ECONOMIC FINDING

Low Energy: Estimating Electric Vehicle Electricity Use

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Based on extensive California data, the average electric vehicle increases overall household load by 2.9 kilowatt-hours per day, or less than half the amount assumed by state regulators, and likely travel under half of the US fleet average, raising questions about transportation electrification for climate policy.

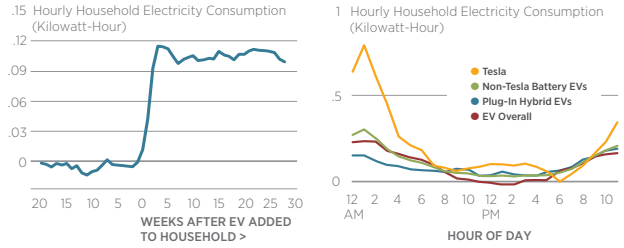
What are the private and social costs and benefits of electric vehicles (EVs)? Data limitations have hindered policymakers' ability to answer those questions and guide transportation electrification. Most EV charging occurs at home, where it is difficult to distinguish from other end uses, meaning published estimates of residential EV load are either survey-based or extrapolated from a small, unrepresentative sample of households with dedicated EV meters.

These data are important because if EVs are driven as much as conventional cars, it speaks to their potential as a near-perfect substitute to vehicles burning fossil fuels. If, on the other hand, EVs are driven substantially less than conventional cars, it raises key questions about their replacement potential.

This research presents the first at-scale estimates of residential EV charging load in California, home to approximately half of the EVs in the United States. The authors employ a sample of roughly 10 percent of residential electricity meters in the largest utility territory, Pacific Gas & Electric, which they merge with address-level data on EV registration records from 2014-2017. The authors' findings include:

- EV load in California is surprisingly low. Adopting an EV increases household electricity consumption by 0.12 kilowatt-hours (kWh) per hour, or 2.9 kWh per day. Given the fleet of EVs in their sample and correcting for the share of out-of-home charging, this translates to approximately 5,300 electric vehicle miles traveled (eVMT) per year.

Figure 1 · Impacts of Electric Vehicle (EV) Adoption on Household Electricity Use



Notes: This figure presents the authors estimates of the impact of EV adoption on household electricity consumption. The left panel shows that household electricity use clearly rises in response to EV registration. This plot also indicates that there is mismeasurement in EV registration dates. The right panel plots difference-in-difference estimates by hour of day and vehicle type. The authors plot separate estimates for Teslas, non-Tesla battery EVs (BEVs), and plug-in hybrid EVs (PHEVs), as well as overall estimates using all EVs. Please see working paper for more description.

- These estimates are roughly half as large as official EV driving estimates used in regulatory proceedings, likely reflecting selection bias in official estimates, which are extrapolated from a very small number of households.

- Importantly, these findings indicate that EVs are driven substantially less than internal combustion engine vehicles, suggesting that EVs may not be as easily substituted for gasoline vehicles as previously thought.

This work is an important step in determining EV utilization rates, and the authors map out future research efforts that include, among other questions, issues relating to the marginal utility of EV transportation, such as limited charging stations; the degree to which EVs complement rather than replace conventional vehicles; and the impact of high electricity prices in California.

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