



The effectiveness of financial purchase incentives for battery electric vehicles – A review of the evidence



Scott Hardman^{a,*}, Amrit Chandan^b, Gil Tal^a, Tom Turrentine^a

^a Plug-in Hybrid and Electric Vehicle Research Center, Institute of Transportation Studies, University of California, Davis, United States

^b Blue Vine Consultants, Birmingham, United Kingdom

ARTICLE INFO

Keywords:

Electric Vehicles
Policy
Incentives
Review

ABSTRACT

Plug-in electric vehicles (PEVs) are in an early stage of market entry. Nevertheless, there are now more than 2 million PEVs in use globally. PEVs result in lower energy consumption, greenhouse gas emissions, and urban air pollution compared to internal combustion engine vehicles (ICEVs). For these reasons policy makers are eager to see PEVs purchased by consumers in larger numbers. Many policy makers have introduced financial purchase incentives to nurture the growth of PEV markets. These incentives range in value from around US\$2500 to US\$20,000 per vehicle. There are several studies that either directly consider the effectiveness of purchase incentives or at least include analysis of these incentives as part of a larger study. The results of these studies have not been assimilated in one place to gain an understanding of whether purchase incentives are effective in promoting PEV sales. This means that how effective these incentives are in increasing PEV sales is not well understood. This paper systematically reviews the literature with the aim of understanding purchase incentives effectiveness in increasing PEV sales. In doing so this paper builds a deeper understanding of purchase incentives. This in-depth understanding allows recommendations to be made on how to design purchase incentives so that they are most effective in promoting PEV market growth. Incentives should be applied when someone is buying a PEV, not afterwards. Incentives should promote BEVs and PHEV with high electric ranges more than PHEVs with low electric ranges. VAT and purchase tax exemptions for PEVs are most effective. Incentives should not be available on high-end BEVs, education and awareness campaigns should promote incentives to consumers. Finally, the premature removal of incentives could negatively affect PEVs therefore incentives should be designed with longevity in mind.

1. Introduction

Plug-in electric vehicles (PEVs) are one solution to creating a transportation system that is more energy efficient, less polluting, and has greater energy security. Compared to the current transportation system which is dominated by gasoline and diesel internal combustion engine vehicles (ICEVs), PEVs are more efficient, produce zero tailpipe emissions, and have far greater well-to-wheel efficiencies [38,39,46]. Many governments are eager to see PEVs adopted in greater numbers for these reasons. Some governments are using policy measures such as financial purchase incentives to encourage consumers to purchase PEVs over internal combustion engine vehicles (ICEVs). Research into the impact of these incentives on PEV sales has been ongoing since 2008. However, within the literature there is currently no single study that reviews this research to better understand under what conditions financial purchase incentives are an effective tool to increase PEV market shares. Previous reviews have

covered purchase incentives along with benefits such as free parking, HOV lane access, and infrastructure development along with other issues such as private motivations and the socio-economic profile of PEV buyers. These reviews do not take an in-depth look at financial purchase incentives meaning a thorough understanding of the issue does not yet exist. Furthermore, they do not contain recent studies that are the first to include evidence from the developing PEV markets. The aim of this paper is to review this literature in detail to understand the effectiveness of financial purchase incentives in the promotion of PEVs. The in-depth review considers all studies that investigate the impact of financial purchase incentives on the uptake of PEVs. Previous studies have reviewed literature mostly containing aggregate sales data which is unable to accurately detect reasons behind trends in the data. The early literature contained mostly choice experiments that aim to predict which factors may influence consumers to choose PEVs. These studies are less representative of actual purchase behaviour than questionnaires that survey consumers who have purchased a PEV. This

* Corresponding author.

E-mail address: shardman@ucdavis.edu (S. Hardman).

review adds to the literature due to it containing these recently published studies, along with studies that use choice experiments and statistical analysis. This review therefore brings greater clarity to this topic than has previously been possible. The review contains studies that analyse different types of financial incentives in different regions. This review is therefore able to observe differences in the effectiveness of the different types of incentives and to detect common themes relating to incentive schemes which may have been picked up in individual studies but were not highlighted as significant factors. By detecting these nuances this review can make policy recommendations explicitly stating which purchase incentives are the most effective, how they should be administered, and which vehicle types should be targeted.

This review paper covers any literature that conducts empirical research on the impact of purchase incentives on PEV market uptake. This review does not include a financial analysis to discover whether purchase incentives reduce the price of PEVs so that they reach price parity with ICEVs. It also does not review any literature that use these kind of techniques, such as papers that use total cost of ownership (TCO) models to calculate whether PEVs are financially beneficial for consumers. These publications do not offer a full analysis of alternative fuel vehicle (AFV) purchase motivations. They focus on the cost difference and on the cost of technologies only. It has long been understood that consumers in general, and early adopters of technologies particularly, are not entirely economically rational in their decision behaviours. This has also been found to be true for the automotive sector, even for buyers of hybrid or electric vehicles [20,50]. Consumers purchase PEVs for a variety of reasons including technological, performance, environmental and symbolic motivations [2,5,6,19,21,28,40]. Some consumers have been found to purchase PEVs for financial reasons, though consumers do not undertake TCO calculations themselves. The impact of purchase incentives is more closely related to how consumers interact with price discounts or coupons. In the case of consumer products discounts increase interest in products, increase sales and increase perceptions of value [17,18]. Therefore, purchase incentives do not attract consumers to PEVs due to them having calculated the financial savings they may or may not achieve. Consumers have been shown to be unable to make these kinds of forecasts and as a result they often make flawed or biased decisions [48]. However, according to Thaler et al. consumers can be 'nudged' to make a decision through changing the choice architecture around a decision. This is how purchase incentives attract car buyers to PEVs. As a result of the financial incentives consumers perceive PEVs as having greater value. Therefore, even though incentives have been designed to lower purchase prices of PEVs so that their TCO is close to an ICEV their impact on the purchase decision is not related to consumers making economic calculations. This paper therefore explores the effectiveness of purchase incentives in encouraging consumer to purchase a PEV or in increasing PEV market shares. It does not consider why these incentives are effective or whether consumers will save money by purchasing a PEV.

1.1. Introduction to PEV markets

PEVs include both battery electric vehicles (BEVs) and Plug-in Hybrid Electric Vehicles (PHEVs). Both BEVs and PHEVs are more efficient and less polluting than ICEVs. PHEVs get their motive power from both an internal combustion engine (ICE), and the vehicles batteries and electric motor. They are a hybrid vehicle and their overall efficiency is lower than that of a BEV, but higher than a non-plug-in hybrid electric vehicle (HEV). BEVs are the most efficient vehicle type, their motive power comes only from their on-board batteries and electric motor. They have no ICE and therefore have zero tailpipe emissions. The most recent introduction of BEVs began around 2008 when Tesla introduced the Tesla Roadster. Although this vehicle was a low-volume vehicle, selling 2450 units between 2008–2012, it marked

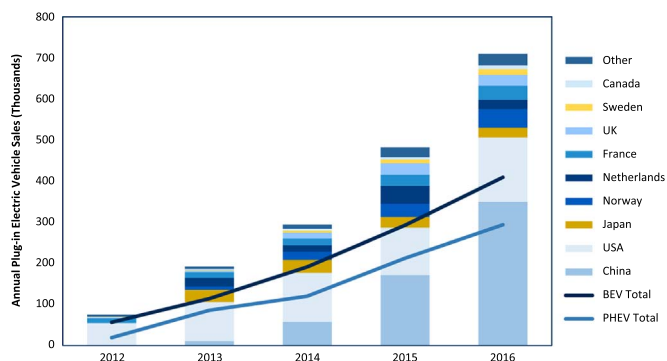


Fig. 1. Global Battery Electric and Plug-in Hybrid Electric Vehicle Markets 2012–2016.

the start of the recent growth of BEV sales. The next significant market introduction was the Nissan Leaf BEV in 2010, after which many automotive original equipment manufacturer (OEMs) released vehicles to the market. More than 225,000 Nissan Leafs have now been sold. In 2011, the Chevrolet Volt PHEV was introduced. To date over 130,000 of these have been sold. In 2012, the Tesla Model S was introduced. Tesla have now delivered over 150,000 Model S BEVs making it the second best-selling PEV. Fig. 1 shows the recent growth in all PEVs from 2012 to 2016. The chart includes BEV and PHEV sales. The chart shows a breakdown of PEV sales in the top 9 markets globally. These are China, USA, Japan, Netherlands, Norway, France, United Kingdom, Germany, and Canada. China is seeing a more rapid growth in PEV sales than the US. During 2015 vehicle sales of PEVs in China overtook vehicle sales in the US making China the largest market for PEVs by volume. According to ICCT in January 2017 the size of the global PEV market surpassed 2 million vehicles [33].

1.2. Introduction to purchase incentives

Purchase incentives take several different forms; they can be grouped into four different types of incentive. All incentives work towards the same common goal which is the reduction of the price consumers pay for a PEV. The incentives are administered in several ways, some at the time of purchase and others after. The four types of incentive are:

- **Point of Sale Grant Incentives-** Point of sale grants reduce the purchase price of a BEV when a consumer buys the vehicle. These reductions come in the form of government purchase discounts or grants. These types of incentive are applied at the time of purchase. In the United Kingdom for example GBP£4500 (US\$5800) is available off the purchase price of BEVs.
- **VAT and Purchase Tax Exemptions-** These exemptions allow buyers of BEVs to pay lower or zero VAT or pay no purchase tax that is applied to some vehicles. These types of incentives are applied at the time of purchase. In the Netherlands for example purchase tax is calculated based on the CO₂ emissions of the vehicles, whereas BEVs do not pay any tax. Buyers of ICEVs can pay anywhere between €1000 (US\$1100) (Toyota Aygo) to over €20,000 (US\$22,000) (Audi A8) in purchase taxes. These incentives reduce the upfront purchase price of PEVs in comparison to their ICEV counter parts. Some schemes use the additional revenue generated from high CO₂ emitting ICEVs to reduce the purchase price of BEVs by providing an additional rebate (e.g France). Schemes that use a combination of high VAT or purchase tax for ICEVs and rebates for PEVs are known as feebates.
- **Post purchase rebates-** Post purchase rebates come in the form of financial incentives being given to consumers after they have purchased the vehicle. This is usually in the form of a cheque. This means consumers receive a monetary payment after they have purchased a BEV. These incentives are used in several US states. In

Download English Version:

<https://daneshyari.com/en/article/5482114>

Download Persian Version:

<https://daneshyari.com/article/5482114>

[Daneshyari.com](https://daneshyari.com)