ARTICLE

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A perspective on equity in the transition to electric vehicle

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HIGHLIGHTS

- Electric vehicle buyers are mostly male, high-income, highly educated, homeowners, who have multiple vehicles in their household and have access to charging at home.
- Electric vehicle model availability is increasing, however most new electric vehicles are luxury vehicles or SUVs which cost more than early models.
- Incentives for electric vehicles do not incorporate equity in their design, many are received post purchase, and some give more incentives to higher income buyers.
- Electric vehicle charging infrastructure is not equitably dispersed and more low-cost charging is needed in lower income residential areas.

Since the recent introduction of electric vehicles began in 2008-2010, 80 different electric vehicle models and close to 2 million electric vehicles have been sold in the US. The need to commercialize electric vehicles meant research and policy has so far focused on how to establish the early electric vehicle market. The newness of electric vehicles, their high upfront cost, the need for charging access, and other issues meant equity has been overlooked. As regions progress toward goals of 100% electric vehicle sales, research and policy should consider how to establish a more equitable electric vehicle market so that the benefits of electrification are experienced by all and so that low-income households are not imposed with higher transportation costs.

Policymakers are pursuing a transition to plug-in electric vehicles (PEVs) with the goal of reducing greenhouse gas emissions, criteria pollution, and energy consumption. Low-income households, including those in underrepresented communities and in disadvantaged communities [1] could benefit from transportation electrification. These households are impacted by transportation emissions, as they are more likely to reside in or near areas of high traffic [2], and spend a higher proportion of their household income on transportation costs. For example, the lowest income households spend 11.2% of their annual income on fuel, maintenance, and repairs compared to all other households that spend 4.5% of their annual income on these expenses [3]. Displacing internal combustion engine vehicles in low-income and disadvantaged communities and communities of color will reduce local air pollution, and the lower maintenance and fuel costs could alleviate strain on household budgets. However, at present, research shows a disproportionally low number of PEVs have been sold in these communities [4, 5]. Households in these communities are less likely to have charging at home or be able to afford to install home charging, have smaller budgets for vehicle purchase, and have fewer vehicles in their household. They are also less likely to have a regular place of work which means they may not have workplace charging access (an alternative to home charging) [6]. These factors make PEV ownership more challenging, and electrification in these communities will only be possible through greater support from policymakers. In addition to the risk that the benefits of electrification (lower emissions and lower vehicle ownership costs) will not be experienced all, it is possible that the transition to electric vehicles will impose higher transportation costs on some households, primarily because of a lack of home charging and the high cost of public charging. If these higher transportation costs were to disrupt these households' access to a vehicle, it would limit their access to opportunities and essential services [7].

Overall, our aim is to synthesize research that largely shows the PEV transition is not yet equitable. We explore PEV policy and consider policy changes that could help address inequities in the PEV market. Our hope is to foster debate in policymaking, so that equity can be more frequently considered, and to encourage more research into PEVs and equity. We hope that this paper reaches audiences with both social science and technical backgrounds to ensure cross-disciplinary dialogue and to raise awareness that technical solutions alone will not lead to a more equitable PEV market.

Throughout this paper we refer to low-income

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households, underrepresented communities, communities of color (which include Black or African American, Native Americans, Hispanic or Latino, Native Hawai'ians, and Other Pacific Islanders), and disadvantaged communities as some examples of communities that have historically been disadvantaged by the transportation system, are disproportionately burdened by negative by-products of transportation, and will need support in the transition to PEVs. Our choice to focus on these topics is because existing literature connects them and equity in the following ways. This list is not intended to be exhaustive and as the PEV transition continues it may become evident that additional groups also need support.

Current state of the electric vehicle market

We investigate the issue of equity in the PEV market by focusing on electric vehicle buyers, model availability and price, incentives, and infrastructure. Our choice to focus on these topics is because some literature exists on them, and because they are relevant to equity as we outline in the following sentences. We investigate PEV buyers since understanding who is buying PEVs may demonstrate the current lack of equity and reveal which communities need additional resources. We focus on model availability since increasing the number and variety and reducing purchase price of PEV models available will make them affordable to more car buyers. We investigate incentives since the design of incentives has implications for their effectiveness in addressing equity. Finally, we investigate infrastructure availability to assess whether electric vehicle charging infrastructure is equitably distributed.

Electric vehicle buyers: PEV buyers (those that purchase or lease a PEV) are mostly male, high-income, highly educated, homeowners, who have multiple vehicles in their household, and have access to charging at home. In California, the largest and most researched PEV market in the US, buyers have a mean income of $190,000 per year, 81% own their home, 81% are college graduates, and 75% are male [8]. Research has also found PEV buyers in California are 55% white compared to 41% of conventional car buyers [9] and in Maryland only 4% of PEV owners are African-American, compared to 30% of the state population [10]. This indicates that PEV buyers are not socioeconomically or ethnically representative of the state population in which they reside. While some PEV owners do reside in disadvantaged communities, these PEV owners have higher income than the average disadvantaged household and their household characteristics are closer to that of other PEV buyers than of households in disadvantaged communities [4]. Buyers in other US states, Canada, and European nations have also been found to follow these trends [11]–[15]. However, PEV buyer profiles are changing over time and are moving away from a select group of high-income consumers, albeit slowly, with Lee et al. [8] finding that middle income buyers increased from <5% of PEV buyers in 2021 to 7.9% in 2017. The authors suggest that this change is a result of saturation among "high-income" PEV buyers and diffusion to other segments.

Early PEV buyers' contribution to the PEV market is substantial; they have been willing to pay a premium for early vehicle models to the benefit of PEV commercialization, and to achieve climate goals, these groups do need to purchase PEVs. However, goals of 100% PEV sales will necessitate consideration of the needs of other consumer groups, including those with fewer vehicles in the household, lower budgets for vehicle purchase, and the inability to charge from home.

Despite the market being mostly white and high-income, household surveys have shown that Black and Latino households are just as enthusiastic, if not more, than white and Asian households on environmental issues [16] and low-emission vehicles [17] primarily due to their concern about air quality in their communities.

In 2020, 21 battery electric vehicles (BEVs), 38 plug-in hybrid electric vehicles (PHEVs), and 3 fuel cell electric vehicles (FCEVs) were available for consumers to purchase in the US. These vehicles include subcompact and compact cars, midsize and large cars, small and standard SUVs, and minivans. While this is progress from the 13 electric vehicle models that were available in 2012, the average starting price of a BEV model in 2020 is $61,889 compared to $42,145 in 2012; similarly the starting price of PHEVs increased from $35,573 in 2012 to $67,597 in 2020 (see Figure 1). The sales weighted average (i.e., the average of all PEVs sold) starting manufacturer suggested retail price (MSRP) of BEVs increased from $39,531 in 2012 to $52,558 in 2020. For PHEVs, the sales weighted average starting price was at $34,781 in 2012, compared with $46,541 in 2020. Notable progress has been made in vehicle range and model variety (in terms of body style), but the same cannot be said for making the vehicles more affordable.

The increase in PEV MSRP is despite lowering costs of lithium-ion batteries from $1,100/kWh in 2010 to around $140/kWh today, close to the target cost of $125/kWh needed to achieve cost competitiveness with internal combustion engine vehicles [18]. Studies predict that this can be achieved by 2022-2025 with existing chemistries [19]. As these cost reductions are achieved, automakers will have greater flexibility in PEV pricing. However, since automakers do not yet profit from PEV sales [20], they may choose to absorb cost reductions to reduce losses and eventually profit from PEV sales. This may mean PEV purchase prices will not follow the same trend as battery costs.

Even if PEV purchase prices are reduced, low-income households face additional social and economic barriers that cannot be solved by technology alone. In the US, two thirds of households do not purchase new vehicles [21]. As such, lower cost new PEVs will likely be purchased by middle income consumers. If this occurs in large enough numbers, this could create a supply of used market vehicles for those that do not buy new cars. Low-cost used electric vehicles are mostly early generation PEVs with around 80 miles of range when new, which may not be suitable to meet the travel needs of low-income households, especially those with single vehicles and without charging from home. Even the current supply of new electric vehicles may not create an ample supply of affordable used vehicles. One reason is that the new PEV market is increasingly luxury models (e.g., Tesla Model 3, Audi eTron, Jaguar i-Pace). Affordable PEVs do exist but their volumes are too few to create and sustain a used market. For example, the most affordable BEV in the US is the $29,900 Mini Cooper SE which only sold 665 units in 2020 in the US, while the $79,490 to $98,490 Tesla Model X sold 15,850 units [22]. The lack of affordable PEV models limits the availability of low cost new PEVs and will not create the flow of PEVs needed to establish a market of affordable used PEVs

Incentives: Purchase incentives are one policy being used to promote electric vehicle adoption. They typically involve monetary

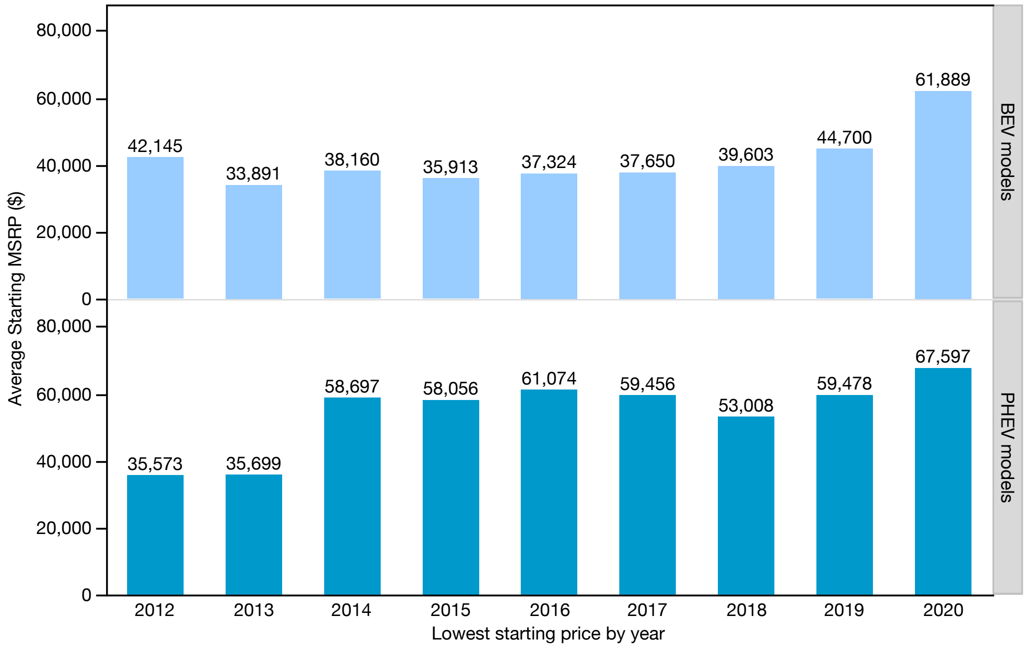

Figure 1: Average starting MSRP (i.e., the cost of the cheapest trim level of available models) of BEV models (top row) and PHEV models (bottom row) available between 2012 and 2020. MSRP data from DATAONE VIN decoder.

payments to car buyers toward the purchase or lease of a PEV. The US federal PEV incentive gives up to $7,500 in income tax credit for new PEV purchases [23]. To receive the full $7,500 credit, consumers need to earn more than $66,000 per year for single filers and $91,000 for dual filers. Consumers earning less receive a lower credit, meaning lower income households receive less than higher income households. The incentive is also received after PEV purchase, meaning a buyer still needs to fund the entire PEV purchase price. Conversely, the recently introduced California clean fuel reward is delivered at point-of-sale but does not equitably distribute incentive funds. For example, the buyer of a $70,000 Lincoln Aviator PHEV receives a 33% higher incentive than the buyer of a $28,990 Prius Prime which is not only a lower cost vehicle but is also more efficient and has a longer electric driving range. Additionally, the program only applies to only new PEVs, is only available at certain dealerships, and has no purchase price or income cap [24].

California, Oregon, and Pennsylvania are examples of states that have incorporated equity aspects in PEV incentives to address the needs of low-income individuals or those living in air pollution districts or disadvantaged communities. Oregon offers up to $2,500 for the purchase of new PEVs, with an additional Charge Ahead rebate of $2,500 for qualifying low or moderate income households [25]. California's Air Resources Board (CARB) has introduced income caps and MSRP caps aimed at targeting incentives towards those that need them most. In Pennsylvania, low-income buyers receive an additional $1,000 rebate on top of the $750 rebate for BEVs [26]. While these programs are progressive, they focus on rebating new vehicle buyers who comprise only 1/3 of all car buyers. CARB also administers the Clean Cars 4 All program (previously called the California Enhanced Fleet Modernization Program) which offers lower-income consumers and those living in particular air districts rebates of up to $9,500 towards the purchase of a new or used PEV [27]. The program requires participants to purchase a vehicle from a participating dealer, which can be problematic since 40% of low-income car buyers do not purchase cars from dealerships [6]. The programs funding is also cyclical, and as of August 2021, funding has not been available since April 2021 [28].

Surveys of PEV buyers, stated preference studies with the general population, and studies analyzing PEV sales all show that incentives are important in encouraging buyers to purchase PEVs [29]. However, high-income buyers would purchase PEVs regardless of incentive availability [11], while lower income buyers' purchase decisions are more dependent on incentives [30, 31]. Despite this, recipients of incentives are predominantly high-income buyers in predominantly white communities [32]. DeShazo et al. [33] simulated the impact of income and purchase price caps on the CARB-funded California Clean Vehicle Rebate Project (CVRP). They find that a $75,000 income cap and $60,000 purchase price cap can improve the cost effectiveness by directing rebates to those that need them most. Research by Guo and Kontou [5] shows that income caps introduced in the CVRP did marginally increase the share of rebates being allocated to lower income households. The Clean Cars 4 All Program, with stricter income caps, more progressive rebate amounts, and greater availability to used car buyers increased rebate allocation in disadvantaged, lower income, lower education, and Hispanic communities [32, 34].

Between June and November 2009, the US Car Allowance Rebate System (CARS) ('Cash for Clunkers') gave participants up to $4,500 towards a new vehicle (with efficiency of >22mpg and MSRP of <$45,000) after they traded in a vehicle that achieved less than 18 mpg. We briefly consider this program since providing rebates for older polluting vehicles could be one mechanism to incentivize PEV purchase, and because the CARS program aimed to have positive outcomes for equity. However, participants were higher income than average used car buyers, though lower income than average new car buyers [35], and only 1% of subsidies went to individuals in the bottom 50% of income [36]. Green et al. [37] found that the ability to use the subsidy as a down payment increased participation, though not for those with preexisting unpaid loans.

The research reviewed here shows that, generally, incentives offered in the US do not sufficiently address equity. Offering incentives based on income, delivering them post purchase, and only offering them for new vehicles excludes many car buyers from purchasing PEVs. Incorporating equity considerations has improved the distribution of some incentives; for example the Clean Cars 4 All program in California appears to be more successful than other programs in that state.

Infrastructure: Residents from low-income communities and residents of multi-family housing (apartments, condos, etc.) face barriers to accessing charging, including lack of charging at home [6, 38, 39], lack of access to smartphones, lack of charging network subscriptions, lack of public charging stations in their communities which have been characterized as "charging deserts," or simply a lack of space for charger installation [40].

Most PEV owners currently charge at home [41], the cheapest and most convenient location to charge. However, home charging is often not an option for people living in multi-family housing who are disproportionately low-income [42], may not have a designated parking spot for a charger, and cannot afford to install a home charger, which can cost $1000-2000 on average. Charging installation in multi-family housing can be particularly problematic due to difficulty in obtaining permission or funds to install chargers. Lopez-Behar et al. [39] highlight the need for both residents and building owners to be motivated to install and fund EV charging infrastructure to overcome these challenges.

There is a larger concentration of public charging infrastructure in wealthier neighborhoods compared to disadvantaged communities and low-income neighborhoods (Figure 2). According to Hsu and Fingerman [43], Black and Hispanic neighborhoods only had 0.7 times the access to public chargers as the no-majority reference group in California. They also determined that even when income, proximity to the nearest highway, and multi-family housing were controlled for, White-majority census block groups were 1.5 times more likely to have access to public charging stations compared to Black- and Latino-majority census block groups.

Even if public charging is better dispersed in low-income communities, this may not appropriately address the issue. Public charging can be 2-4 times more expensive than home charging [44]. Since PEV ownership costs are influenced by electricity cost, expensive public charging can offset the low running cost benefits of a PEV and can lead to higher fueling costs per mile compared to a gasoline vehicle [45]. Assuming home electricity cost is 15 ¢/kWh [46], and the efficiency of a Tesla Model 3 (29 kWh/100 miles), the fuel cost to drive 100 miles would be $4.35. Using public charging at a cost of 31-43 ¢/kWh [44], the fuel cost to drive 100 miles would be $9-12.47. For comparison, the average new sedan in the US achieving 30.9 mpg and using average priced gasoline at $2.79 would pay $9.03 to drive 100 miles. This higher cost would disproportionately affect low-income households who already pay a higher proportion of their income towards transportation.

Several policies have emerged to address some of these challenges [47]. Most focus on providing rebates to low-income households or multi-family housing property owners to install Level 2 chargers, provide faster charging, as they are higher voltage (240V) than standard home electrical sockets (Level 1, 120 V). These policies are often run statewide or by regional utilities, such as California's Electric Vehicle Charger Incentive Education Program run by the Pacific Gas & Electric utility, which provides $500 towards the purchase of a Level 2 charger and $2000 for electrical infrastructure upgrades. Maryland, Massachusetts, New Jersey, and New York have similar policies where funds are often allocated to specifically benefit disadvantaged communities. However, these policies are often limited to charging infrastructure equipment costs and not installation, which can be more expensive than the equipment itself.

The research reviewed here shows that infrastructure is not equitably distributed. Higher income and predominantly white communities have a higher probability of having access to charging compared to lower income and Asian, Black, and Hispanic communities. Lower income households may find the installation of home charging unaffordable, and those in multifamily housing are less likely to have access to charging at home. This lack of home charging access is a barrier to PEV adoption, and public charging may not substitute home charging since it is substantially more expensive to use.

Addressing the lack of equity in the PEV market

The lack of low-income, underrepresented, and disadvantaged households purchasing PEVs is closely related to the lack of affordable new and used PEV models, inequitable design of incentives, and lack of infrastructure in some communities. Addressing these issues will require new and different policies compared to the ones today. Here, we discuss policies that could have a positive impact on equity in the EV market. Table 1 shows an overview of considerations for stakeholders whose goal is to increase equity in the PEV market.

The availability of affordable PEVs and a used market for PEVs is dependent on automakers decisions on what PEVs they bring to the market. Early PEV models were introduced in mostly compact vehicle platforms. However, of the 11 new BEV models introduced to the US between 2018 and 2020, all but 3 are SUVs or luxury vehicles [22]. Automaker decisions to bring these vehicles to the market could be a result of them perceiving high income buyers as the most likely to purchase a PEV and marketing vehicles to these consumers. Regulation could encourage automakers to produce smaller and more affordable vehicles. One way could be through the California zero-emission vehicle (ZEV) sales regulation which is followed by 10 US states [48, 49]. Briefly, a ZEV regulation requires automakers to sell a certain percent of their vehicles as PEVs. Automakers receive credits per PEV sold and credits are calculated (in the case of the California regulation) based on the electric range of the PEV, with more credits for longer range vehicles. Currently, the California regulation only considers vehicle range to calculate per vehicle credits. A recently introduced ZEV sales regulation in Korea [50] considers both vehicle efficiency and range which could encourage automakers to produce smaller, more efficient, and more affordable electric vehicles. PEV leasing could increase the supply of used PEVs faster than purchasing since these vehicles typically enter the used market after 3 years. Encouraging automakers to offer PEVs for lease could be one mechanism to do so, and this may be attainable through higher ZEV credit requirements which may encourage automakers to offer lease deals on ZEVs to increase volume. Automakers may not be receptive to this since higher volumes of used vehicles can impact vehicle residuals, and potentially new vehicle sales.

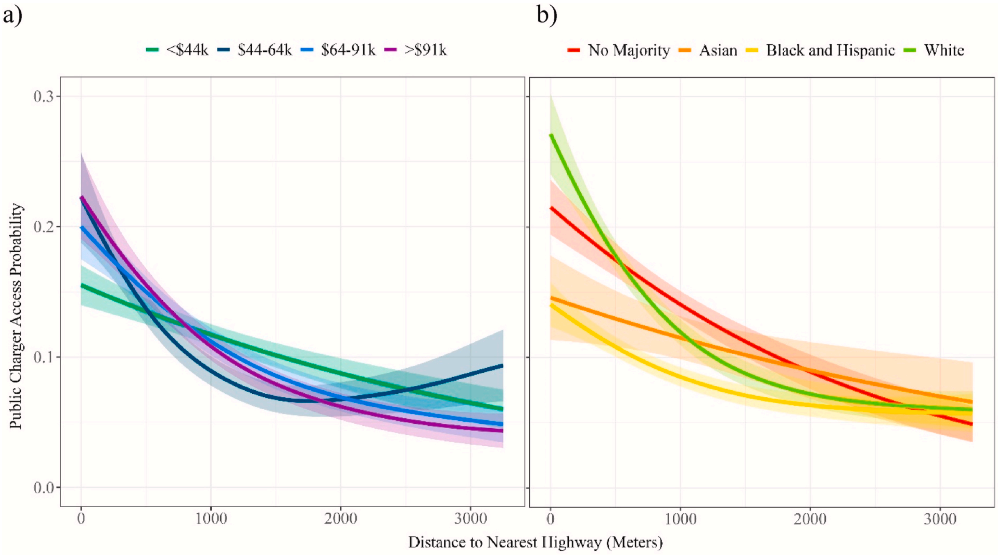

Figure 2: Comparison of the probability of having public EV charging infrastructure access by income, ethnicity, and distance to highway. Generally, higher income levels are correlated with access to charging infrastructure for the same highway access. For the same highway access, Black and Hispanic residents have less infrastructure access. Figure from Hsu *et al* [43].

The US Federal tax credit and most state incentives are received by buyers after buying a PEV. Buyers still need to fund the full price of a PEV through cash or financing. Incentives delivered at point-of-sale that reduce the upfront cost of PEVs will make the vehicles more affordable to more people [6]. Incentives are delivered in this way in many nations, including Canada, United Kingdom, France, Sweden, and others [51]. The US Congress is considering changes to the federal EV tax credit, including implementing an $80,000 purchase price cap, increasing the incentive to a maximum of $12,500, and providing the full incentive regardless of income, however the incentive would still be received after EV purchase not at the point of EV purchase [52]. The California Clean Vehicle Rebate Project has design aspects that promote equity, with an income cap, increased rebates for lower income car buyers, and vehicle purchase price cap [53]. Clean Cars 4 All also has a specific equity focus and offers incentives for both new and used PEVs. This program improved the equitable distribution of incentives, and other regions could consider implementing similar incentive designs to ensure funding is preserved for those that need it, rather than high-income buyers who would purchase an electric vehicle anyway [11]. Introducing purchase price caps and income caps early in PEV market penetration may be beneficial since early buyers' purchase decisions are less reliant on incentives than later buyers [31]. Both the Clean Cars 4 All and CVRP programs frequently experience funding shortages and cannot provide incentives due to the cyclical nature of funding. A more sustainable funding mechanism would provide greater certainty to PEV buyers and guarantee incentives to buyers. One such way could be via a "feebate" that would impose higher fees on conventional vehicles to fund rebates for PEVs [54].

For households who rely on a single vehicle for transportation or depend on their vehicle's reliability and may not be able to afford repairs, a PEV may be seen as risky due to the potential for battery pack failure. Projects like the "Zero-Emission Assurance Project" [55] could help alleviate these concerns by providing rebates for the replacement of a PEV battery for low-income buyers of used PEVs.

Subsidizing the installation of charging stations can alleviate high costs that are prohibitive for businesses, organizations, owners of multi-family housing, and households. Fees for installation include assessing a land site and securing permits, connecting to the grid through digging distribution wires, substations, transformers, and installing the charging unit and equipment [56]. Currently, most charging stations are funded by debt, developer project financing, or automakers, and these funds are often not available to residents or owners of multi-family housing [56]. To this end, policies to support charging infrastructure and installation are critical in low-income communities, but need to be supplemented by other creative financing options [57] or community development financial institutions [58]. In low-income communities, focusing investments on home charging rather than public DC fast charging will provide lower cost charging options. Regions could mandate new multi-family housing developments to install PEV charging in parking spaces or make parking spaces PEV charging ready such that infrastructure could be readily installed. Recently, several cities have done this by mandating new single-family and multi-family housing to be PEV-ready with appropriate outlets and wiring [59]. California has also instituted laws to prevent multi-family housing from restricting PEV charger installation [59]. These laws could be complemented by incentives for retrofits of existing buildings. In addition, governments can evaluate whether they own buildings or parking lots that are good candidates for PEV infrastructure and cities can support right-of-way electric vehicle charging such as those established in Seattle [60].

The Biden administration plans to implement 500,000 new PEV charging stations, but little detail is known on where they will be installed or what entity will be responsible. A significant portion of funds could be allocated to regional districts for disadvantaged and low-income infrastructure development, and the Biden administration has promised that 40% of their clean energy benefits will be deployed in frontline communities [61].

Conclusion

Electric vehicle technology has improved, sales have

TABLE I: Summary of policies, equity considerations, and hypotheses on how they could improve equity based on the literature reviewed in this study.

Policy	Equity considerations	Potential impact on PEV market
Vehicle Regulations	Encourage smaller vehicle types (e.g., through credits)	Greater supply of smaller PEVs could create a supply of more affordable used models for lower income buyers.
	Increase supply of used PEVs	Increasing PEV leasing could create a supply of used PEVs faster than compared to purchasing alone. Provided off lease vehicles remain in the region they are needed, this could make PEVs more available to more households. Increasing volumes of all new PEVs will also contribute to this.
Incentives	Point of sale	Point of sale incentives reduce up front cost of PEVs making them more affordable to more car buyers.
	Income caps	Income caps retain incentive funding for those that need them. Income caps have slightly increased the equitable distribution of incentives.
	Purchase price caps	Purchase price caps retain incentive funding for those that need them. Purchase price caps have slightly increased the equitable distribution of incentives.
	Incentives for low-income used vehicle buyers	Low-income buyers typically do not purchase new vehicles. Incentives for low-income buyers could increase adoption of used PEVs among low-income buyers.
	Incentives not tied to dealerships	Allows incentives to be claimed when purchased from locations other than dealerships, which would give access to more car buyers. Low-income buyers do not always purchase vehicles from dealerships.
	Incentive value not based on income	Providing the full incentive value regardless of income is more equitable than the current federal tax credit.
	Continual incentive funding	Funding shortages mean buyers may not always receive an incentive, making PEVs less affordable and giving buyers uncertainty. This would increase certainty of receiving an incentive.
Infrastructure	Rebates for home charging installation and equipment costs	Lower income households are less likely to have charging at home or be able to afford installation and equipment costs. Current incentives only fund equipment costs. Rebates for installation costs (electrical work, panel upgrades) would increase affordability of chargers.
	Install infrastructure in existing condos and apartments	Condo and apartment dwellers are less likely to have charging at home. Public charging may not be a viable alternative for low-income households due to higher costs. Policies exist for new developments, but not existing multi-unit housing.
	Distribute more charging in low-income communities	Infrastructure is currently not equitably distributed. More equitable distribution would increase service to low-income communities and may increase awareness of infrastructure availability.
	Subsidies for public charging	Public charging, especially DC fast charging, is more expensive than home charging. This could impose higher transportation costs on those without home charging. Subsidies for charging could make public charging more affordable.
Other	Warranties for low-income buyers of used PEVs	PEVs may be perceived as risky due to potential for battery pack failure. Warranties for used PEV batteries may alleviate this concern and help low-income buyers afford battery repairs or replacements.

increased, and more models are available; however, the average BEV model has increased in price by almost $20,000, incentives are not designed to support those that need them most, and infrastructure is not equitably distributed. The majority of PEV buyers are high-income, home-owning, highly educated, predominantly white households. While some research shows change toward lower income buyers, the change is slow. Research shows lower income households are less likely to have charging from home and less likely to find public charging in their communities. This means that those in lower income communities are missing out on the lower running cost benefits of PEV ownership, and their communities are not benefitting from the air quality improvement PEVs can deliver.

These issues cannot be addressed through one solution. Policies related to vehicle supply, incentives, and infrastructure are all needed in addition to research that specifically aims to understand barriers to PEV adoption and policies that enable PEV adoption in underrepresented communities. Supply side regulations can increase the number of PEVs being sold on the new vehicle market, which will (after 3 years if leased) enter the used vehicle market which serves lower income households. If policymakers want to create a more equitable PEV market, incentives should be higher for lower income households, be offered at the point of purchase, be available on used vehicles, and be available regardless of purchase location (e.g., dealers, private sellers). Regarding infrastructure, installing public infrastructure is not the same as providing access to charging in low-income communities. Home charging is the most important charging location in the decision to purchase a PEV, the most frequently used, the cheapest, and most convenient, and access to charging from home increases the odds of continuing PEV ownership. More effort is needed to increase home charging access among underserved communities because of these reasons and the higher cost of public charging.

The discussion in this paper does not fully address the diversity and differences across underrepresented communities, disadvantaged communities, and low-income communities. Our focus was only on private vehicle access, we did not consider other mobility options (car sharing, micro mobility, transit). These are also critical in addressing the mobility needs of underserved communities and should not be overlooked. It is likely that one approach will not yield the same results in all communities, and a tailored approach that involves working with community-facing organizations may partially help address that. Greater understanding of the issues explored will allow researchers and policymakers to work together in finding solutions to increasing equity in the electric vehicle market so that the benefits of electrification are experienced by all. This should include research that specifically studies mobility needs, barriers and enablers to electrification, and how other transport modes may meet community needs. This could be conducted via questionnaire surveys or interviews with households or community leaders.

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