhance further strategies necessary for California to catalyze mass adoption by 2025. Policy makers and private sector leaders will need to continue and strengthen these existing efforts while also developing new policies, detailed in the following section, to overcome the challenges to realizing this vision.

Overcoming the Top Three Barriers to Mass Consumer Adoption in California of Electric Vehicles by 2025

Barrier #1: Lack of Consumer Awareness and Information

According to workshop participants, most car consumers are unfamiliar with electric vehicles, how they perform, their environmental benefits, and the significantly lower fueling costs. Car manufacturers only recently began introducing and marketing a new generation of electric vehicles, so consumers are still learning about and being exposed to them without the benefit of a broad-based outreach campaign and a highly visible presence of electric vehicles on the road. Car dealers may also not be as familiar with electric vehicles as conventional models and therefore may not be prioritizing them in the showroom. In addition, some members of the media who cover electric vehicles may lack a strong familiarity with them or access to data and research necessary to inform their reporting.

Even for consumers who have heard about electric vehicles, they may harbor misperceptions regarding vehicle types, safety, range, impact on electricity bills, and other facets of electric vehicle ownership. Some workshop participants believed that recent media reports, beyond the initially positive stories, fueled these misperceptions. The participants referred to stories of car batteries that caught fire a few weeks after purchase in government laboratory tests, all-battery vehicles not being able to travel far on a single charge, and high electricity bills from vehicle charging. Workshop participants noted that some consumers believe that the batteries are toxic and will not last long after repeat charges, that the charging process can be dangerous, and that owning an electric vehicle is a sacrifice of convenience. In addition, participants cited potentially misleading studies and media reports about the carbon-intensive nature of relying on dirty electricity sources for fuel, which consumers may interpret as evidence that electric vehicles do not offer environmental benefits from switching from conventional, petroleum-based fuels.

Finally, some consumers who have never driven an electric vehicle may believe that their performance levels are not sufficient for California driving needs, thereby overlooking the improved acceleration and handling of some electric vehicles compared to fossil fuel-based models. Without efforts from credible spokespeople and car dealers to promote the vehicles and to offer consumers a chance to drive them personally, these misperceptions may persist and limit near-term sales growth.

Solution: Develop a Consistent and Pervasive Outreach Campaign

Auto manufacturers, charging station purveyors, and advocates will need to coalesce to develop and implement a simple and effective communications and outreach campaign. These stakeholders will need to enlist allies to fund and support the effort and employ creative means to reach consumers through direct test driving experiences and celebrity adoption and product placement.

Electric Vehicle Industry and Advocates

Develop consistent use of terms and create a simple message promoting electric vehicles

"The media misperceptions will have to be overcome. They like to write sensational stories. They love new toys but will write the bad story."

— *UCLA Workshop Participant*

Workshop participants cited confusion among members of the media and the public about electric vehicle terminology, noting that the language often involves acronyms and confusing terms. Examples of confusing technology abbreviations include PEV, BEV, HEV, PHEV, along with terms like "Level 1 Charging" and V2G or "vehicle to grid." The jargon makes outreach more complicated and may reinforce the perception that the cars are specialty items or confusing to own and operate. The electric vehicle industry could decide on simple and memorable terms to describe the cars and the infrastructure and charging processes and then use them consistently in all marketing materials.

Launch an education and outreach campaign and target members of the media, public leaders, and consumers

"The cancer society invested in why we shouldn't smoke. But there's no money behind getting the EV message out."

— *Colleen Quinn Coulomb Technologies*

An outreach campaign could feature consistent and simple terms, as discussed above. The workshop participants suggested that the campaign advertise the benefits of electric vehicles, including the fun of driving them, how they are good for the economy by using domestic energy and by saving drivers gas money, that they are easy to plug in and drive, and that the driving experience includes better torque, smoothness, less noise, and no gas smell compared to fossil fuel-powered cars. In addition, the campaign could highlight how electric vehicles contribute to national oil independence and clean air. This campaign could coordinate with the Electric Drive Transportation Association (EDTA), which is in the process of launching a similar marketing campaign, and Plug In America's marketing campaign to leverage that organization's base of electric vehicle customers to offer personal test drives. The intended audience could be members of the media (to ensure they are aware of new developments with electric vehicles and the full range of perspectives and facts associated with them), public leaders (to encourage them to promote electric vehicles, as discussed above), and consumers (to convince them to consider purchasing or test-driving the vehicles).

Raise funds to implement the outreach campaign

While electric vehicle companies have a profit motive to invest in a communications campaign to encourage vehicle purchases, these companies can enlist other stakeholders to raise funds for the campaign. Charging companies, environmental groups advocating for electric vehicles, and companies with clienteles that would respond to the campaign positively or use their facilities for charging, like Whole Foods or Walgreens, may be natural allies in the campaign. They can assist either through direct contributions or through in-kind efforts like in-store advertising.

Continue to offer opportunities for test driving the vehicles and educate car dealers about them

Auto manufacturers could boost efforts to have electric vehicles available where potential customers congregate. Workshop participants believed that the driving experience would be a powerful source of persuasion to consumers and would dispel common misperceptions about the vehicles and their performance. Auto manufacturers may want to promote multi-day test drives for customers to learn how the vehicles would charge at home and integrate with their daily routines. Electric vehicle car rental fleets could also provide these experiences for potential customers, with the support of automakers and major rental car companies.

Auto manufacturers and utilities could strengthen their efforts to educate salespeople about the vehicles and provide the latest and most important informational resources to dealers and customers. Car dealers are often the first contact customers have with the vehicles, and their knowledge of the vehicles and willingness to place them prominently in the dealerships, with opportunities for test driving, could make a significant difference for sales.

"The Steve Jobs idea was that customers didn't know what they needed until they saw it. And many lack EV driving experience."

— *Leslie Baroody*
California Energy Commission

Encourage high-profile adoption of the vehicles

Electric vehicle companies and their advocates could target high-profile individuals and companies to showcase their cars. Workshop participants cited Hollywood action films as a fitting showcase for the vehicles, with ideas ranging from inclusion as the James Bond car to featuring an electric sports car in *The Fast and The Furious* film franchise and similar car-themed entertainment programs (the movie *Mission Impossible 4* featured the plug-in hybrid BMW i8[51]). Companies that may be sympathetic to electric vehicle promotion efforts could feature the cars in their products and services, from Google home page artwork to Mattel toy cars.

Federal, State, and Local Leaders

Hold media events featuring electric vehicles and motivate public officials to drive them

Federal, state, and local officials can contribute to the outreach campaign and reach a wide audience through media events that feature electric vehicles. Governors, agency heads, and legislators should consider driving electric vehicles to public events and organizing press conferences on electric vehicle infrastructure deployment and sales.

"The first few years are going to be bumpy. It's about getting consumers in the cars. The more they get in them, the more they'll sell them to their friends and neighbors."

— *Jay Friedland*
Plug In America

Designate a single point of contact in government for electric vehicle outreach efforts

State and local leaders could help facilitate communications, outreach, and regulatory and legislative coordination by empowering a single point of contact within government who can oversee all aspects of electric vehicle information and deployment for the public. This electric vehicle "czar" can help ensure that public officials showcase electric vehicles and address the challenges to consumer adoption.

Barrier #2: Lack of Appeal to Broader Market

Electric vehicles tend to appeal to consumers with high incomes, strong environmental values, a desire not to use foreign sources of fuel, and preference for new technologies. Initial sales have been higher in urban areas among environmentally conscious professionals. As a result, workshop participants expressed concern that electric vehicles currently do not appeal enough to the broader market of car consumers, thereby limiting potential market growth. The key factors cited by the participants included the high cost of the vehicles relative to cheaper, fuel efficient alternatives, and the limited range of all-battery vehicles. Many consumers need assurance that an electric vehicle will meet their driving needs, including for longer trips that may be beyond the range of a single battery charge in all-battery vehicles.

Solution: Develop and Promote Incentives for Electric Vehicle Purchase

State and industry leaders will need to reduce the cost of purchasing electric vehicles through tax credits and rebates, as well as payments for grid services, used batteries, and sale of pollution reduction credits. Policy makers can also lower costs for electric vehicle insurance and charging rates. In addition, they can work with industry leaders to develop multiple financing options and invest in battery research.

"When it comes to demand, I'm not worried about Berkeley or La Jolla [California]. But what about the Merceds [in the Central Valley]? How do we make it easy, cheap and fun? Money in the wallet is what they care about."

— UCLA Workshop Participant

Federal Leaders

Continue and strengthen funding for battery research and development that can benefit electric vehicles

While the private sector is currently investing in battery research to improve range and battery life, the federal government could continue its efforts through the Department of Energy loan and grant programs to fund or finance innovative battery research. Improved battery technologies will benefit not just electric vehicles but the effort to integrate variable renewable energy, provide backup power in case of emergency outages, and reduce the need for dirtier peak power production with the enhanced ability to store electricity.[52]

Clarify the technical and cost requirements necessary to enable "vehicle-to-grid" services provided by electric vehicle owners

The federal government, through the Federal Energy Regulatory Commission (FERC), could ensure that the interstate electricity market allows electric vehicle owners to receive payments for grid services provided by their vehicles (described as "smart charging" or "vehicle-to-grid"). The current chair of the FERC, Jon Wellinghoff, has spoken publicly about this potential.[53] In this scenario, vehicle owners would agree to allow utilities to regulate the rate and time of their battery charging. In some cases, if vehicle manufacturers enable it, the batteries can provide electricity back to the grid. As potentially millions of vehicle owners participate, utilities would have a large pool of flexible users that they could aggregate and manipulate to adjust consumer demand to meet supply more closely. This flexible demand could help the utilities avoid having to bring new generation online to meet various demand spikes. In addition, this service could transform the market for electric vehicles

by creating the potential for owners to save money over the vehicles' useful lives as compared to the cost of internal combustion vehicles. FERC can encourage and approve grid operator tariffs to ensure that the participating customers receive payment equivalent to the amount of electricity generation that they offset. Policy makers could identify and address similar barriers at the California Independent System Operator, Public Utilities Commission, or Municipal Utility Governing Boards, as appropriate.

State Leaders

Extend the AB 118 electric vehicle rebate program beyond 2015

As discussed previously, AB 118 provides rebates for electric vehicle car purchases, manufacturing grants, and charging infrastructure programs but will expire in 2015. The State Legislature should consider extending this program to at least 2020 to ensure adequate support for the nascent electric vehicle market.

Create tax incentives and lower fees and insurance payments for electric vehicle owners

State leaders can encourage electric vehicle purchases through targeted tax incentives and similar experimentation. For example, state income tax credits for vehicle purchases might encourage more purchases, while reducing the sales tax rate for electric vehicles would offset the higher upfront cost of purchasing them. In addition, the state could lower vehicle registration fees at the state Department of Motor Vehicles for electric vehicle owners. The state can also lower the cost of ownership of electric vehicles by allowing owners to qualify for reduced car insurance payments.

> "We're still learning about why different people buy different cars. Some people buy because they want to get off petroleum; these people aren't worried about costs. Our planning efforts need to consider that getting these vehicles into the market is the priority."
>
> — *Alex Keros*
> *General Motors*

Work with utilities and stakeholders to promote adoption of electric vehicle charging rates by owners

California's investor-owned utilities offer two types of special rates for home and business owners to charge their electric vehicles at less expensive rates. The "whole-home" option allows all electrical usage in the building, including non-electric vehicle load, on a "time-of-use" rate via the primary meter. Generally, electric vehicle owners can achieve significant savings under these rates if they charge during off-peak nighttime hours (although costs can be significantly higher if they charge during the day). A second, more complicated option involves a separate meter that allows customers to keep non-vehicle uses on their standard rate but enables electric vehicle charging to switch to the time-of-use rates on a second meter. While this method can help avoid significant increases in the total utility bill, it requires sometimes expensive electrical work to install the separate metering capability.[54]

Some workshop participants believed that many electric vehicle owners were unaware of or underused the separate rate options, despite the potential financial benefits. State regulators and utilities could therefore increase promotion efforts about this option and take steps to improve the program by reducing rates further for electric vehicle charging. The California Public Utilities Commission is currently exploring options through its proceeding on alternative-fueled vehicles.[55]

Facilitate distribution of revenues from low carbon fuel standard credit sales to electric vehicle owners

Electric utilities are eligible to receive low carbon fuel standard credits based on the amount of electricity they sell to residential customers for transportation via vehicle charging in their service territory. Other entities, such as public charging station operators, workplace chargers, and government fleet managers, can elect to participate as well in this program. Fuel suppliers regulated under the state's low carbon fuel standard program can then purchase these credits for cash. Under a recent decision by the California Air Resources Board, the utilities must return this revenue to the electric vehicle charging owners.[56] The California Public Utilities Commission is currently in the process of determining the best manner for distributing this revenue.[57] The state could ensure that utilities track and distribute this revenue as efficiently and accurately as possible. Vehicle owners would benefit from a simple, predictable, and transparent process for receiving this revenue. In addition, knowledge of the low carbon fuel standard payments may help persuade consumers to purchase electric vehicles if the revenue will lower their electricity bills.

Work with vehicle manufacturers and utilities to develop separate battery financing programs

Because much of the cost of electric vehicles comes from the battery, state policy makers, working with electric utilities, automakers, and other stakeholders, could develop separate battery financing programs to remove this upfront cost from the vehicle purchase. On-bill financing represents one promising option for this financing arrangement, where a party (or consortium) would provide the capital for financing the battery purchase and then the customer would repay the loan via monthly payments. The resulting payments could potentially be less than the overall monthly fuel savings.

"I don't think we've really seen Nissan or GM or Ford flex its muscle and get the entire supply chain set up. It's going to lead to really dramatic changes. There's a possibility that batteries will get a lot cheaper and better, that we're viewing the market through the lens of a pilot technology. We don't need to apologize for vehicles right now."

— *Ryan Popple*
Kleiner Perkins Caulfield & Byers

Continue and expand programs to fund battery research and deployment

In addition to federally-funded research discussed above, the California Energy Commission funded battery research for transportation through various grant programs. Funding came from the American Recovery and Reinvestment Act (ARRA), AB 118 revenue, and a public goods charge on electricity bills, which expired in 2011 and currently operates through the California Public Utility Commission's Electric Program Investment Charge (EPIC).[58] The Legislature could re-authorize this charge in order to continue and strengthen California's battery research programs and ensure that they remain competitive. As discussed above, improvements in battery development and deployment in the field will benefit ratepayers and grid operators beyond electric vehicle deployment.

Develop alternatives to the gas tax to fund infrastructure investments

State governments fund transportation infrastructure investments in part from gas tax revenues, which are currently collected on a fixed, per gallon basis. However, inflation and deferred maintenance have squeezed transportation budgets, leading to declining road and highway quality. Consumers that purchase more fuel-efficient and electric and hybrid vehicles further diminish gas tax revenue. As a result, infrastructure for electric vehicles and other cars and trucks will decline in quality and safety unless policy makers develop an alternative, more stable source of funding. In addition, state and local policy makers may have less incentive to promote electric vehicles if the resulting decrease in gas consumption hurts transportation budgets.

One solution to this long-term challenge would be to develop a "vehicle miles traveled" or VMT fee that is indexed to the amount of energy drivers use per mile. Such a fee could more accurately distribute the burdens of transportation funding among drivers who use the infrastructure the most and alleviate fears that electric vehicle technologies will lead to declining transportation infrastructure quality and quantity. By taking into account the energy intensity of driving, an energy-based fee would encourage low-carbon fuel consumption such as electric vehicles.[59] Stakeholders could develop similar proposals to recommend to the Legislature.

Electric Vehicle Industry, Electric Utilities and Grid Operators

Develop consumer financing packages to facilitate electric vehicle purchases

Auto manufacturers may increase sales by partnering with utilities to offer discounts and specials. For example, auto manufacturers or electric utilities could offer a first set of miles free to charge. Similarly, auto manufacturers could work with utilities to facilitate on-bill financing of the battery costs, as discussed previously. In addition, the companies could develop incentives that increase with the cost of the vehicles and the range of the batteries.

Develop rules and tariffs to support electric vehicle grid services

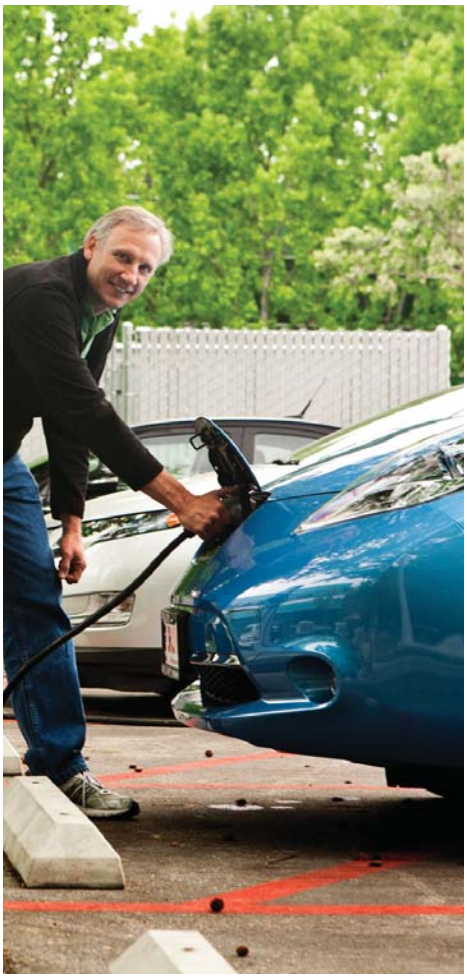
As discussed previously, vehicle-to-grid services may provide an attractive revenue stream for electric vehicle owners. The California Public Utilities Commission and California Independent System Operator, which operates the majority of the state's transmission system, could develop tariffs and appropriate guidelines to compensate vehicle owners for the grid services provided by the vehicle.

Purchase used electric vehicle batteries for grid operations and for non-utility uses

Electric utilities and other entities could provide an important market for purchasing electric vehicle batteries that no longer have sufficient life left for vehicle applications. Often these batteries still possess enough capacity for other applications, and utilities can use them as bulk energy storage at key parts of the transmission, distribution, and generation systems. The California Public Utilities Commission and electric utilities should consider developing programs to facilitate this market and to support research on the best use of these batteries, such as to support home solar energy storage, possibly through AB 118 and other funds. The resulting payments to electric vehicle owners could offset the cost of the vehicles, particularly if utilities or other parties could provide upfront cash payments to the vehicle owners upon purchase.

"If I'm a grid operator, and I have 50 percent renewables on-line, giving me a few million EVs will make me happy. The opportunity for that is important. So we can't just think about the consumer and the car."

— Eric Woychik
Itron



Barrier #3: Lack Of An Adequate Charging Infrastructure

The lack of a convenient, accessible, and pervasive public charging infrastructure, coupled with long charge times, can make electric vehicle ownership seem difficult for drivers who want to charge away from home. Electric vehicle charging companies face challenges deploying their technologies due to different federal, state, and local ownership, installation standards, and permitting costs, driven by differing permitting processes. They often face high costs if they need to purchase or lease a parking spot to place their equipment. The different charging business models and technologies may also present challenges to consumers hoping for consistent and easy methods to charge in non-home settings.

For home charging, the cost of the infrastructure, such as wiring a home for vehicle charging, may deter some consumers who want or need Level 2 charging and discourage the installation of new charging stations at multi-family residences. For non-home charging, owners of multi-tenant commercial buildings may be reluctant to invest in on-site charging for tenants and workers, thereby discouraging the tenants and workers from buying an electric vehicle.

Policy makers have yet to develop a comprehensive vision for regional charging infrastructure deployment, and they and many charging companies are still in the process of identifying the optimal places to locate charging sites, such as at work sites, travel destinations, near busy transportation corridors, or at specific types of parking lots.

Solution: Coordinate and Offer Incentives for Deployment of Charging Facilities

Federal and state leaders could develop tax and other incentives for installing charging stations in multi-tenant homes (often referred to as multi-unit dwellings), businesses, and parking lots. They can also plan for and help standardize electric vehicle charging infrastructure. Local governments can simplify their permitting and review processes, while utilities can develop uniform standards for rules governing charging station deployment and interconnection. Finally, the state should consider requiring charging infrastructure in certain parking areas and pre-wired charging capability in homes and businesses.

Federal Leaders

Develop favorable tax policies for businesses that install workplace and multi-unit building charging stations

The federal government could provide tax breaks to businesses that make these investments. Owners of office buildings and other work sites, as well as landlords of multi-unit buildings, may not have an incentive to install charging stations for their tenants and employees. However, they will be more likely to place them in their buildings' parking lots if the state offered them tax incentives for installing the stations. Federal leaders could also clarify that businesses that make charging stations available for employees do not have to report the value of the charging as an employee benefit subject to taxation.

Work with industry stakeholders to promote uniform rules and standards related to charging infrastructure

The United States and many individual states have a patchwork of utility regulations affecting charging infrastructure. Federal leaders could work with stakeholder

organizations to standardize these regulations with respect to electric vehicle charging. Federal leaders could also work with manufacturers to develop standards for interoperability among charging infrastructure providers. Consumers will be more likely to purchase electric vehicles if the charging rates and infrastructure are consistent and easy to understand across regions and state lines.

Encourage lenders to finance electric vehicle infrastructure deployment at low-cost rates

Federal leaders could explore options, such as tax breaks, for encouraging lending institutions to make low-cost loans available to electric vehicle charging companies. Consumers will be more motivated to purchase the vehicles if low-cost loans increase the availability of charging stations.

State Leaders

Develop a statewide guidance document on charging infrastructure priorities

The Governor's Office of Planning and Research or the California Energy Commission may be logical entities, among others in state government, to develop a document outlining state priorities for deploying the charging infrastructure, including best practices for installation and permitting, priority types of charging sites, and utility rules and tariffs. Agency staff could draft the document in consultation with stakeholders and ensure that they update the document regularly to reflect changing policy and technology conditions.

Streamline and standardize permitting for charging infrastructure

The Legislature could help standardize and streamline the permitting process for deploying charging infrastructure in both residential and public/commercial contexts. Charging companies spend significant resources navigating multiple permitting regimes among various local governments. In addition, some charging stations must undergo environmental review under the California Environmental Quality Act (CEQA), which can inject uncertainty into the installation process and delay implementation. Policy makers may therefore want to develop a more certain and consistent process to expedite this deployment.

Continue to work with industry to collect and analyze data on charging patterns and impacts

The California Energy Commission and utilities, per California Public Utilities Commission directive, are collecting data and information on where the optimal points of charging occur. These entities could use the data to inform the statewide guidance document on charging infrastructure and help state and local governments streamline permitting in the most effective areas for deployment.

Consider developing targets for parking lot owners to install a minimum number of charging stations

Some parking lot owners may only install charging stations if the government requires them. The state (and local governments) could develop a policy to require charging stations for parking lots of a certain minimum size to ensure electric vehicle owners have equal access to fuel based on usage patterns and an informed cost/benefit analysis. Policy makers could also develop options for multiple parking lot owners to share charging infrastructure with their customers or encourage use of mobile charging technologies that do not require permanent installations.

> "According to city staff, permitting fees are cost based, so if permitting processes can be streamlined and standardized, then these fees could be lower and more consistent across municipalities."
>
> — *Greg Haddow*
> *San Diego Gas & Electric*

Ensure that utilities develop consistent standards for grid access for electric vehicle supply equipment

Charging companies face myriad utility standards for installing their technologies and interconnecting to the grid. The state, through the California Public Utilities Commission, could develop consistent standards to facilitate the deployment and usage of electric vehicle charging technology in homes and businesses.

Ensure that new homes and business are pre-wired for electric vehicle charging

The state, possibly through regulations by the California Energy Commission, should consider requiring new homes and businesses to pre-wire for vehicle charging. The wiring would reduce the cost of adding power capability beyond Level 1 charging to already-built homes and businesses.

Coordinate ongoing maintenance and operation of charging infrastructure and provide database for charging customers

With the diversity of charging companies and technologies, policy makers have an interest in ensuring that public or private entities continue to maintain and operate the network of charging sites already in operation over the long term. Potential customers will be deterred if the charging network falls into disrepair or is inconsistent in quality and availability. Policy makers can also help this process by creating a real-time database to track the status and availability of charging options for electric vehicle drivers. Drivers will benefit from having "one-stop shopping" for where charging stations are located and what their status might be at any given moment (such as whether or not the stations are operable and whether other drivers are currently occupying them).

Charging Companies

Develop common standard and communications protocols

Charging companies could work with policy makers to develop common interoperability standards, as presently being addressed by the National Electrical Manufacturers Association (NEMA), and to standardize utility processes and best practices governing installation of the charging technologies.

Ensure transparent fueling prices for consumers

Consumers may be deterred by the prospect of a complex and confusing pricing system for charging vehicles. Charging companies could coordinate to ensure that they have a simple, effective, and transparent method of communicating charging costs to vehicle owners.

Conclusion: The Future of Electric Vehicles

California has a strong interest in promoting the adoption of electric vehicles, based on the benefits to the economy, environment, and quality of life. With electric vehicle sales likely to increase in the long term given projected improvements to battery life and likely cost reductions, the state should begin planning now to address the challenges associated with large-scale adoption of the vehicle technologies. Heightened public awareness, easy access to financing, reduced barriers to purchase, and a well-planned and maintained charging infrastructure will help the state become a leader in electric vehicle deployment by 2025. The state and local momentum to facilitate consumer adoption of electric vehicles will ultimately help California contribute to the global changes now underway in how consumers power their vehicles.

Participant Bios

Leslie Baroody
California Energy Commission

Leslie Baroody is the Electric Vehicle Team Leader in the Emerging Fuels and Technologies Office of the California Energy Commission. She is responsible for managing over $17 million in plug-in electric vehicle (PEV) infrastructure awards, the development of PEV infrastructure solicitations and oversees $1.8 million in awards for regional plans to support PEV readiness in California. She is a participant in the Statewide PEV Collaborative, the Pacific Coast Collaborative and the Governor's Office of Planning and Research task force to implement the recent Governor's Executive Order on zero-emission vehicles. Prior to her current role, Leslie was the Project Manager for the AB 118 Investment Plan for the Alternative and Renewable Fuel and Vehicle Technology Program. Previously, Leslie was an economist with Dames & Moore in San Francisco, a gas rate design analyst at Pacific Gas & Electric Company, and a consultant for companies such as Navigant Consulting. She holds a degree in Economics from the University of California at Davis.

Jay Friedland
Plug In America

Working with the U.S. Congress as well as consumers, industry, and environmental leaders, Mr. Friedland helped drive over US $14B in government funding for plug-in vehicles, including a broad expansion of the US Federal Tax Credit for electric vehicles, as part of the American Recovery and Reinvestment Act of 2009. He serves as the Legislative Director of Plug In America, advocating for public policy broadly supporting electric and plug-in vehicles. A self-described serial entrepreneur, he has built successful companies as well as developing key industry alliances between companies both large and small. In addition to his non-profit advocacy work, Mr. Friedland is the Vice President of Strategy and Sustainability at Zero Motorcycles, Inc. He has driven a fully electric Toyota RAV4EV for more than 10 years.

Greg Haddow
San Diego Gas & Electric

Greg Haddow, Clean Transportation Manager at the San Diego Gas & Electric Company, leads the company's efforts in developing On-Road and Non-Road electric transportation services for its residential and business customers. Greg has spent over 30 years serving various leadership roles in utility and non-utility energy businesses including: strategic planning, marketing, market and load research, and energy program development and management. During his role as director of sales and marketing at SDG&E he played a key role in the growth of energy efficiency and clean transportation in California. Greg is co-chair of the California Electric Transportation Coalition. Prior to joining Sempra Energy he served as Supervisor of Market Research at Pacific Gas and Electric.

Sandra Itkoff
BYD America

Sandra Itkoff has more than 20 years of experience in business development, finance, strategy, operations, and product development in high-growth entrepreneurial environments. Ms. Itkoff joined BYD America, a world leader in state-of-the-art battery technology and a fully integrated manufacturer of long-range all-electric buses and automobiles, as Vice President of Strategy in September 2011. Previously, Ms. Itkoff served as Senior Vice President at Angeleno Group, a private equity firm that invests in high-growth alternative energy and natural resources companies, which she joined in February 2007. She co-led the firm's global fund-raising effort, achieving a 25 percent over-subscription for AG's third fund. As head of business development at Angeleno Group, Ms. Itkoff provided financial, management, strategic, and tactical guidance and resources to AG's 20 portfolio companies. Ms. Itkoff earned an M.B.A. in Finance and International Business from the Chicago Booth School of Business, and a B.A. in Economics from U.C.L.A. Ms. Itkoff recently joined the board of California League of Conservation voters, and was appointed by Los Angeles City Council President Eric Garcetti to serve on the five-member Citizen's Commission to select a ratepayer advocate for the city's Department of Water & Power.

Participant Bios, *continued*

Alexander (Alex) Keros
General Motors

Alex Keros is a Senior Project Engineer for General Motors working on the development of alternative fuel infrastructure solutions. In this role he is responsible for hydrogen and electric infrastructure planning and implementation for GM's Project Driveway and the launch of the Chevrolet Volt. Alex also works closely with Plug-in Electric Vehicle industry stakeholders, including the electrical utilities, to streamline the home charging installation process that is key to customer satisfaction and broad acceptance of plug-in vehicles. Alex is actively engaged in multiple electric vehicle forums and working groups, including co-chairing the PEV Collaborative Infrastructure Working Group. Alex began his career in environmental consulting, managing the assessment and remediation of hazardous waste sites and designing and implementing environmental policy. Alex earned a B.S. in Natural Resource Management and a Masters in Business Administration from the University of Michigan in Ann Arbor.

Adam Langton
California Public Utilities Commission

Adam is a regulatory analyst in the Energy Division of the California Public Utilities Commission. He is the staff lead for CPUC's electric vehicle proceeding and was the lead technical analyst involved in developing the infrastructure components of the NRG settlement. He was the primary author of the CPUC staff paper on the utility role in electric vehicle charging released in August 2010. In support of federal smart grid policies, Adam leads the electric vehicle regulatory working group that supports the national Smart Grip Interoperability Panel. In 2008, he co-authored CPUC's carbon allowance allocation white paper and continues to support Air Resources Board staff in the development of the cap and trade policies related to the electricity sector.

Michael Lord
Toyota

Michael Lord is a Senior Principal Engineer in Vehicle Regulation & Certification Engineering for Toyota Technical Center (TTC), the North American research arm of Toyota Motor Engineering & Manufacturing North America (TEMA). Mr. Lord has a B.A. in Physics from the University of Pennsylvania and studied Japanese language at Sophia University in Japan before joining Toyota Motor Corporation in 1987. In 1993, he transferred to TTC where he works closely with Toyota engineering and US regulators on issues related to future powertrains including the On-Board Diagnostic (OBD), Low-Emission Vehicle (LEV) and Zero Emission Vehicle (ZEV) regulations. Currently, Mr. Lord spends a majority of his time on implementation and policy issues related to the advanced powertrains such as Plug-in Hybrid Electric Vehicles (PHEV), Battery Electric Vehicles (BEV) and Fuel Cell Electric Vehicles (FCEV).

Ryan McCarthy
California Air Resources Board

Ryan is the Science and Technology Advisor to the Chair at the California Air Resources Board. Prior to his appointment at ARB, McCarthy was chief writer of a strategic plan for plug-in electric vehicles in California, written by researchers at the Institute of Transportation Studies at UC Davis in conjunction with the California Plug-In Electric Vehicle Collaborative. He was a Science and Technology Policy Fellow of the California Council on Science and Technology, where he worked in the office of California Assembly Member Wilmer Amina Carter and advised her on energy, environmental, and transportation issues, among others. McCarthy holds master's and doctorate degrees in civil and environmental engineering from UC Davis, and a bachelor's degree in structural engineering from UC San Diego. .

Participant Bios, *continued*

Ryan Popple
Kleiner Perkins Caulfield & Byers

Ryan Popple joined Kleiner Perkins Caufield & Byers as a partner in 2010. He is a member of the greentech team and focuses on sustainable transportation technology. He currently supports companies in this sector including Proterra, INRIX, Fisker, and others. Before joining KPCB, Ryan was the Senior Director of Finance at Tesla Motors, where he was responsible for corporate finance, strategic planning, and product cost development. Ryan has also worked in energy finance with Cilion Biofuels, Chevron, and ExxonMobil. Ryan received a bachelor of business administration degree in finance from the College of William & Mary, which he attended on an Army ROTC Scholarship. Commissioned as a U.S. Army officer, Ryan served 4 years active duty as a tank commander, platoon leader, and executive officer. He also received an M.B.A. from Harvard, where he was a Baker Scholar.

Colleen Quinn
Coulomb Technologies

Colleen Quinn is a seasoned executive leader and government strategist with 30 years experience in government, business and non -profit sectors. She has served in the highest level government and political appointed positions, as well as a senior corporate officer and senior non -profit management and advocacy roles. Quinn has worked with some of the most innovative leaders in Government and business, including Governor Jerry Brown and the Partnership of New York City. Most recently she has led the efforts in the nascent electric vehicle industry to achieve unprecedented outcomes in government to support the industry growth and development of policies to achieve both the environmental and economic development goals of the State and Federal Government. She has led the regulatory and legislative agenda of the Electric Vehicle Service Provider industry on behalf of Coulomb Technologies, Inc. She has also represented Electric Vehicle Manufacturers (Vectrix Corporation) and Plug IN America, the EV Consumer advocacy organization. Colleen has a JD from the University of California, Hastings College of Law, BA from UC Berkeley and a CORO Foundation Fellowship..

Matt Sloustcher
CODA Holdings, Inc.

Matt Sloustcher is the Director of Government Relations at CODA Holdings, Inc., a privately-held company headquartered in Los Angeles, CA that designs, manufactures and sells all-electric vehicles and lithium-ion battery systems purpose built for transportation and stationary energy storage applications. In this role, Matt advocates for policies that promote the electric vehicle and renewable energy industries at the federal, state, local and international levels. Prior to joining CODA in March 2010, Matt was a communications consultant at Peppercom, a mid-size public relations firm, where he focused primarily on the burgeoning cleantech sector. Matt hold a B.A. in Political Science from the University of California Santa Barbara.

Eileen Wenger Tutt
California Electric Transportation Coalition

Prior to becoming the Executive Director of the California Electric Transportation Coalition, Eileen Tutt worked in California State government for over 15 years. Most recently, Eileen served as Deputy Secretary for the California Environmental Protection Agency (Cal/EPA). Prior to her time at Cal/EPA, Eileen worked for the California Air Resources Board, an agency within Cal/EPA. In her ten years at the Air Resources Board, Eileen helped develop regulations and programs that have placed the State of California at the forefront of environmental protection. Active in civic duties Eileen serves as a trustee for the Climate Action Reserve, on the External Advisory Committee for the Sustainable Transportation Center at UC Davis, and as a Board member for the Yolo County SPCA. Eileen is married with two children and received her bachelor's degree in Mathematics with a minor in Statistics.

Participant Bios, *continued*

Diane Wittenberg
California Plug-In Electric Vehicle Collaborative (PEVC)

Diane Wittenberg is the Executive Director and Chairman of the California Plug-In Electric Vehicle Collaborative (PEVC). The Collaborative is a public-private partnership of automotive companies, California utilities, electric charging network providers, environmental organizations, NGOs, California legislators and regulators, and other thought leaders. These organizations have come together to help ensure a successful and sustainable plug-In electric vehicle (PEV) market in California. The Collaborative recently released TAKING CHARGE: Establishing California Leadership in the Plug-In Electric Vehicle Marketplace. The strategic plan identifies challenges and makes 10 broad recommendations and 31 specific actions to facilitate mass-market adoption of PEVs in California. Diane has served as Executive Director of The Climate Registry, a GHG registry governed by many states and provinces. Before that, she was President of the California Climate Action Registry. Previously, she was a Vice President of Edison International and president of Edison EV.

Jason Wolf
Better Place

Jason Wolf is vice president of North America for Better Place. His responsibilities include overseeing the company's efforts in California, Hawaii and Ontario and developing other North American markets. Within the energy and transportation ecosystems, Wolf works with federal, state and local governments as well as utility, business and non-governmental stakeholders to make the vision of zero emission EVs powered by renewable energy a reality. Wolf built a strong management track record in the IT industry before joining Better Place. His experience includes various positions in senior management, strategic planning, product launch, sales and professional services. He most recently served as president of Sterna Technologies USA, the pioneer of Business Positioning Systems software. Before joining Sterna, Wolf held a number of positions during a 10-year career at SAP AG, including senior vice president of Strategic Initiatives and senior vice president of New Product Introductions. Wolf has a B.A. in Economics and Psychology from the University of Tel-Aviv and an MBA from San Jose State University.

Tracy Woodard
Nissan

Tracy Woodard is the Director of Government Affairs for Nissan's North American Operations. She is responsible for all federal and state government activities in the United States including monitoring federal and state legislative and regulatory issues. Woodard is the head of the Washington, DC government affairs office where she spends a great deal of her time. She also manages contract lobbyists who represent Nissan. For the last two years, she has been helping lead Nissan's holistic approach to introduction of the Nissan LEAF. Woodard is responsible for local. regional, and state government interaction as well as other stakeholders such as utilities, major employers, universities, etc. Woodard came to Nissan from the Nashville-based firm of Smith Johnson & Carr, where she worked as a lobbyist for seven years. Previously, she had served as a legislative assistant for the Tennessee General Assembly and as a research aide for the Energy Environment and Research Center in Knoxville. She has a Bachelor of Arts degree in political science from the University of Tennessee. A native of Jefferson City, Tennessee, she now lives in Nashville, and her office is located at Nissan's headquarters.

Eric C. Woychik
Itron

Dr. Woychik is an Executive Consultant in Itron's Consulting and Analysis group. He has extensive experience in a number of areas including business-case development, strategy, regulatory policy, electricity markets, cost-effectiveness, and integrated demand-side-management (IDSM). Over more than 30 years, he has worked with numerous utilities, energy companies and regulatory bodies, provided expert testimony on over 50 occasions, and worked in more than 20 countries. Recent projects include (1) five pieces of testimony on DSM cost-effectiveness, shareholder incentives, and decoupling, (2) Central Maine Power's comprehensive smart-grid plan, (3) integrated DSM cost-effectiveness framework for California, and (4) strategic studies to integrate smart grid services in the organized markets. Dr. Woychik currently manages the Energy Efficiency Portfolio Assessment project, a management study of the four major California investor-owned utilities for the California Public Utilities Commission. His doctoral research was on strategic management of electricity markets.

Endnotes

1 Tom Turrentine, Ryan McCarthy, Kevin Nesbitt, Joshua Cunningham, and Josh Boone, "Taking Charge: Establishing California Leadership in the Plug-In Electric Vehicle Marketplace," California Electric Plug-In Vehicle Collaborative, p. 21. Available at: http://www.evcollaborative.org/sites/all/themes/pev/files/docs/Taking_Charge_final2.pdf (accessed June 7, 2012)

2 For a discussion of series versus parallel configuration vehicles, please visit: http://www.ehow.com/about_6130613_series-vs_-parallel-hybrid.html (accessed August 8, 2012).

3 For more discussion on the three types of vehicles, please visit: http://www.goelectricdrive.com/index.php/plug-in-electric-vehicles (accessed August 8, 2012).

4 Tom Turrentine et al., p. 22.

5 John Voelcker, "Electric Cars ARE Coming, But It Will Be Slow: Why Is This So Hard To Grasp?" Green Car Reports Website, March 30, 2012. Available at: http://www.greencarreports.com/news/1074544_electric-cars-are-coming-but-it-will-be-slow-why-is-this-so-hard-to-grasp (accessed June 7, 2012)

6 John Voelcker, "May Electric-Car Sales: Leaf Recovers, Volt And Prius Steady," Green Car Reports Website, June 1, 2012. Available at: http://www.greencarreports.com/news/1076626_may-electric-car-sales-leaf-recovers-volt-and-prius-steady (accessed June 7, 2012)

7 Teal Brown, John Mikulin, Nadia Rhazi, Joachim Seel, and Mark Zimring, "Bay Area Electrified Vehicle Charging Infrastructure: Options for Accelerating Consumer Access," Policy Brief, Renewable & Appropriate Energy Laboratory, UC Berkeley, June 2010, p. 14. Available at: http://rael.berkeley.edu/sites/default/files/Final%20Paper%20Bay%20Area%20Electrified%20Vehicle%20Charging%20Infrastructure%20Options%20for%20Accelerating%20Consumer%20Access.pdf (accessed August 9, 2012).

8 Tom Turrentine et al., p. 26.

9 Up to 87 percent of electric vehicle charging may take place using at-home or business Level 1 charging. *See* "Strategic Technology and Market Analysis of Electric Vehicle Charging Infrastructure in North America," Frost & Sullivan, July 26, 2012. Press release available at: http://www.frost.com/prod/servlet/press-release.pag?docid=264030714 (accessed August 9, 2012).

10 United States Department of Energy, Electric Vehicle Charging Station Locations, Alternative Fuels Data Center website. Available at: http://www.afdc.energy.gov/fuels/electricity_locations.html (accessed August 9, 2012).

11 California Assembly Bill 118 (Nuñez), Statute of 2007, Chapter 750. Available at: http://www.leginfo.ca.gov/pub/07-08/bill/asm/ab_0101-0150/ab_118_bill_20071014_chaptered.pdf (accessed June 18, 2012)

12 *See* Bay Area Air Quality Management District, "BAAQMD EV Charging Equipment Deployment Program" website. Available at: http://www.baaqmd.gov/Divisions/Strategic-Incentives/Bay-Area-EV-Ready/EV-Charge.aspx (accessed August 9, 2012).

13 Tom Turrentine et al., p. 21.

14 Dynegy Parties and the California Public Utilities Commission, *Joint Offer of Settlement*, submitted to the Federal Energy Regulatory Commission, April 27, 2012, at pp. 4-5. Available at: http://www.cpuc.ca.gov/NR/rdonlyres/CD5E3578-5EAD-47BA-BC5A-B6BD398CCBF6/0/JointOfferofSettlement.pdf (accessed June 11, 2012).

15 For more information on The EV Project, please visit: http://www.theevproject.com/overview.php (accessed August 1, 2012).

16 *See* James Williams et al, "The Technology Path to Deep Greenhouse Gas Emissions Cuts by 2050: The Pivotal Role of Electricity," *Science*, January 6, 2012, Vol. 335, Number 6064, at 53-59. Available at: http://www.sciencemag.org/content/335/6064/53 (accessed August 3, 2012). *See also* California's Energy Future: The View To 2050," California Council on Science and Technology, May 2011. Available at: http://ccst.us/publications/2011/2011energy.pdf (accessed August 3, 2012).

17 California Air Resources Board, "ARB Fact Sheet: Air Pollution and Health." Available at: http://www.arb.ca.gov/research/health/fs/fs1/fs1.htm (accessed August 10, 2012).

18 California Air Resources Board and American Lung Association of California, "Recent Research Findings: Health Effects of Particulate Matter and Ozone Air Pollution," November 2007, p. 4.

19 California Air Resources Board, "2008 Estimated Annual Average Emissions." Available at: http://www.arb.ca.gov/app/emsinv/emssumcat_query.php?F_YR=2008&F_DIV=-4&F_SEASON=A&SP=2009&F_AREA=CA#7 (accessed August 10, 2012).

20 California Air Resources Board, "ARB Fact Sheet: Air Pollution Sources, Effects, and Controls." Available at: http://www.arb.ca.gov/research/health/fs/fs2/fs2.htm

21 Panama Bartholomy, Gerry Bemis, Gina Barkalow, Nancy McKeever, Suzanne Phinney, Julia Silvas, and Joanne Vinton, "The Role of Land Use in Meeting California's Energy and Climate Change Goals," California Energy Commission, August 2007, p. 1. Available at: http://www.energy.ca.gov/2007publications/CEC-600-2007-008/CEC-600-2007-008-SF.PDF (accessed August 10, 2012).

22 Marilyn A. Brown, Frank Southworth, and Andrea Sarzynski*, "*Shrinking the Carbon Footprint of Metropolitan America," Brookings Institute, May 2008, p. 2.

23 Reid Ewing, Keith Bartholomew, Steve Winkelman, Jerry Walters & Don Chen, "Growing Cooler: The Evidence on Urban Development and Climate Change, Urban Land Institute," 2008, p. 4.

24 California Department of Transportation, "2008 California Motor Vehicle Stock, Travel and Fuel Forecast," June 2009, p. 1.

25 Matthew Crosby, "Light-Duty Vehicle Electrification in California: Potential Barriers and Opportunities," California Public Utilities Commission, Staff White Paper, Policy and Planning Division, May 22, 2009, p. 16. Available at: http://www.cpuc.ca.gov/nr/rdonlyres/ad8A4A5e-6ed9-4493-bdb6-326ab86a028e/0/cpucppdelectricvehiclewhitepaper2.pdf (accessed August 9, 2012).

26 "Environmental Assessment of Plug-In Hybrid Electric Vehicles, Volume 1: Nationwide Greenhouse Gas Emissions," Electric Power Research Institute, Natural Resources Defense Council, and Charles Clark Group, July 2007, pp. 1-2. Available at: http://energy.gov/sites/prod/files/oeprod/DocumentsandMedia/EPRI-NRDC_PHEV_GHG_report.pdf (accessed June 12, 2012).

27 Matthew Crosby, p. 17.

28 *See* U.S. Environmental Protection Agency "Beyond Tailpipe Emissions" on-line calculator: http://www.fueleconomy.gov/feg/Find.do?action=bt2 (accessed August 3, 2012).

29 California Air Resources Board and American Lung Association of California, p. 1. *See also* California Air Resources Board, "Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology," August 31, 2010, p. 1. Available at: http://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf (accessed August 10, 2012).

30 See U.S. Environmental Protection Agency "Beyond Tailpipe Emissions" on-line calculator: http://www.fueleconomy.gov/feg/evsbs.shtml (accessed August 6, 2012).

31 Tom Turrentine et al., p. 17.

32 See Mark Glover, "California is nation's key player in electric vehicle sales and development," Sacramento Bee, July 22, 2012. Available at: http://www.sacbee.com/2012/07/22/4646208/california-is-nations-key-player.html#storylink=misearch (accessed August 3, 2012).

33 California Senate Bill 2X (Simitian), Statute of 2011, Chapter 1. Available at: http://www.leginfo.ca.gov/pub/11-12/bill/sen/sb_0001-0050/sbx1_2_bill_20110412_chaptered.pdf (accessed August 13, 2012).

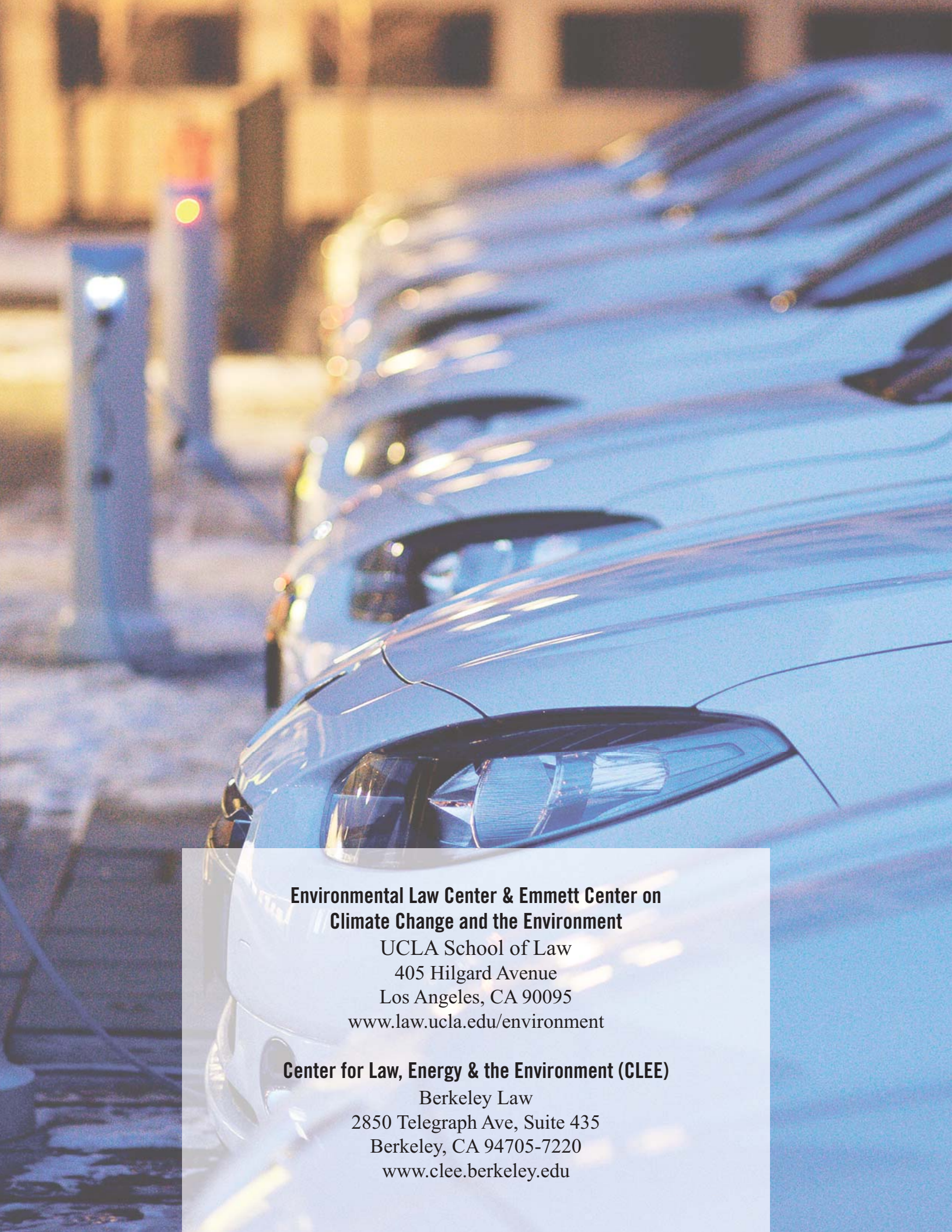
34 Governor Edmund G. Brown Jr., SB 2x Signing Statement, April 12, 2011. Available at: http://gov.ca.gov/docs/SBX1_0002_Signing_Message.pdf (accessed August 13, 2012).

35 California Assembly Bill 32 (Nuñez), Statutes of 2006, Chapter 488. Available at: http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0001-0050/ab_32_bill_20060927_chaptered.pdf

36 California Air Resources Board, "Climate Change Scoping Plan," December 2008, p. ES-1. Available at: http://www.arb.ca.gov/cc/scopingplan/document/adopted_scoping_plan.pdf (accessed August 10, 2012).
37 California Governor Arnold Schwarzenegger, Executive Order S-3-05, June 1, 2005. Available at: http://www.dot.ca.gov/hq/energy/ExecOrderS-3-05.htm (accessed August 1, 2012).
38 California Governor Jerry Brown, Executive Order B-16-12, March 23, 2012. Available at: http://gov.ca.gov/news.php?id=17472 (accessed August 1, 2012).
39 California Air Resources Board, "Climate Change Scoping Plan," December 2008, p. 40.
40 See Louise Wells Bedsworth and Margaret R. Taylor, "Learning from California's Zero-Emission Vehicle Program," California Economic Policy, Volume 3, Number 4, September 2007, p. 6. Available at: http://www.ppic.org/content/pubs/cep/EP_907LBEP.pdf (accessed June 27, 2012).
41 For more information on ZEV and the Advanced Clean Car Program, please visit: http://www.arb.ca.gov/msprog/zevprog/zevprog.htm (accessed June 22, 2012). See also Zero Emission Vehicle (ZEV) Production Requirements, United States Department of Energy website, available at: http://www.afdc.energy.gov/afdc/laws/law/CA/4249 (accessed June 27, 2012).
42 For more information on the Low Carbon Fuel Standard Program, please visit the California Air Resources Board web pages with background http://www.arb.ca.gov/fuels/lcfs/lcfs-background.htm (accessed August 10, 2012). See also "Answers to Frequently Asked Questions": http://www.arb.ca.gov/fuels/lcfs/LCFS_Guidance_%28Final_v.1.0%29.pdf (accessed June 27, 2012).
43 California Assembly Bill 1007 (Pavley), Statute of 2005, Chapter 371. Available at: http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_1001-1050/ab_1007_bill_20050929_chaptered.pdf (accessed August 10, 2012).
44 California Assembly Bill 2076 (Shelley), Statute of 2000, Chapter 936. Available at: http://www.leginfo.ca.gov/pub/99-00/bill/asm/ab_2051-2100/ab_2076_bill_20000930_chaptered.pdf (accessed August 10, 2012).
45 For more information on the High Occupancy Vehicle (HOV) program, please visit: http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project/additional-incentives/2441-hov-stickers?catid=471%3Aother-incentives (accessed June 28, 2012).
46 California Assembly Bill 118 (Nuñez), Statute of 2007, Chapter 750. Available at: http://www.leginfo.ca.gov/pub/07-08/bill/asm/ab_0101-0150/ab_118_bill_20071014_chaptered.pdf (accessed August 10, 2012).
47 California Assembly Bill 118 (Nuñez).
48 For more information on the Clean Vehicle Rebate Project, please visit: http://energycenter.org/index.php/incentive-programs/clean-vehicle-rebate-project (accessed June 22, 2012).
49 Matthew Crosby, p. 52.
50 Matthew Crosby, pp. 45-47.
51 Chris Reiter, "Mission: Impossible, Starring Tom Cruise and the BMW i8," *Businessweek*, December 15, 2011. Available at: http://www.businessweek.com/magazine/mission-impossible-starring-tom-cruise-and-the-bmw-i8-12152011.html (accessed August 3, 2012).
52 For more on the subject of energy storage and its related benefits, please see a previous white paper in this series, "The Power of Energy Storage: How to Increase Deployment in California to Reduce Greenhouse Gas Emissions," UC Berkeley / UCLA Schools of Law, July 2010 (Update November 2011). Available at: http://cdn.law.ucla.edu/SiteCollectionDocuments/Environmental%20Law/Power_of_Energy_Storage.pdf or http://www.law.berkeley.edu/files/The_Power_of_Energy_Storage_July_2010_Update(1).pdf (accessed August 10, 2012).
53 Martin LaMonica, "FERC chairman: Let EV Owners Sell Juice to Grid," *CNET*, September 21, 2010. Available at: http://news.cnet.com/8301-11128_3-20017160-54.html (accessed August 10, 2012).
54 Max Baumhefner, Simon Mui, and Roland Hwang, "The Importance of Model Utility Policies For Vehicle Electrification," *The Electricity Journal*, Volume 25, Issue 5, June 2012,at 21-22. Available at: http://www.sciencedirect.com/science/article/pii/S104061901200142X (accessed August 3, 2012, subscription only).
55 *See* California Public Utilities Commission, Rulemaking R0908009. List of filed documents and decisions available at: http://docs.cpuc.ca.gov/Published/proceedings/R0908009.htm#documents (accessed August 1, 2012).
56 To view the low carbon fuel standard amendments, please visit: http://www.arb.ca.gov/regact/2011/lcfs2011/lcfsappa.pdf (accessed July 18, 2012)
57 *See* California Public Utilities Commission, Rulemaking 11-03-012, Order Instituting Rulemaking to Address Utility Cost and Revenue Issues Associated with Greenhouse Gas Emissions. Available at: http://docs.cpuc.ca.gov/word_pdf/FINAL_DECISION/132932.pdf (accessed August 1, 2012).
58 For more information on EPIC, please visit: http://docs.cpuc.ca.gov/published/News_release/155619.htm (accessed August 1, 2012)
59 For more discussion on a mileage-based fee that accounts for energy usage, *see* David L. Greene, "What is Greener than a VMT Tax?" *Transportation Research Part D: Transport and Environment*, Elsevier, 2011, at 451-458. Available at: http://bakercenter.utk.edu/wp-content/uploads/2012/04/Greene.VMT-tax.1-s2.0-S1361920911000630-main1.pdf (accessed August 1, 2012).

Cover Photo courtesy of Better Place photos

Photos for the whitepaper are courtesy of BetterPlace photos (p. 2 and p. 7), Chevrolet (p. 1, p. 22, p. 24 and back cover), Chargepoint (p. 3, p. 13, p. 20, and p. 23), Toyota (p. 9 and p. 12), The Digitel Myrtle (p. 10), Parker Michael Knight (p. 11), Kevin Krejci (p. 13), Carrott (p. 16)



Environmental Law Center & Emmett Center on Climate Change and the Environment
UCLA School of Law
405 Hilgard Avenue
Los Angeles, CA 90095
www.law.ucla.edu/environment

Center for Law, Energy & the Environment (CLEE)
Berkeley Law
2850 Telegraph Ave, Suite 435
Berkeley, CA 94705-7220
www.clee.berkeley.edu