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Permalink

<https://escholarship.org/uc/item/5bp8z7nt>

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Publication Date

2017-03-01

Incentives to Promote Plug-In Electric Vehicle Adoption: An Introductory Guide

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Issue

This policy guide outlines the effectiveness of different financial and recurring incentives. It describes how these incentives should be utilized to have the greatest impact on battery electric vehicle (BEV) and plug-in hybrid electric vehicle (PHEV) sales. The insights in this guide are taken from empirical evidence within academic literature. Financial purchase incentives are monetary instruments used to attract buyers to PHEVs or BEVs. Reoccurring incentives are received by consumers during vehicle ownership; a wide variety of these incentives have been deployed to encourage BEV or PHEV adoption.

PHEVs and BEVs are currently more expensive than ICEVs. Incentives are used to make PHEVs and BEVs more affordable for consumers to buy and use. Incentives can also be used to make PHEV and BEV ownership more convenient, which can counteract some inconveniences associated with owning a PEV.

Policy Implications

All incentives should be targeted so that BEVs and long range PHEVs (>30 miles electric range) receive similar incentives. Short range PHEVs, which achieve lower electric vehicle miles travelled, should have fewer incentives available to them. Incentives should

not be available to persons of high incomes or to buyers of high-end luxury PEVs.

Policy makers should also invest in the introduction of PEV charging infrastructure. This should be in urban areas, at work places, shopping malls and other destinations in addition to travel corridors. At locations with long dwell times (e.g work places) level 1 and 2 infrastructure should be installed and at locations with short dwell times (e.g travel corridors) fast charging should be installed.

Any policy measure cannot achieve its full efficacy without consumers being aware of it and understanding individual benefits. Policy makers should seek to initiate education and awareness campaigns to promote the incentives that are being offered. Incentives should persist until PEVs gain a stable foothold in the market, after which a phase out period is favorable over an immediate removal.

Incentive Design Features

A well-designed financial purchase incentive would:

- Be delivered as close to the time of purchase as possible, preferable at the point of PEV purchase.
- Offer larger incentives for BEVs and PHEVs with high electric ranges.
- Offer smaller incentives for PHEVs with low electric ranges.
- Not be applicable to high-end luxury BEVs or to persons of very high income.
- Be persistent and last until PEVs gain a stable foothold in the market.

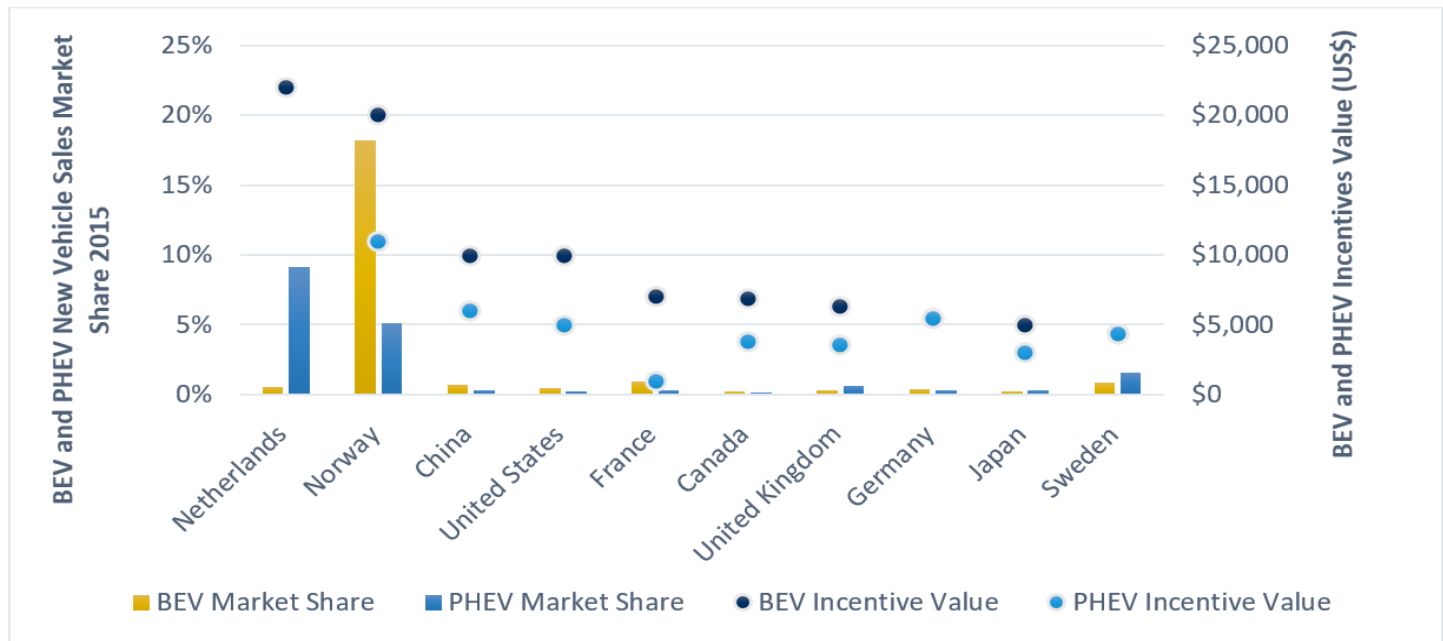


Figure 1: Chart showing that the higher the value of incentives offered, the higher the market for PEVs will be.

Well-designed reoccurring incentives should include the following:

- HOV and fast transit lane access for PEVs. Alternatively, bus lane access can have the same impact in areas where HOV lanes are not present.
- Free, discounted, and preferential parking incentives for drivers of PEVs.
- Waivers or discounts on bridge, road, tunnel, and ferry tolls.
- Congestion charge zones could also be introduced with exemptions for PEVs.
- Policy makers can also use gasoline tax to disincentivise consumers from buying ICEVs.

and the size of PEV markets in the top nations for PEV sales in the world (Figure 1).

In the United States, financial purchase incentives are applied in several ways. The largest incentive is the Federal Tax Credit which is available across the United States. Consumers receive an income tax credit at the end of the year after purchasing a PEV. This does not reduce the upfront purchase price of the vehicle as the tax credit occurs when consumers file their tax returns. Buyers of PHEVs and all BEVs receive a federal income tax credit of up to \$7,500, dependent on battery capacity.

Research Findings

Financial Purchase Incentives

More than 30 studies find financial purchase incentives to be effective in promoting PEV sales. Studies using statistical analysis have found that market shares of PHEVs and BEVs are related to purchase incentives being present. There is a relationship between the value of incentives on offer

and the size of PEV markets in the top nations for PEV sales in the world (Figure 1). Some states have introduced PEV rebate incentives. Consumers receive a check or 'cash back' after they have purchased a PEV. This does not reduce the point of sale price of a PEV, but the rebate is received soon after the purchase of a PEV. In California, for example, buyers of BEVs receive a \$2,500 rebate.

Researchers have compared the effectiveness of the California state and federal incentives. Consumers have been found to rank these incentives as equally important, despite the significant difference in value (Figure 2). Consumers value the \$2,500 state rebate as highly as the \$7,500 federal incentive. This is due to consumers placing a higher value on monetary

sums that are received sooner rather than later. The federal tax credit is still effective in promoting PEV sales but could be made more effective if it was received sooner by PEV buyers. Additionally, the rebate may be even more effective if it is applied at the point of sale.

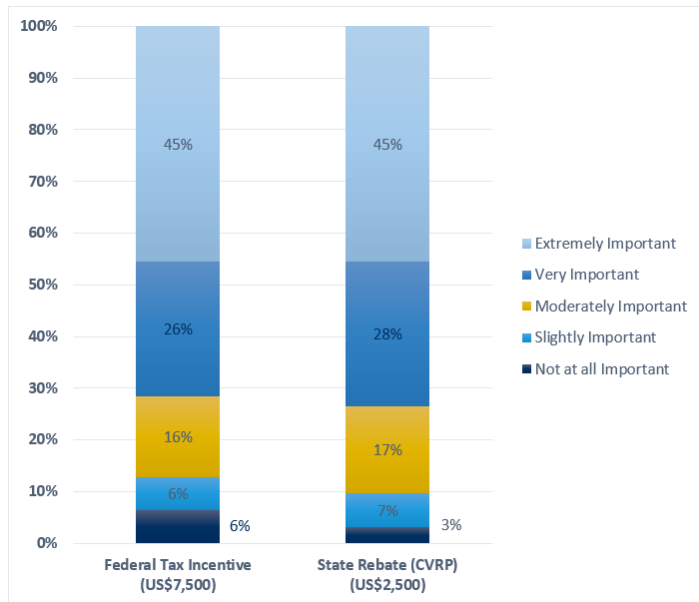


Figure 2: Despite the federal tax credit being worth three times more than the California state rebate, consumers value the incentives equally. This is due to the rebate being received sooner by vehicle buyers meaning they value it more.

Purchase incentives should be different for BEVs and PHEVs. BEVs offer the greatest environmental benefits and should receive the highest level of incentive. PHEVs with long electric ranges (>30 miles) can achieve the same number of electric miles as BEVs and should receive a similar incentive than BEVs do. PHEVs with lower electric ranges should receive a decreasing incentive based on their range and having a poor ratio of electric miles to gasoline miles driven.

Purchase incentives should be lower on high-end BEVs (e.g. Tesla Model S) or for people with high household incomes. Purchase incentives are less important for buyers of high-end luxury BEVs and for people with very high incomes. Incentives are more important for consumers with lower household

incomes and as such, purchase incentives should have a price eligibility cap or an income eligibility cap.

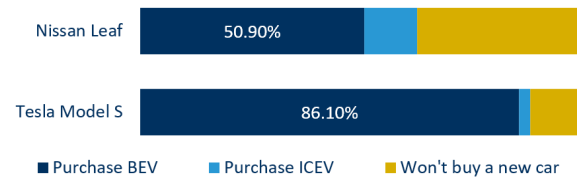


Figure 3: Chart showing consumer behavior if the US federal income tax credit was not available. Most buyers of high-end BEVs (Tesla Model S) would still purchase their vehicle without the incentive. This is related to the generally high incomes of Tesla buyers.

Recurring Incentives

More incentives increases the likelihood of PEVs gaining significant market shares. Therefore, financial purchase incentives should be deployed along with reoccurring incentives.

Within the literature, 25 studies have found that allowing BEVs and PHEVs to access HOV lanes, fast transit lanes or bus lanes for free is effective in encouraging consumers to purchase a BEV or PHEV, though this incentive may encourage consumers to purchase PHEVs over BEVs. PHEVs with short driving ranges should be excluded from this type of incentive. Allowing BEVs and PHEVs to drive in bus lanes has the same impact as allowing them access to HOV and fast transit lanes, though this incentive may have a short lifetime due to bus lanes becoming congested.

There are 15 studies that have found that allowing BEVs and PHEVs to park for free or at discounted rates is effective in encouraging consumers to purchase the vehicles. This may also be a short-term measure due to reduced revenue from parking charges. Policy makers can also introduce priority spaces for PEVs only; these spaces would be in preferential locations. The most effective parking incentives will be combined with charging infrastructure.

There are 10 studies that have found that toll waivers for PEVs, which been introduced in a few regions globally, are effective in encouraging PEV adoption.

These have been implemented on bridge, road, tunnel and ferry tolls. This may be a short term measure due to reduction in revenue. Therefore, tolls may have to transition to discounts when PEVs take significant market shares.

Introducing zones in urban areas where vehicles are required to pay to enter has been introduced in a small number of locations. These locations allow PEVs to enter the zones for free. This has found to be effective in encouraging PEV adoption and in shifting road traffic from ICEVs to PEVs. It also has been found to alleviate congestion.

The price of petroleum has been found to be related to PEV sales. High petroleum prices are correlated to increased sales of PEVs. Policy makers can introduce incrementally increasing tax on vehicle fuel to encourage consumers to adopt more fuel-efficient vehicles, which will include PHEVs and BEVs.

PEV Charging Considerations

The development of charging infrastructure may be the most important consideration for policy makers. 19 out of 19 studies that investigated the importance of PEV charging infrastructure found that it is important for the market introduction of PEVs. The development of public and work place charging has been found to increase rates of PEV adoption, whereas a lack of infrastructure could deter consumers from purchasing a PEV.

Charging infrastructure is needed in urban areas, at destinations such as shopping malls and workplaces and on travel corridors. At locations with long dwell times infrastructure can be level 1 or 2 charging infrastructure. At locations along travel corridors, where consumers will stop for shorter durations, infrastructure should be DC fast charging infrastructure.

Policy makers should also work with utilities to provide time of use electricity tariffs to consumers who purchase PEVs. These tariffs provide discounted

electricity to consumers during off peak electrify hours during which they can charge their PEV for lower cost compared to a standard tariff. This also encourages responsible charging behaviors.

Interactions with Public Transit Networks

Some regions have high levels of public transit use. These regions are also working towards continued increases in the use of public transit. In regions where public transit use is high policy makers should consider the impact incentivizing PHEV and BEV use will have on rates of public transit use. Policy makers should seek to maintain transit use while increasing PEV adoption.

Policy makers should introduce specific policy measures that work towards making it easier and cheaper to access public transit hubs. For example policy makers, could introduce parking and charging incentives at suburban rail stations. Areas where commuters travel to (i.e Urban areas) should have fewer incentives than transit hubs. The aim of this would be to encourage consumers to travel to outlying transit hubs and not urban areas. Introducing a congestion charge zone where all vehicles, except PEVs, are required to pay to enter could also achieve this goal. This has been introduced into some European cities, such as London, successfully.

Further Reading

Hardman, S., Chandan, A., Tal, G. and Turrentine, T. (2017) 'The Effectiveness of Financial Purchase Incentives for Battery Electric Vehicles - A Review of the Evidence', Renewable and Sustainable Energy Reviews. (Under Review)

Hardman, S. (2017) 'Reoccurring and Indirect Incentives for Plug-in Electric Vehicles – A Review of the Evidence', Transportation Research Part A: Policy and Practice. (Under Review)