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REPORT IN BRIEF

Overcoming Barriers to Electric-Vehicle Deployment

Interim Report

Board on Energy and Environmental Systems, Division on Engineering & Physical Sciences · Transportation Research Board · May 2013

Electric vehicles hold many promises—increasing U.S. energy security by reducing petroleum dependence, contributing to climate-change initiatives by decreasing greenhouse gas (GHG) emissions, stimulating long-term economic growth through the development of new technologies and industries, and improving public health by improving local air quality. However, the vehicles have some technologic limitations including restricted electric range and the long time required for battery charging, a higher cost than conventional vehicles, and infrastructure required for charging the battery. This short interim report identifies infrastructure needs for electric vehicles and the barriers to deploying that infrastructure and considers the adoption of plug-in electric vehicles (PEVs) from the customer perspective. It also presents optional roles for the federal government in overcoming barriers along with an initial discussion of the pros and cons of the possible roles. A final comprehensive report is scheduled to be released in late summer 2014.

Background and Introduction

Given the recognized barriers to electric-vehicle adoption, Congress asked the Department of Energy (DOE) to commission a study by the National Academies to address market barriers that are slowing the purchase of electric vehicles and hindering the deployment of supporting infrastructure. The National Research Council (NRC)—a part of the National Academies—appointed an ad hoc committee to gather and review information and conduct analyses to be documented in two reports: the present interim report, which is focused on near-term options, and a final comprehensive report. The committee will continue analyses through late spring 2014 and will issue its final report in late summer 2014.

This report focuses on the light-duty vehicle sector in the United States and restricts its discussion of electric vehicles to PEVs, which include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). While the batteries for both vehicles are charged by being plugged into the electric grid, BEVs operate solely on electricity stored in a battery—that is, there is no other power source—while PHEVs have internal combustion engines that can supplement the electric power train.

Summary and Overview

Overall, there are no serious technical barriers to the deployment of infrastructure at residences, workplaces, and publicly accessible locations. A substantial fraction of detached homes have great capacity for at least basic charging, although widespread deployment might face challenges in the case of multifamily housing and rental properties.

Increasing the availability of workplace charging is an important infrastructure opportunity given that vehicles are typically parked at workplaces for at least 8 hours each day during the workweek. Workplace charging might also present a primary charging opportunity for those who lack access to residential charging.

In the case of publicly accessible charging, the high installation costs and low revenue associated with providing electricity present challenges for developing sustainable business models and thus might require public-private partnerships or other forms of continued government support in the near term.

Many of the activities suggested here could increase the public's familiarity with PEVs and encourage their adoption. Others could provide information that would help in designing effective policies and ensure that the PEV investment is working to increase the fraction of electric miles traveled. The disadvantages of the possible activities are that they require resources—time, money, or staff. The strain on federal resources emphasizes the need to understand which policies are most effective, what does not work, and the best ways to revise or restructure policies or programs to make them more effective. The final report will explore those and other options further and will consider other barriers to PEV deployment, including technologic and economic ones.

Barriers Related to Customers, Manufacturers, and Dealers

Most potential PEV customers have little knowledge of PEVs and almost no experience with them. Lack of familiarity with the vehicles and their operation and maintenance creates a substantial barrier to widespread PEV deployment.

Few PEV model choices are offered to customers, and the variety offered does not meet the needs of all customers. However, sales of PEVs must increase to justify further investment by automobile manufacturers for diversifying the products offered.

Most BEVs have small driving ranges, and this could be a substantial barrier to their widespread adoption. However, commuting by electricity stored in vehicles should be feasible on a large scale in the United States given that some BEVs can routinely travel 40–80 miles on one charge. In addition, nearly 70% of average daily travel is less than 40 miles and over 90% is less than 80 miles.

PEVs have higher purchase prices than comparable conventional vehicles. Research indicates that people heavily discount the value of future gains; stickerprice premiums typically will be difficult to overcome with fuel-savings promises alone.

Dealerships are independent franchises that are not owned or operated by the automobile manufacturers. Training and educating dealership personnel—salespersons, mechanics, financial specialists, and managers—entail substantial costs to a franchise. Given those costs, many dealerships do not appear to be fully prepared to explain PEVs and educate customers about them. As a result, there appears to be an information gap at the primary point of sales.

Few data on customer perceptions, attitudes, and behavior regarding PEVs are publicly available. Although some studies have examined those topics, further research could help to determine how to structure effective programs and policies. Little research has been conducted to determine which government policies concerning PEVs are the most successful and why.

Possible Federal Roles

Produce public-service announcements that showcase current PEV owners, describe the benefits of PEV ownership, and illustrate how a PEV meets various transportation needs; create marketing campaigns that help customers to understand incentives and that target audiences with transportation needs that might fit PEVs; and provide ride-and-drive activities or demonstrations at high-visibility locations to familiarize the public with PEVs.

Continue to provide economic incentives—such as continuing or extending tax credits or rebates—to encourage customers to buy PEVs; increase the tax on gasoline by increasing taxes on motor fuels or by instituting a broad-based carbon tax; and use the convening function to coordinate state and local incentives that would encourage PEV ownership and use, such as access to carpool lanes, parking benefits, and reduced vehicle registration or licensing fees. Some research has shown that purchase rebates can be more effective than income- tax credits.

Support research to obtain a better understanding of why potential customers would or would not purchase PEVs and how they have responded to various initiatives, programs, or incentives that are aimed at promoting widespread PEV adoption, including DOE's Clean Cities programs; and revise or adapt programs as information on their effectiveness is collected.

Continue to support research on and development of electric-drive technologies to improve their performance and reduce their costs; reduced costs would encourage purchase and indirectly encourage the use of electric-drive technology in a variety of models.

Barriers Related to the Charging Infrastructure

Charging a PEV is analogous to filling the fuel tank of a conventional vehicle with gasoline, although at a much lower rate. PEVs can be "filled" at a variety of locations, including private residences and workplaces; thus, the electric analogue of a gas station is not likely to be the primary source of energy for a PEV. Furthermore, unlike a conventional vehicle, PEVs can be "filled" at different rates by using different charger types. Charging rate affects the length of time required to charge a PEV, the equipment and installation requirements, and the cost of providing charging at a particular location.

It is critical to standardize the many components of the charging infrastructure. Multiple plugs for fast chargers and the lack of standardization of payment methods for various charging networks are particularly problematic.

There are no serious technical barriers to the installation of charging infrastructure at most residences that have access to garages or carports. Charging at such residences would meet the needs of all foreseeable PHEVs and of most BEVs

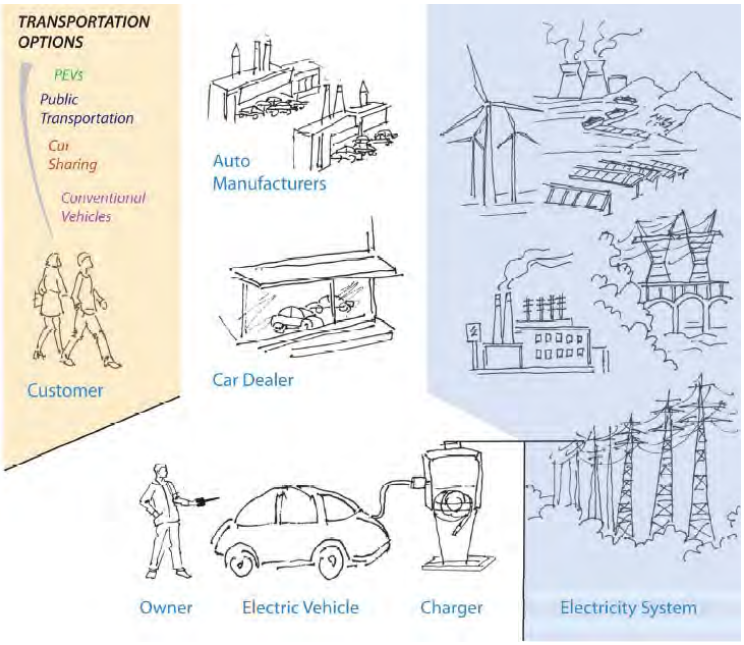

FIGURE 1-2 The ecosystem of the plug-in electric vehicle, which includes the automobile manufacturer, the car dealer, the customer, the owner, the electric vehicle, the charger, and the electricity system.

that have ranges of up to 100 miles. The main barriers to the widespread adoption of residential charging of PEVs appear to be the cost and the effort of installing the wiring and charging apparatus.

An overarching need for the deployment of all aspects of the PEV charging infrastructure is an understanding of the charging needs for PHEV and BEV drivers, how their needs might change in the future, and how they might change in response to various policy initiatives. Those needs are affected by a variety of factors, including the types of PEVs on the road, travel patterns of these vehicles, and the costs of charging at different locations.

Residential charging is problematic for residences that have access only to on-street parking, as might be the case for multifamily dwellings in high-density locations. Residential charging also might be problematic for those who rent their homes and therefore would not have authority to make structural changes to the property that would be required for installing a charger and possible electricity upgrades. An owner of a rental property could be reluctant to invest in charging equipment that might not be used by the next tenant. Thus, for those drivers who lack access to residential charging, the barriers might be partially overcome by having access to workplace or public-charging infrastructure.

Increasing the availability of workplace charging infrastructure offers a potentially important opportunity to encourage the adoption of PEVs. The workplace provides a place where vehicles are parked typically for at least 8 hours during the day. Over that time, even a low-power charger can add a useful amount of vehicle range. Important unknowns regarding workplace charging infrastructure are the potential effects and needs if and when much larger battery capacity becomes affordable; this might be particularly important in less densely populated areas. Another important unknown is how the use of workplace charging might depend on whether employees have to pay for it.

Publicly accessible charging infrastructure provides several important benefits, such as extending the electric range of all PEVs, relieving range concerns of BEV owners, and providing increased visibility of both PHEVs and BEVs. However, the high cost of installing public charging stations and the little revenue obtained from providing electricity present challenges for developing sustainable business models. In the near term, deploying publicly accessible charging infrastructure might require public-private partnerships or other forms of continued government support.

Possible Federal Role

Continue efforts to collect, analyze, and disseminate data on vehicle charging, PEV sales, and policy effectiveness. The resulting information could help to address the extent to which various charging options meet residential, workplace, and publicly accessible charging needs. It could also improve understanding of what policies are most effective in maximizing the fraction of electric miles traveled. The analysis could include research to understand the effects of installing charging infrastructure on economic and related activity.

Continue tax incentives and subsidies for installing charging infrastructure and encourage state and local governments to streamline permitting and to adopt building codes that require new construction to be PEV-charging-enabled.

Encourage or subsidize local governments to establish dedicated parking spots or to install charging infrastructure that is publicly accessible.

Offer a financial incentive, such as an accelerated depreciation schedule, so that businesses are more willing to offer workplace charging; exempt electricity provided by workplace charging infrastructure from being treated as a taxable benefit; work with utilities and their regulators to minimize special charges that might be incurred because of workplace charging; and support research on demonstration installations.

Provide incentives to demonstration projects proposing credible business models that could eventually be sustained when subsidies are no longer available; provide

increased clarity and simplicity regarding regulatory compliance with such laws as the Americans with Disabilities Act; and incentivize landowners, retailers, and public agencies to offer host sites for installing charging infrastructure in key highway corridors.

Use the convening function to encourage standardization of charging plugs and payment methods. The committee recognizes that such standardization might restrain innovation, but increasing compatibility increases coverage of the whole charging infrastructure.

Barriers Related to the Electric Grid

Another important consideration for PEV deployment is the electric grid, which provides the electricity that powers PEVs. The mass deployment of PEVs would create a substantial new load for the electric grid, and how the power sector handles this addition might affect the deployment of PEVs.

The existing electric infrastructure does not present a barrier to the expansion of PEV technology in the United States given the projected growth of PEV use in the next decade. With the exception of a scenario in which PEVs are concentrated within an overburdened branch of the distribution system, no major physical barriers have been identified.

As PEVs account for a more significant share of total electricity consumption, there are no foreseeable barriers to provision of generation and distribution capacity to accommodate the growth through the normal processes of infrastructure expansion and upgrades in the electric-utility industry.

The current time-based rate structures—time-of-use or real-time pricing—available to most commercial and industrial customers and some residential customers provide an incentive to PEV owners and utilities in that they encourage charging at times when lower-cost generating capacity is available.

Regulating third-party entities—nonowner, nonutility charging-service providers—as utilities could increase operating costs and decrease business-model flexibility. Furthermore, the role and scope allowed to utilities, as opposed to third-party entities, in providing charging equipment are unclear.

The lack of access to or price premium for clean electricity could be a barrier to PEV adoption by vehicle owners who are seeking to mitigate their environmental impact. Overall, however, there is already a net benefit of using PEVs compared with using vehicles that have traditional internal-combustion engines given the existing mix of electricity-generation sources. The benefit can be increased by a continued transition to generation sources that have lower life-cycle emissions.

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