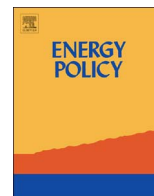




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Plug-in vehicles and the future of road infrastructure funding in the United States



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HIGHLIGHTS

- Fees on plug-in cars are proposed or implemented to collect foregone fuel taxes.
- Plug-in cars are responsible for a very small percentage of declining tax revenue.
- An additional tax on plug-in cars does not stop the decline in fuel tax revenue.
- Adjusting fuel taxes to inflation is a more effective tool to increase tax revenue.

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ABSTRACT

In the United States, road infrastructure funding is declining due to an increase in fuel efficiency and the non-adjustment of fuel taxes to inflation. Legislation to tax plug-in vehicles has been proposed or implemented in several states. Those propositions are contrary to policies to promote fuel efficient vehicles. This paper assesses (1) the magnitude of the decline in federal fuel tax revenue caused by plug-in vehicles and (2) quantifies the revenue that could be generated from a federal plug-in vehicle registration fee. We find that the contribution of plug-in vehicles to the decline of the federal fuel tax revenue is at most 1.6% and the majority of the shortfall can be attributed to the non-adjustment of the fuel tax rate and the increase in vehicle fuel efficiency by 2040. An additional tax of \$50–\$200 per plug-in vehicle per year in the reference case would generate \$188–\$745 million in 2040 which represents an increase of 1.69–6.71% in federal fuel tax revenue compared to no tax. The lesson for policy makers is that plug-in vehicles do not contribute significantly to the funding shortfall in the short- and medium-run and a supplemental tax would generate a small percentage of additional revenue.

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1. Introduction

Many countries rely on gasoline and diesel taxes to finance their road infrastructure. In the United States, the consumption-based tax revenue raised at the federal level contributes to the Highway Trust Fund (HTF) which was established by the Highway Revenue Act of 1956 (DOT/FHWA, 1998). The current federal tax rates are \$0.184 and \$0.244 per gallon of gasoline and diesel, respectively. Taxes are also imposed on other fuels such as liquefied petroleum gas, liquefied natural gas, compressed natural gas, etc. (FHWA, 2014). In addition to the federal taxes, states collect gasoline and diesel taxes to fund local infrastructure projects. The current primary revenue-related issue for transportation infrastructure is the extent to which transportation construction and

maintenance is tied to gasoline and diesel consumption. Transportation revenues have stagnated since 2001 and expenditures associated with road construction and maintenance have outpaced revenues (Kile, 2011; Ungemah et al., 2013). At least three factors have contributed to the stagnation in revenues. First, the general increase in fuel efficiency of conventional gasoline vehicles. Between 1980 and 2012, average fleet fuel efficiency increased from 15.97 to 23.31 miles per gallon (MPG) which represents a 30% reduction in fuel consumption of the average vehicle (U.S. DOT Bureau of Transportation Statistics, 2015). Second, the stagnation in annual vehicle miles traveled (VMT) can be explained by the recent economic recession (FHWA, 2012). While there may be an increase in VMT in future years, the extent of that increase is expected to be inconsequential (FHWA, 2012). Finally, gasoline and diesel taxes are set as a fixed amount per-gallon without being adjusted to inflation at the federal level and in most states, i. e., the real tax rate is declining over time. The last adjustment at the

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federal level occurred in 1993 and some states have not adjusted their per-gallon gasoline tax since 1961 (ITEP, 2014). This inflexibility of the tax base is responsible for an effective decrease of 30% in the federal fuel tax rate.

Given the erosion of the tax base, the HTF has suffered a decline in its balance and experienced significant funding shortfalls. Over the last seven years, lawmakers have had to transfer a total of \$65 billion from the United States' general fund to the HTF to keep it solvent (Cawley, 2013; Kile, 2015). To secure adequate infrastructure funding in the future given the continued funding shortfall, proposals have been made to increase the federal fuel tax (Kile, 2015), replace the fuel tax with a fee on vehicle miles traveled (VMT) (TRB, 2006; Schank and Rudnick-Thorpe, 2011; Duncan and Graham, 2013), or shift to state and local funding schemes (Goldman and Wachs, 2003). Given the need for new ways of funding road infrastructure, some states have identified plug-in vehicles, i. e., plug-in hybrid and battery electric vehicles, as a source of revenue and have started charging an additional annual registration fee for such vehicles.

States that charge a per-vehicle registration fee for alternative fuel vehicles are Colorado (\$50), Georgia (\$200), Idaho (\$140), Nebraska (\$75), North Carolina (\$100), Virginia (\$64), Washington (\$100), and Wyoming (\$50) (NCSL, 2015). Similarly, an "Electric Vehicle Plug-In Registration" for fully electric vehicles that "is not lower than \$100" was proposed in Massachusetts (MA Legislature, 2014). According to the National Conference of State Legislatures, "states are also addressing concerns regarding the effect that the growing use of electric vehicles may have on funding for transportation infrastructure, which relies heavily on gasoline taxes" (NCSL, 2015). Washington State senator Mary Haugen stated that "electric cars will be driving on the highways right along with all the other cars. [...] We believe they should be paying their fair share" (Seattle Times, 2011). In the case of Washington State, the governor's budget office estimates that the \$100 fee would bring in 1.9 million for the 2015–2017 budget cycle and that the overall Department of Transportation budget is \$6.9 billion over the same budget cycle (Seattle Times, 2011). In North Carolina, the fee was expected to raise \$160,000 in 2014 given an anticipated gap between infrastructure needs and revenue of \$60 billion over 30 years (The Newsand Observer, 2014). At the federal level, the Developing a Reliable and Innovative Visions for the Economy (DRIVE) Act includes provisions to extend user fees to electric vehicles because "ownership of electric and alternatively fueled vehicles continues to constitute a larger percentage of users" and to "ensures all motorists pay their fair share" (EPW, 2015). Given the examples from Washington and North Carolina, there is little indication that policy makers should believe that electric vehicle fees can make up for the fuel tax revenue shortfall, yet policy proposals to charge fees are implemented or discussed in several states.

The funding model based on gasoline and diesel consumption is not viable in a world that, in the very long-run, will have transitioned away from internal combustion engines to mainly highly fuel efficient plug-in vehicles. Previous research suggests that state and federal fuel tax revenue, under various scenarios, could decrease by as much as 5% and 12.5% by 2020 and 2030, respectively (Hajiamiri and Wachs, 2010). The problem is that registration fees or taxes are contrary to policies intended to promote the use of plug-in vehicles; such vehicles have received considerable attention and funding due to concerns about energy independence, energy efficiency, and greenhouse gas emissions (EISA, 2007). The U.S. federal government provides income tax credits as high as \$7500 to incentivize the purchase of battery electric vehicles (Krause et al., 2013). Similarly, state and local governments provide credits or exemptions to sales taxes, excise taxes, registration fees, and parking fees (Gallagher and Muehlegger, 2011). Even

with those incentives, the Energy Information Administration (EIA) estimates the share of plug-in vehicles in 2040 to be 1.71% and 5.14% in its baseline and most optimistic scenario, respectively (EIA, 2014).

Notwithstanding the need for a comprehensive change in policies with respect to infrastructure funding including all types of vehicles, we question policy makers introduction of a fee on plug-in vehicles that (1) is likely to have a small contribution to revenue because of the small market share, (2) is opposed to policies subsidizing plug-in vehicles, and (3) is fixed at a per-vehicle rate instead of a VMT rate as proposed by researchers. There is a lack of empirical evidence to suggest that these fees will adequately address the funding shortfalls in the future that have become increasingly apparent, and this paper aims to close that knowledge gap at the federal and, to a certain extent, state level. This paper focuses on the impact of the expected growth in the plug-in vehicle fleet within the context of fuel taxes that are not adjusted for inflation. Specifically, we extend the current research in this area in two ways: First, we consider the funding shortfall in the context of the continued practice of not adjusting fuel taxes to keep pace with the inflation and the consequences of increased fuel efficiency. Second, we forecast how much federal revenue might be generated from an annual tax or registration fee on plug-in vehicles under the current sales projections to determine if such a tax could alleviate the expected funding shortfall. We show that the majority of the funding shortfall is due to the non-adjustment of fuel taxes and the increase in fuel efficiency. Little can be attributed to the growing use of plug-in vehicles; thus a registration fee would not alleviate the funding shortfall. Although the low impact of plug-in vehicles on road financing is not a surprise given the low adoption numbers, it is useful to quantify those impacts in this article to form a basis for policy discussions. Given the tension between the desire of policy makers to increase the use of alternative fuel vehicles and the funds needed for transportation infrastructure maintenance, the lesson we draw for decision makers is that, taking energy security and energy efficiency into account, at least in the short- to medium-run, policies to promote plug-in vehicles should be maintained. To meet environmental goals, a Pigouvian tax on fuel consumption is the appropriate tool but in the presence of increasing fuel efficiency will not satisfy highway funding needs. On the other hand, a VMT fee will cover the funding needs of highways in the long-run but does not achieve environmental goals since reducing fuel economy is not incentivized. Each goal should be achieved using the appropriate policy tool. Finally, there is the potential of having more plug-in vehicles on the road by 2040 than currently estimated by the EIA. Our paper explores some of the issues relevant to dealing with that possible outcome.

2. Methods

In this section, we describe the general model setup. Additional modeling information can be found in the Supplementary Information that is available online. The EIA's 2014 Annual Energy Outlook (AEO) projections are our primary source of data to model the impact of plug-in vehicles on the current and future funding gap of the HTF as well as the effects of possibly taxing plug-in vehicles at the federal level. The EIA provides projections for a reference case which assumes current policies with a 2.4% average gross domestic product (GDP) growth rate between 2012 and 2040 and a \$141 (in 2012 dollars) oil price by the end of the projection period (EIA, 2014). The EIA models an additional 29 scenarios for comparison to the reference case that reflect potential variations in policies, GDP growth, and oil price evolution. For our model, we selected data from 12 scenarios (including the reference case) that

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