AN EMPIRICAL ANLAYSIS OF BATTERY ELECTRIC VEHICLE HOUSEHOLD BEHAVIORS IN CALIFORNIA: RESIDENTIAL CHARGING AND VEHICLE UTILIZATION PATTERNS

ABSTRACT

Battery electric vehicles (BEVs) are emerging as a central component of decarbonization efforts in the transportation sector. With continued growth in BEV adoption, it becomes essential to have a rigorous understanding of post-adoption household behavior, to translate adoption into actionable insights for large-scale infrastructure planning. Post-adoption behavior is multi-dimensional, encompassing decisions related to charging, driving, vehicle management, and trip planning. This thesis focuses on two core dimensions that directly determine energy and infrastructure impacts: charging practices and vehicle utilization.

Across many regions where charging deployment is developing, residential charging constitutes the predominant channel through which BEV households replenish energy. Because home charging is highly discretionary, it reflects a combination of mobility needs, price signals, household constraints, and more, which can produce clusters in charging schedules across households. Such synchronization can increase coincident demand and amplify localized peak loads on distribution networks. Characterizing the determinants of temporal charging patterns is therefore important for informing large-scale grid system planning.

BEV operation is also conditioned by the technological and infrastructural environment within which charging and travel occur. Rapid advances in battery capacity, coupled with the

expanding availability of higher-power charging, have relaxed operational constraints and increased the extent to which BEVs can serve as substitutes for conventional gasoline vehicles. However, though range and charging access are frequently analyzed as determinants of adoption and market growth, their implications for realized driving behavior after purchase remain less established and require further evaluation.

This study addresses these gaps using household-level data from California, a leading BEV market in the United States. The analysis examines two complementary dimensions of post-adoption behavior- temporal patterns of residential charging and realized vehicle utilization. The analysis of temporal at-home charging frequency indicates that charging timing is systematically associated with household and sociodemographic characteristics as well as pricing incentives, while the assessment of battery range and charging access underscores their distinct contributions and extent to which they can substitute for one another in shaping BEV use.

These results have direct implications for decarbonization policy and planning. Identifying indicators of charging timing can inform tariff design and managed charging strategies to mitigate coincident demand and reduce localized grid stress. The joint assessment of battery range and charging access in relation to utilization can support infrastructure siting decisions and expectations about future BEV energy demand. Taken together, the study bridges transportation behavior and planning perspectives, by linking vehicle use- which generates energy demand, to charging practices- which determine how that demand is replenished and when it materializes on the grid.