Energy Policy 65 (2014) 562–566

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Communication

Increasing electric vehicle policy efficiency and effectiveness by reducing mainstream market bias

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HIGHLIGHTS

- We argue that U.S. electric vehicle policies are inefficient and ineffective.
- We introduce "mainstream consumer bias" as an explanation for policy deficiencies.
- We propose an alternative policy agenda to address some of these policy problems.
- Proposed policy options include strategic niche management, targeted R&D and incentives, and loans.

ARTICLE INFO

Article history:
Received 30 July 2013
Received in revised form
8 October 2013
Accepted 9 October 2013
Available online 6 November 2013

Keywords:
Plug-in electric vehicles
Technology diffusion
Transportation
Policy effectiveness

ABSTRACT

Plug-in electric vehicles (PEVs) provide an opportunity for reducing energy use and emissions in the transportation sector. Currently, a number of federal policies are in place to incentivize deployment of PEVs to mainstream consumers with demographics and vehicle attribute preferences most common to today's new vehicle purchasers. This article argues that policies intending to give PEVs a foothold in the market should not focus on mainstream consumers and should instead focus on niche markets—specifically carsharing and postal fleets—and early adopters including green consumers. Two arguments can be made in support of eliminating the mainstream market bias of current policies toward a policy of cultivating niche markets. The first is *efficiency*: so far PEV policies featuring a mainstream market bias have proven to be inefficient and costly. The second is *effectiveness*: it is becoming increasingly evident that PEV policies would be more effective in achieving potential societal benefits if they focused on early adopters and niche markets using such approaches as strategic niche management, accessible loans and financing, and appropriately targeted incentives. PEV policies focused on early adopters and niche markets would create complementary system effects that will lead to increased PEV market penetration and realization of intended societal benefits.

1. PEV policies and mainstream market bias

"Electric cars are at a fork in the road, with oblivion lying in one direction, and the mass market in the other" (Lochhead, 2013), begins a February 2013 U.S. popular press article on the future of plug-in electric vehicles (PEVs). Despite extensive government programs and incentives, PEV sales in the U.S. reached only ~53,000 in 2012 (0.3% of vehicle sales), far below levels required to meet the Obama administration's goal of one million PEVs on the road by 2015 (EDTA, 2013; Shepardson, 2013; whitehouse.gov, n.d.). It is now clear that the one million vehicle threshold will not be achieved by 2015. This is because the goal was disconnected from market- and technology-constraints and, as a result, strictly dependent on how much the U.S. government was willing to spend to achieve it.

As PEV policy costs mount—with an expectation to exceed $7 billion by 2019 (CBO, 2012)—and the success of PEV policy increasingly in doubt, PEV policy strategy is also at a fork in the road. The government can continue to offer generous subsidies to prop up EV purchases within the mainstream market, or can choose to spend the money to nurture PEV niche markets, thus realizing the societal benefits of PEVs more efficiently and effectively. In this paper we reveal problems associated the mainstream market bias of today's PEV policy and discuss policy mechanisms that would result in more efficient and effective deployment of PEVs.

2. PEV policy failures resulting from mainstream market bias

Policies to encourage PEV adoption generally fall into three categories: (1) research and development (R&D); (2) investments

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0301-4215/$ - see front matter © 2013 Elsevier Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.enpol.2013.10.024

in charging infrastructure and electric vehicle service equipment (EVSE); and, (3) vehicle tax credits or rebates.[1] Although these policies are intended to address the primary barriers to mainstream PEV adoption[2], we argue in Sections 2.1–2.3 that each category of PEV policy contains a mainstream market bias that threatens the ability of these policies to achieve the intended goals.

2.1. Mainstream bias in R&D expectations

A number of federal R&D efforts are explicitly aimed at mainstream consumers. The US *EV Everywhere* initiative, for instance, has a goal of producing PEVs with "sufficient range and fast-charging ability to enable average Americans everywhere to meet their daily transportation needs more conveniently" by 2022 (U.S. DOE, 2012b). The U.S. Department of Energy (DOE) notes that increased range and decreased cost "are essential to achieving mass market adoption" (U.S. DOE, 2013c). Thus, R&D goals include ambitious targets such as "a battery that will go 300 miles on a single charge" (whitehouse.gov, n.d.) and as a result substantial resources are being invested to meet these mainstream market goals.

For instance, Congress approved $330 million in funding for battery and vehicle research in 2012; President Obama proposed allocating $2 billion over 10 years on R&D for advanced vehicles including PEVs; and the proposed 2014 budget includes $575 million for DOE vehicle research (LeBeau, 2013; Loveday, 2013; Shepardson, 2013; The White House Office of the Press Secretary, 2013). The underlying assumption for justifying such investments is that PEVs must rival conventional vehicles in all respects in order to be viable market contenders. However, advancements in PEV performance to achieve mainstream penetration often fail to reduce—and may increase—costs in the short term, thereby pricing them out of reach for most consumers (Axsen et al., 2011; Dijk et al., 2013). More importantly, these investments crowd out other investments that would bring more basic PEV designs to market, and which ultimately may be more attractive for early adopters. For example, Axsen et al. (2010) found that potential early adopters chose lower-performance PEV battery designs than those assumed by experts, and that their expectations could be met with existing battery technology.

2.2. Mainstream bias in charging infrastructure investments

Investment in charging infrastructure is central to US PEV policy. The Alternative Fuel Infrastructure Tax Credit offers up to 30% of the cost of PEV charging infrastructure; the U.S. DOE Transportation Electrification Initiative provided nearly $20 million to facilitate the creation of 4600 charging stations; and the $230 million EV Project (about half of which is federally funded) builds and monitors "mature" EVSE networks in several cities (CBO, 2012; EV News, 2013; Smart and Schey; U.S. DOE, 2012a, 2013a).

These efforts presuppose that in order to meet the needs of mainstream PEV drivers, a dense, elaborate network of charging stations is required. This assumption likely derives from experience with other alternative fuel vehicles (AFVs), which face the "chicken-and-egg" problem: people will not purchase AFVs without adequate fueling infrastructure, and fuel providers will not invest in infrastructure until a critical mass of AFVs is achieved (McNutt and Rodgers, 2004; Melaina and Bremson, 2008; Meyer and Winebrake, 2009; Struben and Sterman, 2008; Winebrake and Farrell, 1997). However, "chicken-and-egg" does not quite apply to early PEV markets since the charging infrastructure challenge is fundamentally different than other AFVs. Most importantly, more than half of US households already have the ability to charge PEVs at home (Axsen and Kurani, 2012; Zpryme, 2010), so in effect millions of "charging points" already exist throughout the US (U.S. DOE, 2011). A 2012 survey of PEV owners found that virtually all charge their vehicles at home, and one-third use a simple 120-volt outlet to do so (J.D. Power and Associates, 2012). According to a City of New York study, early adopters do not require a high density public charging network but instead need the capability to charge at home, whether in a personal or commercial garage (NYC).

As Kley et al. (2011) observe, "range anxiety" is more psychological than physical, and pilot programs in Europe have shown that public charging infrastructure is rarely used. In fact, in most *EV Project* cities each publicly accessible Level 2 EVSE is used on average once every 5–10 days (0.1–0.2 charging events per day—compared to 0.9 charging events per day for residential Level 2 EVSE), and DC Fast Chargers are used less than four times per day on average—effectively 5% of the time available (Ecotality, 2013a; Ecotality, 2013b; Kley et al., 2011). Investments in public PEV charging infrastructure, therefore, may offer marginal value in realizing the intended benefits of PEV adoption. In fact it has already been shown that EVSE investments are less cost-effective than increased PEV battery range, viewed in the context of reduced petroleum consumption (Peterson and Michalek, 2013). So in effect millions are being spent on public EVSE to alleviate mainstream consumers' range anxiety, while failing to significantly increase PEV adoption.

2.3. Mainstream bias in tax credits

In 2009, the US government established a *Plug-in Electric Vehicle Tax Credit*, which allows PEV purchasers to deduct between $2,500 and $7,500 from their federal income tax liability, depending on battery capacity and vehicle weight (CBO, 2012; U.S. DOE, 2013b)[3]; President Obama has proposed increasing the tax credit cap to $10,000 (LeBeau, 2013). According to the Congressional Budget Office (CBO), the PEV tax credit is too small to stimulate a significant amount of new consumer demand (CBO, 2012; Deloitte, 2011), and most taxpayers do not have a tax liability great enough to even use the credit (only 20% of taxpayers had an estimated tax liability of $7500 or more; and only 40% had a $2500+ liability in 2011). Thus, the majority of PEV tax credits will subsidize purchases that would have happened anyway without the tax credit and will have little-to-no effect on petroleum displacement and emissions reduction (CBO, 2012).

3. Benefits of re-focusing PEV policy on niche markets

To design more cost-efficient and effective policies to encourage PEV deployment, it is necessary to eliminate mainstream market bias and consider a target audience of early adopters–consumers who care about the environment and are willing to accept tradeoffs in features and price in order to achieve the

[1] Additional incentives targeted at the general public include, for example, use of HOV lanes, reduced taxes or fees, and preferential electricity rates for PEV charging; however these require relatively minor investment of government resources, and are not expected to have significant impacts on PEV market penetration. Here we limit our discussion to the three policy categories outlined above.

[2] The primary barriers to mainstream PEV adoption include: higher upfront cost; limited range; reliability concerns; limited charging infrastructure; and long charging time (Browne et al., 2012; Carley et al., 2013; ConsumerReports.org, 2012; Deloitte, 2011; Egbue and Long; J.D. Power and Associates, 2012; Zpryme, 2010).

[3] Several states and localities also offer financial incentives to reduce the upfront cost of PEVs (U.S. DOE, 2013a).