*Via E-mail*

May 10, 2013

Members of the Grid Modernization Steering Committee
c/o Jonathan Raab, Raab Associates, Ltd.
Tim Woolf, Synapse Energy Economics, Inc.
Massachusetts Department of Public Utilities
One South Station, 5th Floor
Boston, MA 02110

**Re: D.P.U. 12-76: Encouraging the use of Plug-In Electric Vehicles**

Dear Members of the Grid Moderation Steering Committee:

The Natural Resources Defense Council (NRDC) respectfully requests that the Grid Modernization Steering Committee develop and submit to the Massachusetts Department of Public Utilities a set of principles intended to remove barriers to the widespread adoption of plug-in electric vehicles. Through its investigation into the modernization of the electric grid, the Department of Public Utilities has an opportunity to adopt principles and measures that are critical to helping the electric vehicle market flourish in ways that are beneficial to the Commonwealth's consumers, the electric grid and energy security and clean environment goals.

The widespread use of electricity as a transportation fuel can reduce Massachusetts' dependence on petroleum and protect consumers from the volatility of the world oil market. Electricity also has the potential to be a much cleaner fuel for transportation compared to petroleum. This transformation of the transportation sector will require the active engagement of the electric industry as a transportation fuel provider. The price of electricity as a motor vehicle fuel, the ease of vehicle charging, and the environmental benefits of plug-in electric vehicles will largely be determined by the decisions of utilities and state utility regulators.

Enclosed with this letter are three documents that outline and support utility principles that remove barriers to widespread electric vehicle adoption.

The first enclosure, "Utility Policies Are Fundamental to Vehicle Electrification," describes how utility commission action related to rate setting, cost recovery and customer education can have a significant impact on electric vehicle deployment and grid reliability. The principles for model utility electric vehicle policies evolved from NRDC's extensive involvement in the

California Public Utilities Commission proceeding[1] on electric vehicles and are described in *The Electricity Journal's* "The Importance of Model Utility Policies For Vehicle Electrification," an article authored by NRDC.[2]

The second enclosure is the "Resolution on Expanding the Alternative Fuel Vehicle Market" adopted by the National Association of Regulatory Utility Commissioners (NARUC) at their November 14, 2012 124th Annual Meeting. NARUC "urges State and federal regulators to collaborate with other policymakers to remove barriers to [alternative fuel vehicle] deployment."

The third enclosure, "Plugging Vehicles into Clean Energy," describes synergies between plug-in electric vehicles, renewable energy and energy efficiency. An integrated approach to utility regulation can facilitate the deployment of all three and maximize the environmental benefits of plug-in electric vehicles.

Thank you for your attention to this letter and its enclosures. Please feel free to contact me with any questions.

Sincerely,

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[1] California Public Utilities Commission, Decision 10-07-044, Order Instituting Rulemaking 09-08-009.
[2] Max Baumhefner, Simon Mui and Roland Hwang, "The Importance of Model Utility Policies For Vehicle Electrification," *The Electricity Journal*, Vol. 25, Issue 5, June 2012.

## UTILITY POLICIES ARE FUNDAMENTAL TO VEHICLE ELECTRIFICATION

*The widespread use of electricity as a transportation fuel could significantly reduce America's dependence on petroleum and protect consumers from the volatility of the world oil market and is likely necessary to meet long-term climate and environmental goals.[1] This transformation of the transportation sector will require the active engagement of the electric industry as a transportation fuel provider. The price of electricity as a motor vehicle fuel, as well as the ease of plugging-in, and the environmental benefits of plug-in electric vehicles, will largely be determined by the decisions of utilities and state utility regulators.*

### A. The Need For Uniformly Supportive Utility Electric Vehicle Policies

There are over 3,000 electric utilities in the United States.[2] The price of electricity as a transportation fuel and the ease of plugging in can vary tremendously from one utility service territory to another. Uniformly supportive utility policies and active utility engagement on a national scale will be critical to the expansion of the electric vehicle market. National organizations, such as NARUC, will play a critical role in coordinating EV policies across the country. Regional regulations should reflect local considerations, but the following principles should be universally applicable:

- ✓ *Remove barriers to a thriving plug-in vehicle market.*
- ✓ *Minimize costs and avoid adverse grid impacts associated with vehicle charging.*
- ✓ *Maximize the customer, utility system, and environmental benefits of vehicle electrification.*

### B. Every Utility Should Offer Appropriate Rates that Maximize Savings Relative to Gasoline

Plug-in electric vehicles ("EVs") currently have higher purchase prices relative to conventional vehicles but lower operating costs. Whether EVs will be cost-effective for consumers will greatly depend on the ability to maximize fuel cost savings. Utility electricity rates that provide customers access to lower off-peak prices can result in significant savings, but on standard electricity rates in some areas, payback periods may be too long for many consumers. Charging during off-peak hours also minimizes potential adverse impacts to the distribution system and prevents unnecessary investments in additional generation and transmission assets.

**Fuel Costs and Savings for Nissan Leaf, by Utility Rate[3]**

| | Electricity Price ($/kWh) | Electricity Price ($/gal equivalent)[4] | First Year Fuel Cost | Discounted 10 Year Fuel Savings |
|---|---|---|---|---|
| **Average Residential Rate Connecticut** | $0.193[5] | $1.77 | $976 | $7,243 |
| **Average Residential Rate New York** | $0.187[6] | $1.72 | $950 | $7,439 |
| **PG&E EV Rate (off-peak)** | $0.098[7] | $0.90 | $497 | $10,873 |

Rates designed for plug-in electric vehicles ("EVs") can dramatically increase annual fuel savings and reduce payback periods to fit within timeframe the average consumer keeps a new car.[8] **Driving an EV on appropriate rates can be cheaper than driving a comparable conventional vehicle on buck-a-gallon gasoline.**

Unfortunately, many utilities lack rates that are appropriate for EVs. While gasoline prices vary regionally, the differences are slight compared to the variation in electricity prices by utility service territory. Drivers across America should have access to rates that maximize savings relative to gasoline and encourage off-peak charging.

- ✓ *All utilities should offer rates that maximize savings relative to gasoline and reward charging during off-peak hours to minimize adverse impacts to the electrical grid.*

### C. All Electric Vehicle Drivers Should Have Access to Low Cost Off-Peak Electricity

Rates that place both household and EV consumption on time-variant pricing can generally reduce customers bills significantly relative to standard residential rates, the prices of which may vary by marginal consumption, but do not generally vary by time-of-day. However, "whole-home" time-variant EV rates will not work for everyone; some customers may not be able to shift household consumption to avoid higher on-peak prices. Consumers should have the option to choose "EV-Only" rates that provide price transparency and guarantee significant savings relative to gasoline if charging is predominately done during off-peak hours. While many utilities currently offer EV-only rates, installing the second-meters that are often necessary to access such rates can be prohibitively expensive.

- ✓ *Utilities and utility regulators should develop low-cost metering and/or billing solutions to ensure all EV drivers have access to low-cost charging.*
- ✓ *The price of electricity as a transportation fuel should be as clear as the price of gasoline at the pump.*

### D. Targeted Customer Education and Outreach is Essential

Rate options and other programs for EV customers must be coupled with customer education and outreach. Even in California, where utilities have been very active with respect to vehicle electrification, the majority of customers with EVs remain on standard tiered residential rates, despite the fact the upper-tier prices on those rates can largely eliminate savings relative to gasoline.[9] Most customers remain unaware of potential savings available from time-variant rates.

- ✓ *Utilities should identify customers who would benefit financially by making a switch to an EV-rate and proactively inform those customers of potential savings based on their individual circumstances.*
- ✓ *Utility regulators should track the number of customers with EVs and the number of customers on appropriate rates to measure the efficacy of utility outreach efforts.*
- ✓ *Utility regulators should authorize the recovery of reasonable costs associated with targeted outreach.*

### E. Utilities Should Be Notified When Customers Buy Electric Vehicles

If utilities are to minimize the costs of integrating vehicle charging, they must receive timely notification when a customer buys an EV. Even in California, the largest PEV market in the country, vehicle charging is only forecasted to account for three percent of total electricity delivered in 2020 and is not expected to require significant new investments in generation or transmission assets.[10] However, the instantaneous demand of a single PEV can be comparable to that of an entire home, which could result in local distribution system impacts if not properly managed.[11] The cost of replacing a transformer on an emergency basis can be twice that of a planned upgrade.[12]

Notification is also essential to facilitate targeted customer outreach regarding EV rate options, policies, and programs. Existing utility rules generally require customers to provide notification whenever they add significant new load, but customers are often oblivious as to this requirement and only contact the utility if something goes wrong.[13] Utilities must be proactive in their efforts to identify which customers have EVs. Potential sources of actionable information include automakers, auto-dealers, charging equipment installers, local building permit offices, smart meter data, and state DMVs. Legislative changes are sometimes necessary to allow access to DMV data, which is the most comprehensive source.

- ✓ *Utilities and utility regulators should ensure timely notification and sponsor legislation, as needed, to secure access to DMV vehicle registration information*

### F. The Costs of Distribution Upgrades Necessary to Accommodate EV Load Should Be Recovered Using the Same Set of Cost-Recovery Rules that Govern Costs Associated with Comparable Loads

From the point-of-view of a transformer, load is load. There is no reason to treat EV load less favorably than comparably demanding loads such as hot-tubs and air conditioners, which lack the corresponding environmental benefits. Existing utility rules governing cost recovery are generally sufficient to recover costs associated with integrating vehicle load.

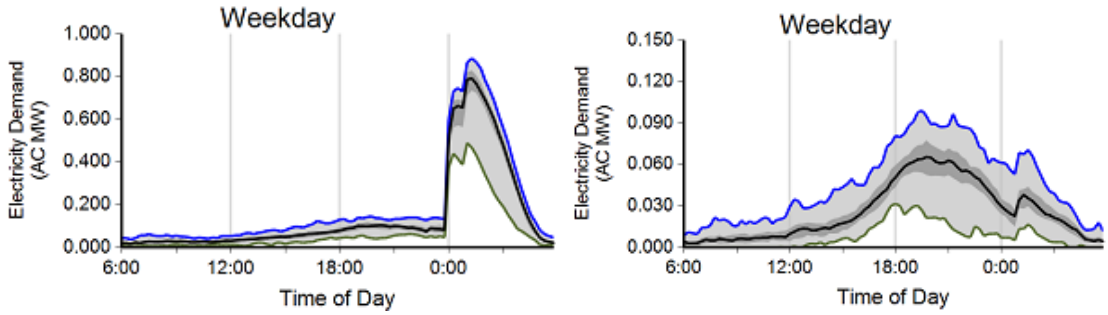
Attributing a distribution upgrade cost to a specific load based solely on order of addition is also inherently flawed. It is arbitrary to state that a plug-in vehicle added in August "caused" the need for a transformer upgrade, when an air conditioner added in July brought the transformer to the point where the addition of any significant new load would have necessitated an upgrade.

- ✓ *Utility regulators should not alter the existing cost recovery framework in anticipation of EV load.*
- ✓ *Rather than attempting inherently flawed cost attribution, utility regulators should focus on policies that minimize costs.*

## G. Price Signals Combined With Targeted Outreach Can Effectively Minimize Adverse Grid Impacts

The figure below contrasts the latest data depicting the range of aggregate electricity demand of residential electric vehicle charging in San Diego (on the left), which has time-of-use rates and extensive customer education and outreach programs, and the Washington D.C. metropolitan area (on the right).

*Second Quarter, 2012, Aggregate Vehicle Demand versus Time of Day:*
*San Diego (522 vehicles) vs. Washington D.C. (88 vehicles)* [14]




In San Diego, almost all residential weekday charging activity occurs between the hours of midnight and 5:00 a.m., the "Super Off-Peak" period on San Diego Gas & Electric's EV rates. In contrast, drivers in the Washington D.C. metropolitan area appear to simply plug-in when they arrive home, during hours that often coincide with system-wide peak electricity demand. It is worth noting that pushing vehicle charging to off-peak hours does not require active management by individual drivers or a sophisticated, communication-enabled, "smart grid." Customers can take advantage of the simple timers and other programmable charging options offered by their vehicles and get on with their lives.

- ✓ *The early market is the time to shape charging behavior norms.*
- ✓ *Utilities and utility regulators should combine price signals with targeted outreach to ensure savings relative to gasoline are maximized and charging occurs off-peak to minimize adverse impacts to the electrical grid.*

## H. Regulatory Treatment of Third Party Charging Service Providers

State public utilities codes often define the term "electric utility" in very broad terms, potentially subjecting third-party EV charging service providers to the jurisdiction of state utility regulators. In most instances, such companies will simply act as customers of utilities and will be subject to the terms of service, rates, and other policies adopted by state regulatory commissions. Such companies should not be subject the full extent of utility regulatory authority. However, in making it clear that companies acting as customers of utilities will not be subject to the full extent of their jurisdiction, regulators should proceed with appropriate diligence and avoid creating sweeping exemptions that could hinder future efforts to ensure the environmental performance and integrity of the electrical grid. Regulators should simply make it clear that providing vehicle-charging services does not alone render a company subject to utility regulation. This is the approach taken by California Assembly Bill 631, which also expressly reserves all other sources of state regulatory authority.[15] NRDC prefers such exemptions to proscriptive directives (e.g., "The Commission shall not regulate any aspect of companies that offer vehicle charging services"). Such broad disavowals of authority could create loopholes in regulatory frameworks governing the procurement of electricity and undermine the integrity of Renewable Portfolio Standards.

- ✓ *Utility regulators and legislators should provide regulatory certainty to third-party charging service providers by making it clear that charging vehicles will not alone subject such companies to utility regulation, but should avoid sweeping disavowals of regulatory authority.*

## I. Utility Ownership of Vehicle Charging Equipment

Providers of public access charging should not face inappropriate competition from regulated utilities. Utilities wishing to provide public access charging should generally do so through unregulated affiliates. However, outright prohibitions on utility ownership of charging equipment could prevent partnerships and projects that have the potential to accelerate vehicle deployment and benefit all utility customers. Utilities can facilitate demonstration projects, will often own charging equipment for their own fleet vehicles, and may play a necessary role in underserved markets. Sweeping prohibitions should be avoided at this early stage in the development of the market.

- ✓ *Utility regulators should ensure protections are in place to prevent regulated utilities from unfairly competing with third-party providers of charging services, but should craft such protections narrowly to prevent foreclosing utility efforts that could benefit all utility customers and accelerate the deployment of clean vehicles.*

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[1] Michael Kintner-Meyer et.al., *Impacts Assessment of Plug-In Hybrid Vehicles on Electric Utilities and Regional U.S. Power Grids Part 1: Technical Analysis*, Pacific Northwest National Laboratory (2007). *California's Energy Future: A View to 2050*, California Council on Science and Technology, ISBN-13: 978-1-930117-44-0 (2011).

[2] *See* Energy Information Agency, *Table 10. Class of Ownership, Number of Consumers, Sales, Revenue, and Average Retail Price by State and Utility: All Sectors*, 2010.

[3] Assumptions: $33,000 Nissan Leaf with a $7,500 Federal tax credit, compared to a 27 mpg $21,000 conventional vehicle running on $3.50 gallon/gasoline, with a 3% discount rate and declining annual mileage.

[4] The price of gasoline at which driving a 27 mile-per-gallon conventional vehicle is equivalent to driving an electric vehicle with 0.34kWh/mi efficiency (that of the Nissan Leaf).

[5] Energy Information Agency, *Table 4 Average Retail Price for Bundled and Unbundled Consumers by Sector, Census Division, and State, 2010*. Residential sector.

[6] *Id*.

[7] Off-peak price on Pacific Gas & Electric's "Schedule EV" rate.

[8] Polk, *Length of U.S. Vehicle Ownership Hits Record High*, February, 2012.

[9] Driving an electric vehicle with an efficiency of 0.34kWh/mi on Pacific Gas & Electric's "Electric Schedule E1" Tier 4 price of $0.335/kWh is the cost equivalent of driving a 27 mile-per-gallon conventional vehicle on $3.08/gallon gasoline.

[10] California Public Utilities Commission, *Joint IOU Assessment Report for PEV Notification*, Rulemaking 09-08-009 (2011), at 13. *Note*: driving 10,000 miles on electricity would only increase the average American annual household consumption by about a third assuming 0.34 kilowatt-hour/mile PEV efficiency, and average annual residential electricity consumption of just under 11,000 kilowatt-hours per household. *See:* Energy Information Agency, *Table 5A. Residential Average Monthly Bill by Census Division, and State* (2009).

[11] Today's PEVs are generally capable of charging at 1.2, 3.3 or 6.6 kilowatts, a range which is comparable to the range in peak summer demand between typical California coastal and inland homes, according to Pacific Gas & Electric.

[12] California Public Utilities Commission, *Joint IOU Assessment Report for PEV Notification*, Rulemaking 09-08-009 (2011), at 27.

[13] *Id*. at 47.

[14] *See* Ecotality, EV Project Quarterly Report, Second Quarter, 2012.

[15] California Assembly Bill 631 (Ma, 2011): "The ownership, control, operation, or management of a facility that supplies electricity to the public only for use to charge light duty plug-in electric vehicles does not make the corporation or person a public utility within the meaning of this section solely because of that ownership, control, operation, or management. For purposes of this subdivision, "light duty plug-in electric vehicles" includes light duty battery electric and plug-in hybrid electric vehicles. This subdivision does not affect the commission's authority under Section 454 or 740.2 or any other applicable statute."

***EL-1/ERE-2/GS-1 Resolution on Expanding the Alternative Fuel Vehicle Market***

**WHEREAS**, On July 20, 2011, the Board of Directors of the National Association of Regulatory Utility Commissioners (NARUC) adopted a resolution on *Alternative Fuel Vehicle Development and Deployment* recognizing that alternative fuel vehicles (AFVs) can enhance national energy security and reduce emissions, and that continued leadership by State and federal policy makers is needed to ensure the goals of that resolution are fulfilled in today's rapidly evolving AFV market; *and*

**WHEREAS**, Utility companies and third-party providers are considering various business models for entering the AFV service market, including providing charging and fueling infrastructure; *and*

**WHEREAS**, Third-party equipment manufacturers are forging ahead with new technologies to make charging and fueling safe, easy, convenient, and affordable for customers; *and*

**WHEREAS**, There is a growing convergence of energy and transportation policy at the State level, with many State legislatures and governors considering and adopting policies that impact the role and responsibilities of utilities in the AFV market; *and*

**WHEREAS**, Utility companies are preparing for the AFV market by deploying advanced metering technologies and control systems, designing innovative rates and incentives, and assessing transmission and distribution systems, to minimize any potential risk to reliability and to maximize consumer savings; *and*

**WHEREAS**, As AFV penetration increases, a coordinated system to provide utility companies timely notification of AFV purchases and the location of planned public and private charging and fueling infrastructure would facilitate strategic system-wide planning, targeted customer education and outreach and further accelerate the development of the AFV market; *and*

**WHEREAS**, The continued commitment of utility companies to environmental improvements in the production and delivery of alternative fuels, programs and policies will help realize the full economic, environmental, and societal benefits of AFVs; *and*

**WHEREAS**, Local and State governments and State commissions are uniquely positioned to further the development of the AFV market by collaborating with utility companies and other stakeholders on educating consumers on the availability, environmental benefits, and cost-effectiveness of AFVs, as well as the proper installation and efficient use of charging and fueling infrastructure; now, *therefore be it*

**RESOLVED**, That the National Association of Regulatory Utility Commissioners convened at its 2012 Annual Meeting in Baltimore, Maryland, and urges State and federal regulators to collaborate with other policymakers to remove barriers to AFV deployment, and ensure consistent, fuel-neutral policies to help realize the full economic, environmental and societal benefits of AFVs; *and be it further*

**RESOLVED**, That NARUC supports utility company programs and policies that allow for the continued development of the AFV market, including addressing any potential upgrades to grid and pipeline infrastructure that may be needed to maintain the integrity of the utility system and design of innovative rate programs or incentives to maximize customer savings; *and be it further*

**RESOLVED**, That NARUC believes third-party providers of fueling and charging services that purchase power or fuel from a regulated public utility or other competitive energy supplier to provide to the public should not be considered public utilities and therefore not regulated as such; *and be it further*

**RESOLVED**, That NARUC encourages utility companies to collaborate with federal, State and local policymakers to address potential consumer protection concerns, safety issues and reliability impacts that could arise from fueling and charging services provided by third-parties; *and be it further*

**RESOLVED**, That NARUC supports a competitive AFV marketplace, where utility companies, businesses, governments, and third-party service providers are able to participate in the owning, leasing, operating, or maintenance of charging or fueling equipment; *and be it further*

**RESOLVED**, That NARUC encourages utility companies to work with local governments, State agencies, automakers, and other stakeholders to secure timely notification of AFV purchases and proposed charging or fueling infrastructure installations to facilitate strategic system-wide planning and targeted customer outreach; *and be it further*

**RESOLVED**, That NARUC supports customer education and outreach on the benefits of AFVs, including their availability, environmental benefits, and cost effectiveness, and the proper installation and efficient use of charging or fueling infrastructure, as well as the availability of programs and tariffs that maximize savings from AFV use and protect the integrity of the utility system; *and be it further*

**RESOLVED**, That NARUC encourages State legislatures and governors to consider consistent, fuel-neutral transportation funding solutions and policies that support the growth, adoption and increased environmental performance of AFVs.

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*Sponsored by the Committees on Electricity, the Committee on Energy Resources and the Environment and Committee on Gas*
*Recommended by the NARUC Board of Directors, November 13, 2012*
*Adopted by the NARUC Committee of the Whole, November 14, 2012*

*October, 2012*[1]

# Plugging Vehicles into Clean Energy

Max Baumhefner[1] & Ed Pike[2] co-authors; Andreas Klugescheid[3] contributing author

[1]*Natural Resources Defense Council,* [2]*Energy Solutions (the majority of this author's research was performed while employed by the International Council on Clean Transportation);* [3]*BMW Group*

*The authors wish to thank their colleagues in the California Plug-in Electric Vehicle Collaborative for their valuable comments and recommendations.*

**Abstract**

California has an opportunity to complement and coordinate its plug-in electric vehicle, renewable energy, and energy efficiency strategies to maximize environmental benefits and expand the market for both plug-in electric vehicles and clean energy. Giving consumers options to offset energy and emissions associated with vehicle charging can attract potential buyers who remain uncertain about the environmental benefits of plug-in electric vehicles. The increased energy awareness that accompanies vehicle electrification can also be leveraged to further California's energy efficiency and renewable energy goals. This paper briefly summarizes the relationship between clean energy and vehicle electrification and describes five voluntary paths to link the two: 1) on-site energy efficiency; 2) on-site renewables; 3) off-site renewables; 4) Renewable Energy Certificates; and 5) facilitating the integration of variable centralized renewable resources. Policy makers and stakeholders should leverage and coordinate existing programs and develop innovative approaches in each of these five areas to expand the markets for both plug-in electric vehicles and clean energy solutions.

## 1 The Plug-in Electric Vehicle Clean Energy Nexus

While driving a plug-in electric vehicle ("PEV") in California emits only about a quarter as much greenhouse gas pollution as the average new US passenger vehicle, many customers within the PEV market segment are motivated by a desire to drive completely "emissions free."[2] Maximizing the "green" advantage of PEVs could be important to support early commercialization and market expansion. Almost half of respondents in an international study conducted by Accenture reported that knowing electric vehicles were charged with renewable electricity would encourage them to buy one.[3] Researchers from Simon Fraser University and the University of California at Davis found that combining "green energy" with PEVs caused conventional car buyers participating in a design exercise to purchase PEVs 23 percent more frequently.[4]

Electrification of transportation also presents a singular opportunity to raise the energy awareness of consumers in the electricity sector. Sixty-seven percent of participants in a yearlong study conducted by the University of California at Davis and BMW reported that driving an electric version of the MINI Cooper, the "MINI E," changed the way they think about energy.[5] In fact, several participants installed solar panels and undertook building energy efficiency upgrades. Once people plug-in their vehicle, they often start thinking differently about the source of their electricity. Even in the US, where climate change and related topics are not necessarily as "top of mind" as in Europe, MINI E drivers became much more aware of their "fuel" and most thought that it should come from renewable resources by the end of their lease period.[6]

California's electricity mix is already one of the cleanest in the nation and will only get cleaner as the state makes progress towards its goal of procuring a third of its electricity from renewable resources by the end of this decade.[7] Nevertheless, providing PEV drivers and other stakeholders with clear paths to drive "emissions free" could be an effective method to increase PEV sales by providing

a clear and simple message about the environmental benefits of PEVs. Further addressing non-tailpipe emissions could also counter the negative environmental narrative promoted by critics of vehicle electrification. Policies and programs that promote both PEVs and clean energy could further improve the public perception of electric vehicles and support the expansion of renewable energy and energy efficiency.

# 2 Five Potential Means to Link Plug-in Vehicles and Clean Energy

## 2.1 On-Site Energy Efficiency Upgrades

Energy efficiency is generally the lowest cost resource to offset increased electricity usage from PEV charging and does not create any local or greenhouse gas pollutants. The increased energy awareness that accompanies vehicle electrification provides an opportunity to help meet California's ambitious energy efficiency goals while cutting consumer costs.[8]

Driving a PEV can increase typical household electricity consumption by about a third, an amount that can generally be completely offset using readily available residential efficiency upgrades, including lighting, heating, cooling, and building envelope improvements.[9] Businesses can also cost-effectively combine energy efficiency upgrades with PEV charging equipment installations. Nationally, commercial buildings have the potential to reduce load 30 percent using currently available technologies.[10] For example, curbside and garage PEV charging could be offset through the use of highly efficient Light-Emitting Diodes, intelligent lighting and ventilation controls, and other building efficiency options.[11]

In some applications, energy efficiency could potentially help customers who would otherwise lack sufficient electric panel capacity to install PEV charging equipment.[12] Unlike the sunk cost of a larger electric panel, investing in energy efficiency provides a continuing stream of cost savings. Efficiency improvements can also help customers avoid higher utility bills that can result from upper-tier prices or demand charges.[13]

Both Assembly Bill 2853 and Governor Jerry Brown's "Zero Emission Vehicle Action Plan" include directives to increase the number of PEVs in state-owned fleets, the number of state employees who drive PEVs, and the number of PEV charging stations in state-owned buildings and parking facilities.[14] Those installations could be coupled with energy efficiency upgrades to minimize increased energy costs associated with PEV charging.

Existing energy efficiency programs, such as those administered by electric utilities and other parties, can be leveraged to offset PEV charging. In fact, California Senate Bill 1340 expanded the scope of Property Assessed Clean Energy programs, which provide financing for distributed generation and energy efficiency upgrades, to include PEV charging infrastructure and the CALGreen building code contains voluntary provisions for both energy efficiency and PEV readiness.[15] "Energy Upgrade California" and similar programs could provide information about energy efficiency to PEV owners, a segment of the population likely to adopt energy efficiency measures. Similarly, energy efficiency outreach programs could provide information about the benefits of PEVs to those interested in driving on electricity. "Energy Service Companies" and other private energy efficiency contractors could also target commercial and residential customers installing PEV charging equipment.

In sum, the increased energy awareness that results from the use of electricity as a transportation fuel can drive cost-effective energy efficiency, further improving the economics of vehicle electrification, while existing energy efficiency programs could provide a platform to educate interested customers as to the benefits of PEVs. Coordinating these efforts would help California meet its long-term environmental goals.

## 2.2 On-Site Renewable Generation

On-site renewable electricity provides a tangible connection between vehicle charging and clean energy. Nearly 40 percent of the first wave of PEV drivers in California own rooftop solar systems, and an additional 17 percent report an intention to install solar within a year.[16] Several existing state programs, as well as emerging private sector collaborations, could build upon this synergy.

The California Solar Initiative grants rebates for rooftop photovoltaic systems. The size of the

system that can be installed under the program is limited by total on-site load at the customer premises with the amount of the rebate varying depending on estimated or actual system performance.[17] California is currently phasing out the rebate program, as the market no longer requires the same degree of public support, though a federal tax credit remains in place. The California Public Utilities Commission is also currently considering an investment plan recommended by the California Energy Commission which, amongst other items, includes additional funding for the New Solar Homes Partnership, a program that provides incentives for rooftop solar on new construction.[18] In keeping with the state's loading order prioritizing energy efficiency, to qualify under the program, homes must be at least 15 percent more efficient than required by state building codes.[19] The policy justification for the additional funding for the New Solar Homes Partnership is partially based on the potential connection between distributed generation and plug-in vehicles.[20] In addition, the South Coast Air Quality Management District has issued a solicitation for five megawatts of distributed on-site renewable electricity for transportation fuel in the District.[21]

Net energy metering ("NEM") is another policy that facilitates implementation of distributed generation. Net energy metering is an accounting and crediting approach that allows customers with on-site generation to receive bill credits for energy exported to the grid when their systems are producing electricity in excess of on-site need. These bill credits are applied toward their energy bills, which helps address the fact that solar systems generate electricity during the day, while electric vehicles are most likely to be charged during the night. The California Public Utilities Commission recently clarified that NEM new enrollments will be allowed until the end of 2014, pending completion of a review of program costs and benefits, including costs to non-participating customers.[22]

Private sector partnerships are also underway to meet the demonstrated consumer interest in both PEVs and on-site renewables. Ford and Nissan have partnered with SunPower, and BMW has partnered with Real Goods Solar to offer residential customers the opportunity to offset their vehicle electricity demand through renewable energy.[23] Clipper Creek, a manufacturer of PEV charging equipment, recently announced a similar partnership with SolarCity.[24] On-site solar may also be an attractive strategy for businesses to avoid potential demand charges, especially if they are charging during hours of peak electricity demand.

In addition to these efforts, the National Renewable Energy Laboratory is investigating the use of on-site renewables to power both battery electric and hydrogen fuel cell vehicles.[25] The potential for synergies across these technologies should be considered when setting public and private R&D priorities.

## 2.3 Off-Site Renewable Generation

Some utilities offer customers the opportunity to contract directly with renewable energy providers or purchase shares in local renewable energy projects. The Sacramento Municipal Utility District's "Solar Shares" program allows customers to purchase a portion of the electricity generated by a local one-megawatt solar farm. San Diego Gas & Electric recently applied for approval from the California Public Utilities Commission for a "Share the Sun" program, which allows customers to contract directly with solar developers for electricity delivered by San Diego & Gas Electric. Such programs allow PEV drivers who would like to install on-site renewables, but who are unable to do so, a chance to provide tangible support for renewable generation. Utilities that already offer off-site renewable programs should consider targeting PEV drivers in outreach efforts, and utilities with increasing numbers of PEV customers should consider developing off-site renewable programs to meet the potential customer demand.

## 2.4 Voluntary Purchases of Renewable Energy Certificates

Voluntary purchases of Renewable Energy Certificates ("RECs") by utilities, charging service companies, automakers, and consumers could prove a scalable and affordable means to both support renewable electricity development and improve the public perception of the environmental benefits of vehicle electrification. Innovators in this area would be well suited for recognition at the US EPA's "Green Power Leadership" awards.

### 2.4.1 Definition of RECs

When a renewable energy facility operates, two products are created: 1) the electrical energy; and 2) the renewable attributes of that energy. These

renewable or "green" attributes can be sold separately as RECs.

The Center for Resource Solutions ("CRS") is the nation's leading certifier of RECs. The CRS "Green-e" certification requires that the underlying electricity be produced by a qualifying resource built within the last 15 years. The purchaser of a Green-e certified REC has the sole right to make renewable claims about the associated electricity. To ensure the exclusivity of this right, CRS verifies that RECs sold are "retired" on behalf of the purchaser, are not sold to another entity, or used to meet regulatory obligations. RECs are not reviewed for "additionality," i.e., whether a specific project would have been built absent anticipated revenue from the sale of RECs. Any investment decision in a renewable energy project is contingent upon many factors, including availability of transmission lines, financing, tax incentives, and power purchase agreements. The revenue available from the sale of RECs is only a single component. However, a functioning REC market supports additional investment toward renewable energy by providing a revenue stream that would not otherwise exist. This should foster investments that would not otherwise be made.[26]

### 2.4.2 Buying and Selling RECs

RECs are often purchased by electricity providers to comply with state renewable energy goals, or Renewable Portfolio Standards. "Appendix A" contains a map of states with such policies in place. Those goals vary state-to-state and sometimes stipulate that the entity purchasing RECs must also purchase the underlying electricity, and may require certain percentages of in-state generation or generation from preferred resources.[27] Accordingly, the price of RECs that can be used for compliance purposes varies tremendously depending on the requirements of the relevant state mandate.[28]

In voluntary markets, RECs are typically purchased by organizations wishing to "green" their electricity or by electricity providers that offer customers voluntary "green pricing" programs. Because voluntary markets are not subject to the supply constraints imposed by specific state policies, REC prices can be lower than in compliance markets. Of course, buyers are free to stipulate requirements such as proximity to their state's electricity grid and can buy RECs that could otherwise be used for compliance with state Renewable Portfolio Standards, ensuring a high degree of additionality.

The cost of purchasing RECs sufficient to cover an electric vehicle's annual consumption appears to be very small relative to both the cost of a vehicle and the cost of the electricity necessary to charge it. Two to four megawatt-hours, i.e., two to four RECs representing one megawatt-hour each, would be sufficient to cover most PEV owners' annual electric driving needs.[29] Currently, wholesale REC prices are low in most markets, though trending upwards. The cost of REC purchases sufficient to meet annual vehicle consumption would be likely under $20.[30]

### 2.4.3 PEV Owner Purchased RECs

Individual electric vehicle drivers can easily purchase Green-e certified RECs online, though entities such as corporate buyers wishing to purchase at scale can often secure lower prices.[31] Intel, Kohls Markets, and Whole Foods are examples of corporations that purchase large quantities of RECs.

### 2.4.4 Utility Supplied RECs

PEV drivers with access to utility green pricing programs can already choose to have their utility retire RECs on their behalf sufficient to meet their household electricity consumption. Many utilities, including Sacramento Municipal Utility District, Los Angeles Water and Power, and smaller regional utilities already offer customers voluntary green pricing programs.[32] Pacific Gas & Electric and San Diego Gas & Electric both recently applied for approval of green pricing options from the California Public Utilities Commission.[33] RECs purchased for such green pricing programs are in addition to those required by Renewable Portfolio Standards.

Many utility REC programs in California have been remarkably successful. The 20 percent participation rate in the City of Palo Alto Utilities' program leads the nation and both PacifiCorp and Sacramento Municipal Utility District were in the top four utilities nationwide for voluntary renewable energy sales per year.[34] Nationally, however, only around two percent of those utility customers who have the option to choose green pricing do so.[35] Utilities wishing to expand green pricing programs could offer PEV-specific programs, or could leverage the increased energy awareness that accompanies vehicle electrification to increase participation in existing programs. Vehicle electrification could

also encourage greater numbers of utilities to offer green pricing programs.

### 2.4.5 Automaker and Electric Vehicle Charging Company Supplied RECs

Automakers and electric vehicle charging companies can also purchase RECs on behalf of their customers in order to further improve the public perception of electric vehicles and encourage additional sales. REC purchasing by automakers or electric vehicle charging companies would also ensure that all of their customers, in any utility service territory, would have the option to support clean energy.

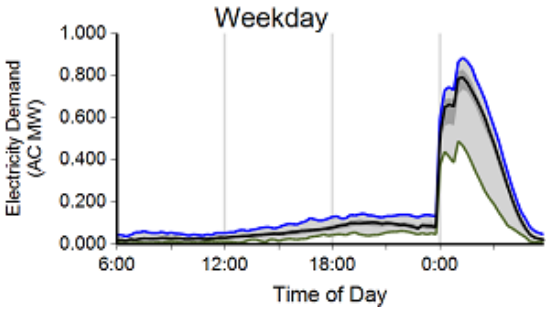
BMW recently announced a partnership with Green Mountain Energy to offer customers leasing the BMW "ActiveE" the opportunity to purchase Green-e certified RECs sufficient for vehicle charging over the life of the two-year lease for a single payment of $48.[36] Participating customers receive a window decal for their ActiveE reflecting the decision to drive on wind energy.

## 2.5 Facilitating the Integration of Variable Renewable Resources

The California Renewable Energy Resources Act of 2011 obligates electricity providers operating in California to procure at least 33% percent of their retail service from eligible renewable resources by the year 2020.[37] PEV electricity consumption will not significantly add to overall renewable electricity utility procurement requirements. Even if all of California's projected 2020 PEV fleet were to drive exclusively on green electricity, it would equate to around two to three percent of the total renewable electricity that would be required to meet California's statewide renewable energy goal.[38] In fact, PEVs offer the opportunity to facilitate the integration of large-scale renewables that do not necessarily coincide with peak demand, such as wind, which often peaks during the evening and nighttime hours when vehicles are most often charged.[39]

Time-variant rates, including "time-of-use" block rates, already encourage off-peak charging when wind turbines are often most productive. Time-variant rates are generally designed to reflect the variable cost of service, including wholesale prices and generation from eligible renewable resources. Rates can be set on a whole-house basis for residential customers, or specifically for PEV load if separately metered. Time-of-use rates available to California PEV customers have set prices for different blocks of hours during the day, with high prices during "peak" hours and lower prices during "off-peak" hours. *Figure 1* shows that San Diego Gas & Electric has been very successful in coupling time-of-use pricing with active customer education and outreach. Approximately 80% of PEV charging in the San Diego area occurs between midnight and 5:00 A.M.

*Figure 1: San Diego Gas & Electric PEV Charging Profile*[40]




PEVs could potentially provide even larger grid benefits for California renewables integration if charging times could be managed to match real-time renewable generation while still meeting customer needs. One option to match charging to real-time generation is to provide an information service from the California Independent System Operator to the customer via utility Advanced Metering Infrastructure, the Internet, or other means.

> Fuel cell electric vehicles, along with efficient gasoline powered vehicles and PEVs, are part of California's strategy to reduce GHG by 80% in 2050 and cut conventional pollutants. Renewable hydrogen for fuel cell vehicles faces several challenges and opportunities similar to those facing PEVs. California has set a requirement for 33% renewable hydrogen, which can be produced both from renewable electricity and other renewable feed stocks such as biogas.

Customers could then adjust their charging schedule to match the availability of renewable generation. General Motors and PJM Interconnect are currently testing the customer information option, leveraging the Chevy Volt's "OnStar" system to match charging to renewable generation.[41]

Alternatively, a customer could pre-authorize flexible charging schedules within certain parameters or a company could actively manage battery charging. For instance, Project Better Place and PJM Interconnect have studied control by a "Central Network Operator" as a potential cost savings measure in the Baltimore-Washington area.[42] In 2009, BMW demonstrated this potential in a partnership with the European utility, Vattenfall, matching the charging needs of a MINI E fleet with intermittent wind energy.[43]

Businesses with existing energy management systems could test algorithms to shape PEV load in response to forecasted renewable generation. Companies that own and charge batteries leased to customers that can aggregate load and leverage existing battery charging control networks may provide an additional opportunity to match charging to renewable generation. Intelligent load management could also help customers avoid higher on-peak prices and demand charges.

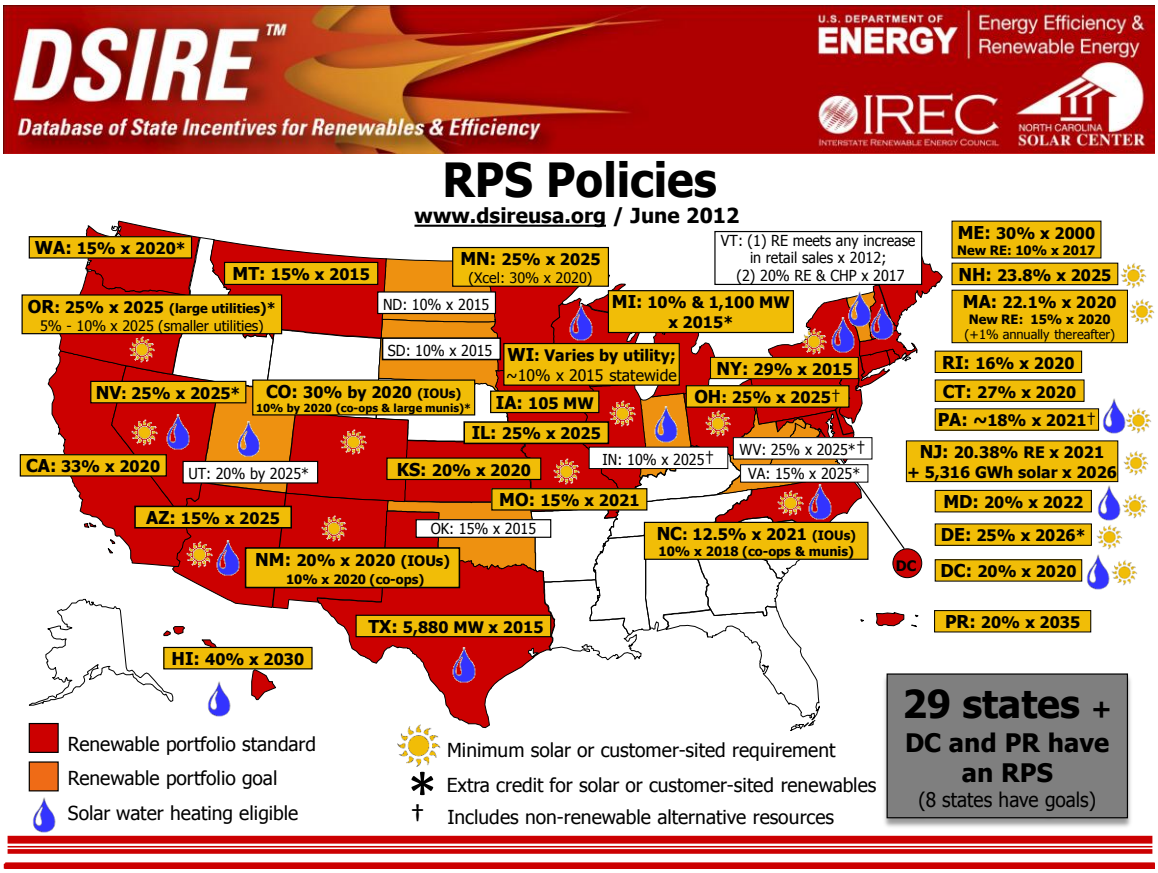
Several actions will help further the benefits of PEV deployments for meeting renewables targets. The first is educating customers on the benefits of time-variant rates and making such rates accessible to all utility customers. More active load management would require communications systems, protocols, and technology, as well as appropriate rate structures. Developing and demonstrating the technology and systems for active load shaping should be a priority for public and private sector PEV and renewable electricity R&D.

In the longer term, vehicle-to-grid ( "V2G" ) technology which leverages vehicle batteries to provide distributed energy storage to support the grid may offer further opportunities to integrate renewable resources and lower costs since vehicles are parked for the vast majority of the day. The technology faces challenges including battery durability, utility distribution network management, and two-way coordination between PEV owners and utilities. However, as noted in a recent California Plug-in Electric Vehicle Collaborative workshop on the subject, several V2G pilot projects are underway, and Governor Brown's *2012 ZEV Action Plan* calls for the California Independent System Operator to develop a "V2G Roadmap" to enable the commercialization of V2G technology and services.[44]

# 3 Conclusion

Governor Brown's Executive Order focused on zero-emission vehicles includes a goal of reducing the state's greenhouse gas emissions by 80% relative to 1990 levels by the year 2050.[45] California has a golden opportunity to leverage PEV technology, renewable electricity, and energy efficiency programs to meet this goal while reducing the state's dependence on oil and fostering a clean energy economy. Coordinating the state's PEV and clean energy programs would set a global precedent. Were California its own country, it would have the third largest number of PEV deployments behind the US without California and Japan.[46] Specific near-term opportunities for California policy-makers and stakeholders include:

- Co-promoting utility and other PEV, energy efficiency, distributed generation, off-site renewable, and green pricing programs.
- Targeting "Energy Upgrade California" and similar energy efficiency education and outreach programs at potential and current PEV owners and leveraging existing energy efficiency programs to educate customers about the benefits of PEVs.
- Coordinating the installation of vehicle charging equipment with energy efficiency upgrades at state-owned buildings and parking structures.
- Encouraging PEV drivers, utilities, PEV charging companies, and automakers to purchase RECs sufficient to offset PEV driving.
- Conducting the customer education and outreach necessary to ensure PEV charging occurs during off-peak hours when adverse impacts to the distribution grid are minimized and the potential to integrate off-peak renewable resources is the greatest.
- Supporting the development of communications systems and pilot projects to demonstrate managed PEV charging to match large-scale renewables availability, while exploring research of vehicle-to-grid technology in the longer term.




Source: *Database of State Incentives for Renewables and Efficiency*.

[1] Minor revisions made in November, reflected in this version of the paper.
[2] US EPA, *Beyond Tailpipe Emissions*. Note that the calculator compares electric vehicles to the average new US passenger vehicle including both cars and light trucks/sport utility vehicles.
[3] Accenture, *Plug-in Electric Vehicles Changing Perceptions, Hedging Bets*, 2011, p. 16.
[4] K.S. Kurani, J. Axsen, N. Caperello, K. Bedir, and J. Tyree Hagerman, *Consumers, Plug-in Electric Vehicles, and Green Electricity*, presented at "Plug-in Electric Vehicles and Clean Energy in California," Sacramento, California, October 24, 2012.
[5] Tom Turrentine, Dahlia Garas, Andy Lentz, and Justin Woodjack, *The UC Davis MINI E Consumer Study*, May, 2011, p. 71.
[6] *Ibid.* at p. 70.
[7] *See* California Senate Bill X1-2, 2011.
[8] *See* California Air Resources Board, *Climate Change Scoping Plan*, December, 2008; California Public Utilities Commission, *California Long Term Energy Efficiency Strategic Plan*, September, 2008.
[9] The average U.S. household uses 11,500 kilowatt-hours per year (Energy Information Agency, *Table 5.A: Residential Average Monthly Bill by Census Division, and State 2010*.) A PEV with an efficiency of 0.33 kilowatt-hours per mile driven 10,000 miles per year would increase the average home consumption by less than a third, an amount that can be offset using readily available technologies (Rich Brown, Sam Borgeson, Jon Koomey, and Peter Biermayer, *U.S. Building-Sector Energy Efficiency Potential*, September, 2008, Table 2.) For reference, current Nissan Leaf drivers are averaging approximately 7,900 miles per year. (*See* Ecotality, *EV Project Quarterly Report,*

*Second Quarter*, 2012. Note: estimation assumes linear vehicle adoption throughout quarter in question.) Of course, PEV utility is expected to increase as technology improves and more charging infrastructure is deployed. Electric mileage for plug-in hybrid drivers will also depend on individual driving patterns. For reference, according to Chevy's "On-Star" data, Volts are being driven 62% on electricity.

[10] *Ibid.*

[11] Streetlight and garage energy efficiency opportunities are described in the references below. For instance, the saving described below for a San Mateo County garage retrofit would save enough electricity to power roughly 80 light-duty PEVs per day drawing enough power to drive 25 miles each. (Jordan Shackelford and Terry Pang, *LED Street Lighting and Network Controls*, 2010; Jordan Shackelford and Terry Pang, *Street Lighting Network Controls Market Assessment Report*, 2010; and Energy Solutions, *San Mateo County Drives Down Electricity Costs in Parking Garage By 67% with Efficient T8 Lamps and Wireless Lighting Controls*.)

[12] This is, of course, dependent on inspectors accounting for energy efficiency upgrades when conducting load calculations.

[13] Some utility tariffs incorporate marginal pricing, whereby prices increase according to marginal consumption, with higher prices for the upper tiers of consumption. Utility tariffs can also include demand charges, which are based on power requirement (e.g., kilowatts), as opposed to power consumed (e.g., kilowatt-hours) and are meant to recover capacity costs imposed on the electrical grid.

[14] *See* California Assembly Bill 2583, 2012; and Governor's Interagency Working Group on Zero-emission Vehicles, *Draft 2012 ZEV Action Plan*, September, 2012.

[15] *See* California Senate Bill 1340, 2010; Jordan Shackelford, Alex Chase, Michael McGaraghan, and Stuart Tartaglia, *Reducing Barriers to Electric Vehicle Adoption through Building Codes*, 2012.

[16] California Center for Sustainable Energy, *California PEV Owner Survey*, August, 2012, p. 9.

[17] California Public Utilities Commission, *California Solar Initiative Program Handbook*, September, 2012.

[18] *See:* California Energy Commission, *The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan*, October, 2012, p. 192.

[19] California's "loading order" requires the procurement all cost-effective energy efficiency before other resources. *See: Energy Action Plan – 2008 Update*; *Final 2005 Energy Action Plan II*; and *Final 2003 Energy Action Plan I*.

[20] *See:* California Energy Commission, *The Electric Program Investment Charge: Proposed 2012-14 Triennial Investment Plan*, October, 2012, p. 194.

[21] Alfonso Baez, *Session 2: Stationary and Infrastructure: Renewable Energy Generation to Support Electric Transportation*.

[22] California Public Utilities Commission, *CPUC Takes Action to Support Solar by Clarifying Net Metering Cap*, 2012. For a prior evaluation, see California Public Utilities Commission, *Introduction to the Net Energy Metering Cost Effectiveness Evaluation*, March, 2010.

[23] Ford, *Here Comes the Sun*, 2011; Sunpower, *SunPower Helps Nissan LEAF Owners Further Reduce Emissions and Save on Electricity Costs*, 2011; BMW, *BMW of North America Selects Real Goods Solar for Solar Partnership*, 2012.

[24] SolarCity, *SolarCity to Make Solar-Powered Electric Vehicle Charging Available Across its Service Territory*, 2011.

[25] National Renewable Energy Laboratory, *NREL Improves System Efficiency and Increases Energy Transfer with Wind2H2 Project, Enabling Reduced Cost Electrolysis Production*, November, 2010; Power Electronics Technology, *NREL Explores Benefits of Solar-Powered Charging for Plug-in HEVs*, January 24, 2008.

[26] For more details see Center for Resource Solutions, *Greene-e Long Disclosure*, 2012.

[27] To comply with California's procurement mandate, utilities must generally purchase both the electricity and the associated RECs. This requirement is sometimes referred to as "bundling."

[28] Ryan Wiser, *State of the States: Update on RPS Policies and Progress*, 2010, p. 19.

[29] This is equal to 6,000-12,000 miles per year at 0.33 kilowatt-hours per mile. Mileage for individuals could vary from this band.

[30] Consumers can buy RECs online from sites such as "buycleanenergy.org/" for about $5 each. Accordingly, $20 would be sufficient for 12,000 miles of driving, which, as noted in endnote eight, exceeds current PEV driving patterns. Of course, entities purchasing in larger quantities can secure lower prices.

[31] For example, the website "buycleanenergy.org/" outlines three simple steps for individuals wishing to purchase RECs.

[32] Sacramento Municipal Utility District's "Greenenergy" program charges one cent per kilowatt-hour, which goes towards general REC purchases. Other programs give customers the option of choosing what percentage of their monthly electricity usage will be met by RECs; Anaheim Public Utilities allows customers to purchase additional 100 kilowatt-hour blocks of RECs in increments of $1.50 per month. Los Angeles Water and Power's "Green Power" program bundles RECs and the associated power and allows customers to choose what percent of their power they would like to be renewable.

[33] Pacific Gas & Electric, *PG&E Announces New Green Energy Program to Give Electric Customers More Renewable Options*, April, 2012; San Diego Gas & Electric, *Application of San Diego Gas & Electric Company (U 902 E) for Authority to Implement Optional Pilot Program to Increase Customer Access to Solar Generated Electricity*, January, 2012.

[34] National Renewable Energy Laboratory, *NREL Highlights 2010 Utility Green Power Leaders*, 2011.

[35] Lori Bird, Claire Kreycik, and Barry Friedman, *Green Power Marketing in the Unites States: A Status Report (11th Edition)*, October, 2008, pp. 5-6.

[36] Green Mountain Energy, *Support Renewable Energy to Contribute to a Greener Grid and a Cleaner Future for Your BMW ActiveE*, 2012. This program provides RECs sufficient to cover three years of driving 15,000 miles per year.

[37] California Senate Bill X1-2, 2011.

[38] A total of 78.8 to 90.5 terawatt-hours of renewable electricity will be needed in 2020 to comply with the Renewable Portfolio Standard. (California Energy Commission, *Proposed Method to Calculate the Amount of New Renewable Generation Necessary to Comply with Policy Goals*, Table 1, p. 3.) One million PEVs with an average efficiency of 0.33 kilowatt-hours per mile, each driven 10,000 electric miles per year would increase demand by 3.3 terawatt-hours. The incremental renewable procurement to go from 33 percent to 100 percent renewable electricity would be about 2.2 terawatt-hours, or 2-3% of available renewable electricity.

[39] *See* Ecotality, *EV Project Quarterly Report, Second Quarter*, 2012.

[40] *Ibid.*

[41] OnStar News, *Volt Owners May Soon Get Charged with Renewable Energy*, January 23, 2012.

[42] Stephen Schneider, Rob Bearman, Hugh McDermott, Xu Xu, Scott Benner, and Ken Huber, *An Assessment of the Price Impacts of Electric Vehicles on the PJM Market*, 2011.

[43] Vattenfall AG, *Klimaentlastung durch den Einsatz erneuerbarer Energien im Zusammenwirken mit emissionsfreien Elektrofahrzeugen* (Climate Change Mitigation Through Usage of Renewable Energy Sources in Combination with Emission Free Electric Vehicles), March, 2011.

[44] *See* Governor's Interagency Working Group on Zero-emission Vehicles, *Draft 2012 ZEV Action Plan*, September, 2012.

[45] Office of Edmund G. Brown Jr., *Executive Oder B-16-2012*, March 23, 2012.

[46] International Council on Clean Transportation, *Tracking Markets and Performance*, 2012.