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Increasing Electric Vehicle Adoption among Disadvantaged Population: A Case Study in LA

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Abstract

In the shift towards 100% carbon-free energy, ensuring equitable access to clean energy benefits is crucial. The adoption of electric vehicles (EVs), particularly in the personal light-duty vehicle segment, has gained traction, driven by various incentives at the federal, state, and local levels. However, disadvantaged populations face unique challenges in embracing EVs. This paper, using Los Angeles as a case study, explores EV adoption patterns among disadvantaged population groups in both a business-as-usual scenario and an equity scenario. Modeling reveals that by 2035, over half of EV owners will be from low- to middle-income backgrounds with limited access to home charging. Strategies such as increasing incentives for used EV purchase from $2500 to $4000, targeted for disadvantaged communities, can boost EV adoption among low-middle income groups by 2%, while providing a $300 annual voucher to households using public charging can further facilitate equitable EV adoption.

Keywords: Electric Vehicle Adoption; Equity; Disadvantaged Population; Used Electric Vehicle Adoption.

1 Introduction

As cities and states embark on the ambitious journey to achieve 100% carbon-free energy by 2035, the imperative of ensuring equitable access and benefits for all population groups becomes paramount [1]. The transition to clean energy and sustainable transportation presents numerous challenges. It is incumbent upon agencies, experts, and practitioners to craft strategies that engage communities, fund equitable technology and infrastructure investments, expand existing programs, and design new policies. These endeavours aim to enhance equity by incorporating the insights of community members, fostering a more equitable energy future [2].

Within this framework, many cities have introduced incentive programs to encourage the adoption of electric vehicles (EVs). However, the equitable distribution of these incentives across various population groups and their capacity to facilitate affordable EV ownership for disadvantaged communities remain uncertain. This paper underscores the necessity of evaluating existing incentive programs and advocates for necessary adjustments to catalyse greater EV adoption among marginalized populations.

2 Methodology

For evaluating future scenarios of personally owned EVs and corresponding EV charging infrastructure, we leveraged three models: the Automotive Deployment Options Projection Tool (ADOPT) [3], the Electric Vehicle Infrastructure – Projection (EVI-Pro) tool [4], and the Electric Vehicle Infrastructure for Equity (EVI-Equity) model [5]. Figure 1 shows the modelling framework of this.

ADOPT [3] is a forecasting tool designed to predict the adoption rates of light-duty vehicles, including battery EVs (BEV), plug-in hybrid electric vehicles (PHEVs), and conventional gasoline vehicles. ADOPT models consumer choice and market dynamics by incorporating factors such as vehicle cost, fuel prices, consumer preferences, and government incentives. It helps stakeholders, including policymakers and industry analysts, understand how different factors might influence the future composition of the vehicle fleet, guiding strategic planning and policy development for sustainable transportation.

EVI-Pro [4] assesses EV adoption, driving and charging behaviour, and infrastructure needs to estimate the type and quantity of charging needs and consequently the charging facilities required for various regions. By integrating demand analysis, charging patterns, charging cost, and geospatial data, EVI-Pro helps policymakers, planners, and businesses make informed decisions about where and how to deploy charging infrastructure to support the growing number of EVs.

EVI-Equity [5] is a tool aimed at ensuring equitable access to EV charging infrastructure. EVI-Equity focuses on identifying disparities in EV charging access across different communities, particularly underserved or marginalized areas. EVI-Equity estimated household-level personal vehicle purchases, ownership, and utilization, as well as refuelling preferences and behaviour in the context of heterogeneous socioeconomic and demographic characteristics of individual households. It employs data on demographics, existing infrastructure distribution, and potential EV adoption trends to highlight where investment in charging stations could reduce inequality.

More details of three models can be found in the reference.

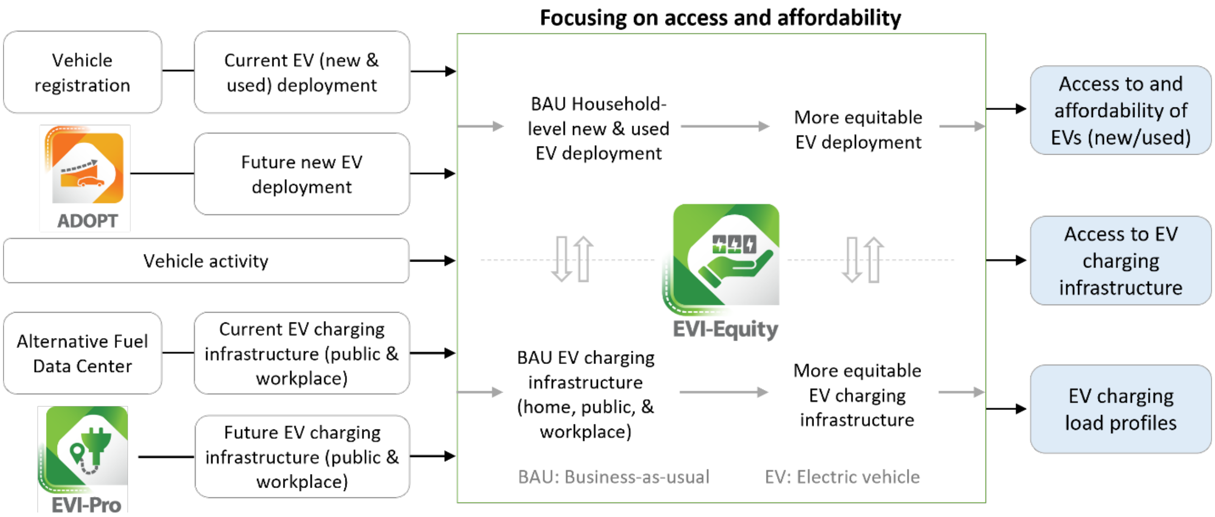

Figure 1 Modelling Framework

With three models, this research first estimates the EV stock and market prices until year 2035, and then evaluate the access and affordability of disadvantaged populations to EV owning and charging facilities. Based on this analysis, the research identified strategies to more equitably improve the access and affordability to EVs and charging infrastructure among disadvantaged population. To demonstrate how the identified strategies can help improve the equity of EV ownership, this study explored two scenarios: (1) Business-as-usual scenario which shows the EV adoption and associated burden among disadvantaged population if nothing changes; and (2) Equity scenario which identifies potential financial support strategies that can increase EV adoption and reduce burden. Each scenario is discussed in detail in Section 3.4.

3 Analysis and Results

3.1 EV Stock and Price Prediction

Access to EVs depends on the price of EVs and purchasing power of potential consumers, which, in turn, are influenced by socioeconomic factors. Analysis first evaluated longitudinal evolution of new and used EV stock and purchase price. The introduction of new EVs into the market was projected using the ADOPT model, while the transition of vehicles from new to used in the private car sector was assessed with the EVI-Equity model. This model considers several factors: the typical duration of ownership post-purchase [6], the average age of vehicles, the rate of vehicle disposal [7], and the average age of used vehicles at the time of sale [6]. Figure 2 presents the forecasted numbers of EVs up to 2035, categorized by technology type (PHEV vs BEV) and production year. By the year 2035, it is anticipated that Los Angeles will host approximately 1.6 million plug-in EVs, encompassing both BEVs and PHEVs, in line with California's mandate for zero-emission vehicles (requiring all new cars sold in the state from 2035 to be zero-emission) and findings from the LA100 study [1], [8]. It is expected that the majority of EVs in Los Angeles by 2035 will be BEVs, with about half of all EVs being no more than 5 years old. Furthermore, about 90% of the EVs are anticipated to be 10 years old or younger by 2035, indicating a rapidly expanding and evolving EV market.

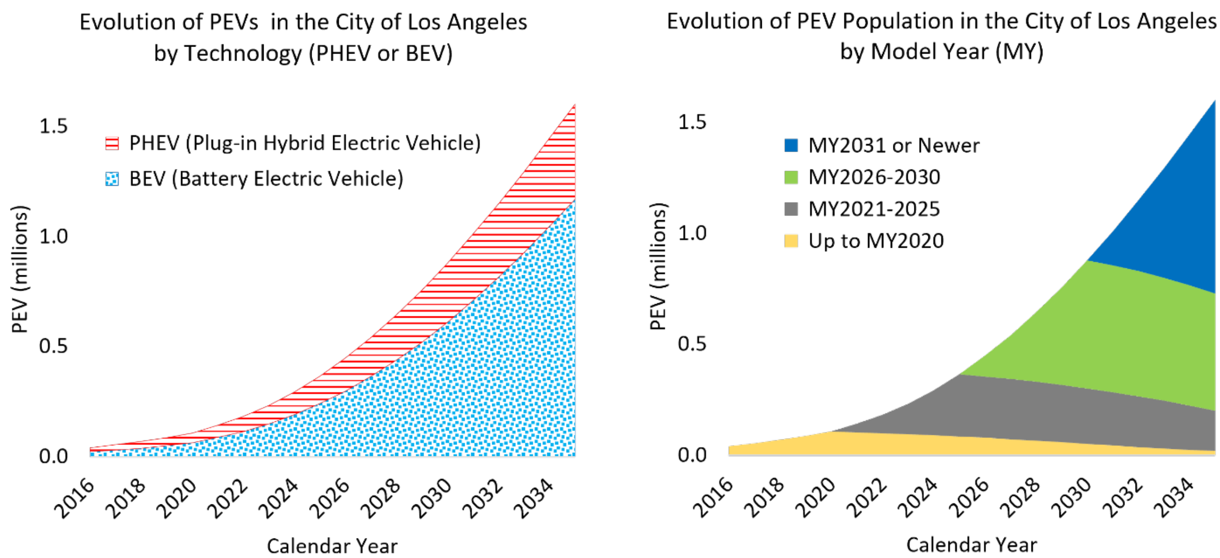

Figure 2. EV stock in Los Angeles by technology (PHEV versus BEV) and model year

Source: EVI-Equity
MY = model year)

In addition to EV stock, EV price (at the point of purchase—new or used) was also estimated using the EVI-Equity model. As depicted in Figure 3, the cost of EVs is expected to decrease over time. This trend is due to the introduction of more affordable models in the new EV market and the natural depreciation of used EV prices as they age, enhancing their overall affordability. By 2035, the projected cumulative sales-weighted average buying price for EVs in Los Angeles is anticipated to be $35,000 for new EVs (with a range of $32,000 to $38,000) and around $23,000 for used EVs (with a range of $20,000 to $25,000). The price illustrated in Figure 3 represents the actual market value paid by consumers for both new and used EVs in Los Angeles for each year. For instance, an EV still in use in 2035 might have been acquired as a used vehicle in 2030 for $15,000 (excluding rebates), whereas another might be bought new in 2035 for $160,000 (excluding rebates). Therefore, the fleet-wide purchase price in a given year, such as 2035, encompasses all transactions from that year and previous ones. The overall weighted buying price for EVs shows a downward trend, as Figure 3 indicates, due to the entry of more economical new EVs and the decreasing market value of used EVs over time. The figure also highlights the significant differences in purchase prices between Plug-in PHEVs and BEVs, as well as between new and used models, across the forecast period up to 2035.

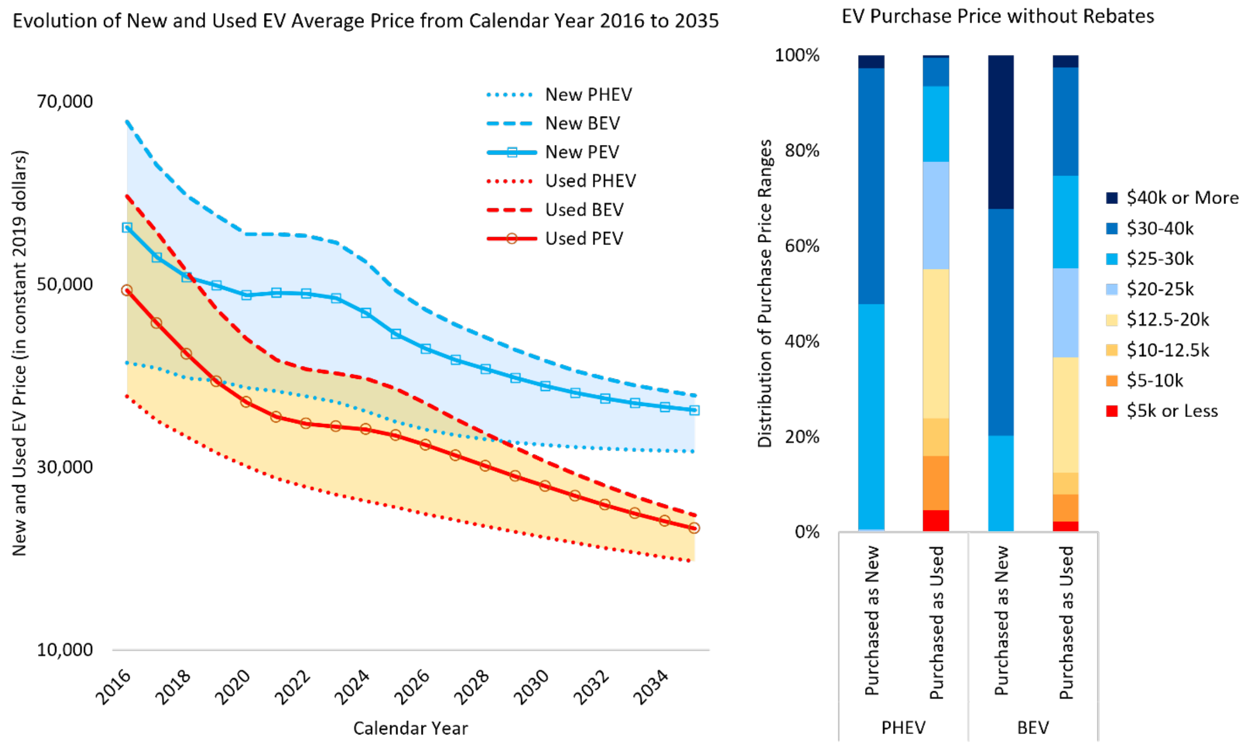

Figure 3. Projected purchase price for new and used EVs

EV = plug-in electric vehicles, including both BEVs and PHEVs; Source: EVI-Equity

3.2 EV and EVSE Access

With the projected EV stock market and price changes, EVI-Equity was used to estimate how the access to EV and charging infrastructure vary across income levels and housing types.

The distribution of EVs is expected to vary by income, as shown in Figure 4. The EVI-Equity model projects that in 2035, roughly half of EV owners in Los Angeles will earn over $75,000 per year, while the other half will earn $75,000 or less. This mirrors the income distribution of current gasoline car owners. Most EVs will be purchased as new due to market dynamics, but lower-income households are expected to buy a more balanced mix of new and used EVs, with a majority of used EV purchasers being in this income bracket. Therefore, improving EV access for these households may require two strategies: introducing more affordable new EV models and offering financial and logistical support for used EV purchases.

Home charging access will differ based on housing type, as shown in Figure 4. For EV owners earning over $75,000 annually, approximately 55% will live in single-family homes, whereas over 50% of those earning $75,000 or less will reside in multifamily homes, often as renters, reflecting Los Angeles' housing landscape. This variation has implications for home charging, with around 20% of EV owners in 2035 lacking access, predominantly among those in multifamily homes. Policy changes and alternative charging solutions, including building code modifications, financial support for charging infrastructure in multifamily homes, and public chargers in these neighborhoods, can address the needs of EV owners without home charging access.

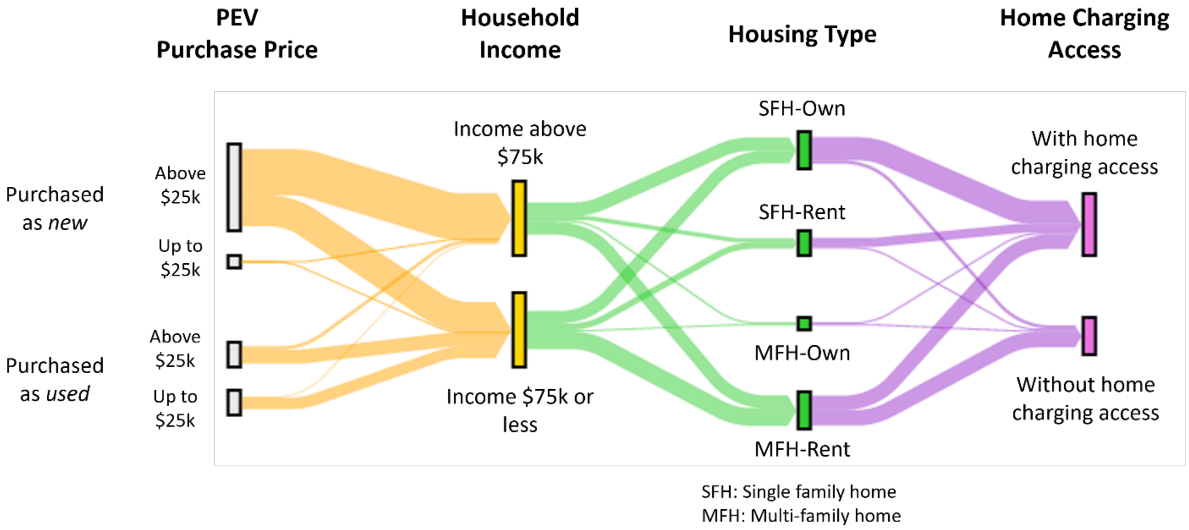

Figure 4. Breakdown of EV owners in Los Angeles in 2035 by household income, housing type, and access to home charging (based on BAU scenario), where plug-in EVs (PEVs) include both BEVs and PHEVs.

3.3 EV and EVSE Affordability

We assess used EV affordability using EVI-Equity, California-specific data, and credit-based financing differences (e.g., 40% higher interest rates for used vs. new vehicles. Figure 5 depicts a household in Los Angeles earning 20% below median income ($60,000), with two vehicles and a good credit score (700–800). Transportation costs are 15% of income without an EV. Adopting an EV makes it 12%–26%, varying with new/used, rebates, vehicle type (sub-premium/standard), and home charging. New EVs raise expenses, particularly for <$60,000 households. Used standard EVs (e.g., Nissan Leaf, Kia EV6) maintain or reduce costs, especially with rebates. A used Nissan Leaf lowers expenses by 5%, decreasing transportation costs from 15% to 12% (with home charging) and 13% (without home charging). This underscores the significance of standard used EVs for affordability and the necessity of supporting them for lower-income households.

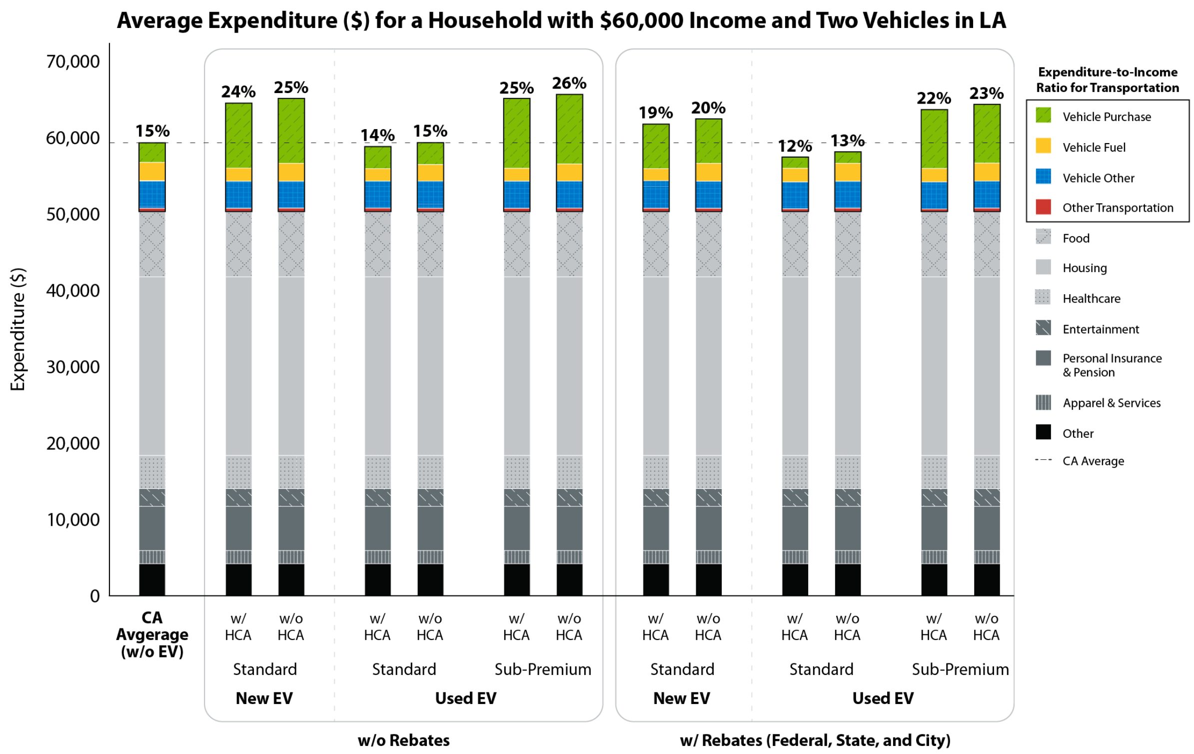

Figure 5. 2022 household expenditures related to EV and home charging access (based on today's market conditions)

HCA = home charging access, CA = California

w/o = without, w/ = with

3.4 Strategies to Improve Access and Affordability

Building on the insights gained from Sections 3.1 to Section 3.3, projections indicate that by 2035, households earning $75,000 or less annually are expected to constitute half of all EV owners, with a roughly equal distribution between new and used EV purchases. These households are more likely to reside in multi-family dwellings where access to home charging facilities is significantly restricted. Ownership of EVs, whether new or used, and the type of housing, may impose additional financial burdens on these households. Therefore, strategies such as financial incentives for acquiring used EVs, and support for the use of public charging infrastructure emerge as vital measures to encourage EV adoption within disadvantaged population. This section delves into the equity scenarios that incorporate these strategies and assesses their impact by comparing them with a business-as-usual (BAU) scenario, focusing on the access and affordability of EVs and EVSE for the low-income demographic.

The details of the scenarios are discussed below:

- **Business-as-Usual (BAU) scenario:** A $7,500 federal and $2,000–$7,500 state rebate for new battery electric vehicles (BEVs) ($1,000–6,500 for plug-in hybrid electric vehicles [PHEVs]) and a $4,000 federal and $1,500–$2,500 city rebate for used EVs were modelled based on income thresholds in the BAU scenario.
- **Equity scenario:** an Equity scenario was evaluated in which the city rebate increases from $2,500 to $4,000 for households with annual incomes up to $40,000. The income threshold of $40,000 was determined based on LADWP inputs (i.e., participants of existing low-income customer assistant programs).

As shown in Figure 6, the analysis showed that, increasing low-income rebates for used EVs from $2,500 to $4,000, aligning with federal levels could potentially stimulate a 2% increase in used EV adoption among low-income households, roughly 50,000 vehicles by 2035. Notably, this analysis assumes that increasing rebates by a certain amount equates to a similar income increase. It is expected to have minimal effects on new EV deployment patterns and will not alter high-income groups' EV purchasing behaviors. This analysis does not consider broader market dynamics or potential competition for used EVs among different socioeconomic groups.

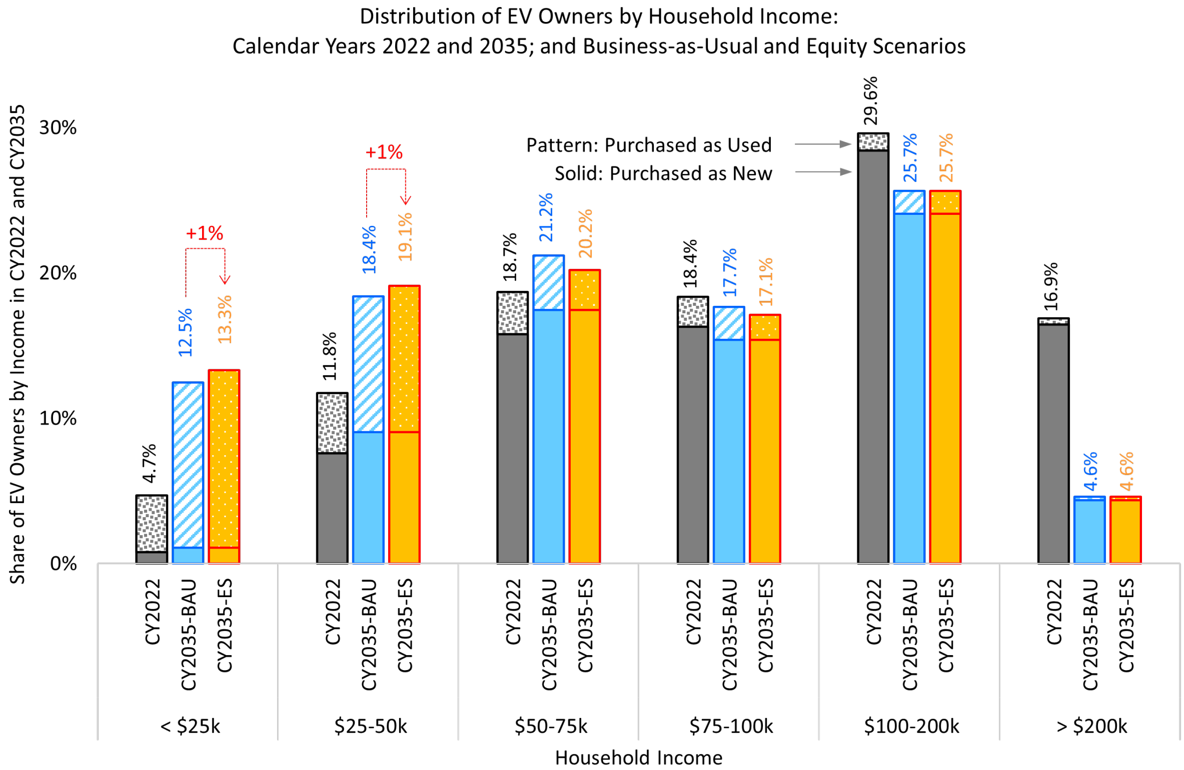

Figure 6. Share of predicted EV owners in Los Angeles in 2035 by household income and EV market (purchased as new versus used) in Business-as-Usual and Equity scenarios

CY = calendar year, BAU = Business-as-Usual, ES = Equity scenario

By comparing the impact of new and used EVs vs. gasoline vehicles on expenditure-to-income ratios for LA households earning $75,000 or less annually, this research further identified that incentives are needed for EV owners who do not have home charging access. The household expenditure estimations within the EVI-Equity model draw upon data from a consumer expenditure survey [9], local fuel prices, projections of future fuel price trends [10], and the comparative maintenance and repair costs between gasoline vehicles and EVs [11].

The left segment of Figure 7, focusing on vehicle purchase and financing, reveals that on average, opting for used EVs could enable these households to save approximately 3% of their total expenditures—a decrease from 7% to 4% relative to their income, in comparison to the costs associated with new EV purchases. While acquiring new EVs might elevate the expenditure share for the majority of lower-income households, the analysis indicates that the levelized driving costs of new EVs, even without rebates, are expected to be lower than those for new gasoline vehicles by 2035 for the broader new vehicle consumer base. However, lower-income families, who are less likely to purchase new vehicles, would see an increase in expenditures when opting for a new EV, as demonstrated in Figure 7.

In terms of operating costs, EVs offer a reduction in fuel expenses across all scenarios, irrespective of home charging availability, as depicted in the middle section of Figure 7. Furthermore, EVs are shown to decrease maintenance and repair costs by 35%, corresponding to a 0.5% reduction in the household expenditure-to-income ratio in comparison to gasoline vehicle ownership, as detailed in the right section of Figure 7. With respect to fuel expenses, the absence of home charging facilities could lead to a 1% rise in household expenditures relative to income, primarily due to the elevated costs associated with public charging—amounting to approximately $300 annually. To mitigate this additional financial strain for households without home charging options, an equivalent annual financial assistance of about $300 would be necessary. This measure could significantly ease the financial impact of relying on more costly public charging stations.

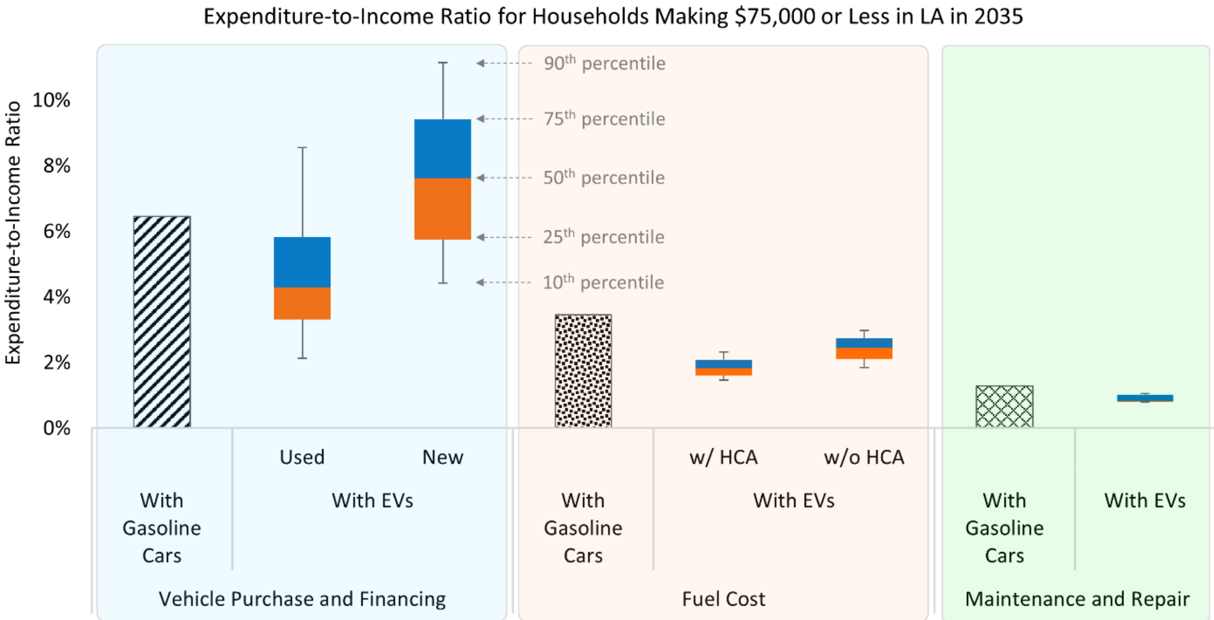

Figure 7. Expenditure-to-income ratio for households with an income of $75,000 or less that adopted EVs in Los Angeles by 2035

HCA = home charging access

4 Conclusions

This research uses Los Angeles as a case study to analyze the potential inequitable distribution of electric vehicle adoption and charging access across population groups, then identify strategies to improve equity in EV adoption and charging access. Key takeaways are summarized below:

- By the year 2035, it is anticipated that households earning $75,000 or less (in 2019 dollars) will constitute a considerable segment of EV ownership. These groups are expected to predominantly opt for used EVs over new ones, unlike their counterparts with higher incomes. Facilitating equitable adoption of EVs among these households necessitates a combination of financial incentives and logistical support tailored towards the acquisition of used EVs.
- Projections for 2035 suggest that households in Los Angeles with annual incomes of $75,000 or less who choose used EVs could see a 3% reduction in their overall household spending, proportionate to their income, when compared to those opting for new EVs.
- Enhancing the rebate for used EV purchases for low-income families from the existing $2,500 to $4,000 is projected to boost used EV adoption by 2% among this demographic in Los Angeles. This increase translates to roughly 50,000 additional vehicles.
- Given that public charging generally incurs higher costs than residential charging, households without access to home charging facilities face elevated charging expenses. This scenario is associated with an average 1% rise in household expenditures relative to income, equating to an annual increase of $300

for a household earning $30,000. Implementing public charging vouchers or financial subsidies could alleviate this economic strain and promote broader EV adoption among households without private charging options.

This study highlights the importance of providing financial incentives to support the EV adoption in disadvantaged population and emphasizes the significance of standard used EVs for affordability and the necessity of supporting them for lower-income households. The further analysis identified the potential finical support that can help improve EV ownership among disadvantaged population and level the cost burden of charging on EV owners who can solely depend on public charging. The research findings offer valuable insights to municipalities and practitioners for shaping inclusive and sustainable transportation strategies, and for ensuring that disadvantaged communities benefit from the transition to cleaner, more efficient transportation alternatives.

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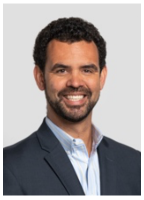

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