DRISI
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Research Notes

Planning, Policy and Programming

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Project Title:
UTC-Cost of Plug-in Electric Vehicle Ownership: Understanding Vehicle Choice and Cost of Ownership Using Behavioral Data, NCST

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Cost of Plug-in Electric Vehicle Ownership: Understanding Vehicle Choice and Cost of Ownership Using Behavioral Data

Understanding Vehicle Choice and Cost of Ownership Using Behavioral Data

WHAT IS THE NEED?

Starting with Assembly Bill 32 (AB 32) in 2006 that set the greenhouse gas (GHG) reduction targets for the state of California, numerous legislations have been passed to support the mission. In the realm of transportation, there has been a slew of policy initiatives to support the adoption of alternative fuel vehicles (AFVs) with zero tailpipe emissions, primarily battery electric vehicles (BEVs), plug-in hybrid vehicles (PHEV), and hydrogen fuel cell (HFC) vehicles.

Among other regulations, policymakers have implemented rebate and tax credit programs to encourage adoption by reducing the purchase cost. They have also introduced regulations to boost the fuel-cost savings from adopting these fuel technologies by offering special electricity rate plans.

Though these initiatives have helped the AFV market so far, there is increasing concern about the cost efficiency of these technologies, particularly in absence of the incentives and given its interaction with fuel standard regulations for conventional Internal Combustion Engine vehicles (ICEVs). The cost efficiency of AFVs compared to ICEVs and hybrid electric vehicles (HEVs) are subject to changes in gasoline price, electricity price, and government policies like the Corporate Average Fuel Economy (CAFE) standards that mandate vehicle manufacturers to improve the fuel economy of their fleet.

WHAT ARE WE DOING?

The research will be conducted in four distinct phases as outlined in the following sections.

1. Derive the cost components for the Total Cost of Ownership (TCO) model using empirical data collected by the PH&EV Research Center, public data and existing research.
2. Model the vehicle use pattern of both PEV, ICEV, and HEV drivers, and the charging behavior of PEV owners. Consequently, estimate the TCO and payback period of different PEV models (by vehicle size and range) controlling for vehicle usage and charging behavior modeled.
3. Estimate the break-even point under present technology and policy conditions. Then perform scenario analysis under policy conditions that may affect the capital and fuel cost savings from PEVs compared to ICEVs.
4. Comparative analysis of end-use emissions from PEVs, ICEVs, and HEVs (by vehicle class and range) accounting for heterogeneity in vehicle miles traveled (VMT) and charging behavior.

WHAT IS OUR GOAL?

TThe primary purpose of the project is to build a TCO model for PEVs, ICEVs, and HEVs to analyze the impact of vehicle use patterns, policy, technology, and fuel price dynamics on their cost efficiency, as well as to estimate the break-even point for these technologies in the vehicle purchase decision.Second, the estimates of GHG emission benefits from PEVs are often measured in relation to an average ICEV, not considering advancements in vehicle technology or charging behavior. Specifically, the two primary goals of this project are:

1. To investigate the questions above, and
2. To provide a policy memo with comparative scenario analyses to inform policies supporting PEV adoption.

WHAT IS THE BENEFIT?

To test the sensitivity of the payback period and break-even point to vehicle use patterns and charging behavior, Monte Carlo simulations of the net present value of ownership of PEVs and ICEVs will be done using the distributions of VMT and charging activity modeled earlier for each vehicle type.

Environmental benefits of PEVs in comparison to ICEVs and HEVs is a major factor driving the state regulations supporting PEV adoption. However, as prior literature has found, there is considerable spatial and temporal variation in the emission benefits of PEVs. Emission benefits (end-use) of PEVs can also depend on vehicle use pattern.

Therefore, to analyze the heterogeneity in the environmental benefits of PEVs in comparison to HEVs and ICEVs due to vehicle use pattern, the VMT and charging behavior distributions modelled earlier will be used to model the end-use emissions of PEVs by vehicle size and range capability.

WHAT IS THE PROGRESS TO DATE?

- Completed literature review, data collection and data cleaning for analysis.
- Completed bottom-up calculation of the vehicle manufacturing and cost of ownership analysis of battery-electric and plug-in hybrid electric vehicles for the passenger car and passenger truck segment.
- Completed TCO analysis for 6 market segments defined based on household income and housing type for a given market adoption scenario.