Examining Barriers to Low-Income Californians Adopting Electric Vehicles

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A Culminating Project Presented to the Department of Public Policy and Administration at California State University, Sacramento in Fulfillment of the Requirements for the Degree of Master of Public Policy and Administration

May 13, 2024

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Acknowledgements

I want to express my heartfelt appreciation to my family for their endless love, support, and encouragement. To my parents, who made the ultimate sacrifice so their children could achieve their dreams. Gracias mamá y papá por darme el mundo, los quiero. To my siblings, I love you all and am so proud to be your little sister. To my partner Ramon, thank you for your love and support throughout this journey, and for always keeping me fed and caffeinated. To my dear friend Tish, I am so grateful for our friendship, thank you for keeping me on track.

Thank you to the PPA faculty who helped guide me throughout this journey, especially my advisor, Ted. I am honored to have been part of your last cohort. Ahrum, thank you for your patience and assistance with a portion of my culminating project.

I dedicate this project to the women who have shaped me into the person I am. To my tita, you showed me what true strength and resilience look like. I carry that with me every day. To my mamá, your bravery and vigor inspire me every day. I am where I am because of your sacrifices, and this degree is as much yours as it is mine.

Everyone on this planet should strive to use their unique skills to make the world a better place. My vehicle for change is policy.

Abstract

In 11 years, Californians will no longer be able to purchase new gas-powered vehicles. Through Executive Order, Governor Newsom directed the state's transition to zero emission vehicles by 2035. Undoubtedly, this transition will generate environmental and health advantages, particularly for low-income Californians who have historically suffered from health disparities exacerbated by unjust environmental policies. However, low-income populations are currently underrepresented in electric vehicle adoption, even though available survey data demonstrates they are supportive of the transition.

Since low-income populations may not fully understand what the transition will entail, and how costly it could be, legislative and regulatory leaders must be thoughtful and intentional with closing this knowledge gap. Along with detailing the specific challenges low-income Californians face with the transition, this report presents and analyzes various alternatives to address them. State leaders responsible for overseeing the transition must ensure equity is at the center of this transition. The rest of the nation will take cues from California, so it is paramount that the state prioritize low-income populations during this transformational period.

Introduction

California is committed to addressing the impacts of climate change and has consistently set forth most ambitious climate goals. In an effort to reduce overall greenhouse gases (GHGs) and particularly those produced by the transportation sector, Governor Newsom issued Executive Order N-79-20 in September 2020 (Becker, 2020). This order requires all new passenger vehicles sold in California to be zero emission by 2035 (Becker, 2020). In other words, beginning 2035, Californians will no longer have the ability to purchase new vehicles that have a combustible engine; they will only be able to purchase new vehicles that do not release any emissions. The shift from traditional combustible (gas powered) engines to zero emission vehicles (ZEV) is a necessary and key component in reducing overall GHG emissions and achieving state climate goals.

While there are a number of environmental and health benefits associated with drivers transitioning to ZEVs, there remain questions as to how this shift is affecting drivers who do not currently drive a ZEV, particularly those with limited resources. Given that this transition will be disruptive to societal norms, my culminating project aims to better understand how the state's transition to ZEVs is impacting low-income drivers. Specifically, how will Californians with the fewest resources adjust to this transition, and in the process, what are the most pressing barriers that are preventing them from adopting a zero emission vehicle? Up until this point, the populations who have purchased zero emission vehicles are not reflective of the entire state. Therefore, this project attempts to bring a greater focus on understanding the specific challenges low-income drivers are experiencing.

In order to understand how to increase low-income adoption of ZEVs, ahead of the 2035 mandate, this culminating project will closely examine the most significant barriers that low-

income drivers face. First, I will examine why it is important to bolster low-income driver adoption by reviewing literature about past environmentally unjust policies, current adoption trends, and challenges to adoption. With the zero emission mandate being just a few years away and potentially more challenging for drivers who have fewer resources, greater information is needed to increase the adoption rate of low-income drivers. Second, I will analyze available electric vehicle adoption data along with public opinion data that provide a glimpse into how drivers feel about the mandate, relative to their income level. It is necessary to look at the data through a low-income lens to understand what the barriers are. Finally, since I am in position to understand the political feasibility of policies being enacted by the state legislature, I will share which policies have a probability of being adopted by the state Legislature and are the most political feasible.

Section I: Literature Review

Previous Policies Have Resulted in Environmentally Unjust Outcomes

First, it is important to note that literature related to California's climate actions and transportation goals is widespread, substantial, and highly interdisciplinary. The wide-ranging breadth of literature can be overwhelming since there are various angles to approach the issue. At the same time, the literature paints a picture of how California came to embrace its current environmental policies and why the state is moving towards zero-emissions vehicle adoption.

One of the most important themes within the literature is centered around equity and environmental justice. Hennessy and Syal (2023), along with other authors, offer an important historical context for the former policies that led to low-income communities suffering from

higher pollution rates and poor air quality. Many authors have examined previous policies that resulted in environmentally unjust outcomes for low-income Californians. It is not surprising that authors acknowledge the disparate outcomes that have resulted from policies such as redlining and those related to the transportation system. Jackson (2021) highlights that future environmental policies should account for environmental failures by prioritizing low-income and minority groups who have disproportionately borne the negative impacts of gasoline and diesel emissions.

Environmental justice scholars commonly emphasize two important environmentally unjust policies: housing redlining and positioning of transportation infrastructure. Redlining resulted in minorities living in substandard locations, compared to whites (Alvarez, 2022). Minorities, who are often low-income, continue to be overrepresented in communities that were historically redlined. Therefore, authors discuss the topic of environmental injustice since its effects are still felt in the present day. The literature highlights the notable differences between communities that were and were not redlined. Non redlined neighborhoods which are not near dense transportation infrastructure have a higher concentration of tree canopy and green, open space, which have a positive correlation with health outcomes (Alvarez, 2022). Authors recognize that the government created environmentally unjust policies and recognize the potential to correct these failures with future policies. This historical context is reviewed since it is important for setting the stage around discussions of environmental and transportation policies moving forward.

Other policies reviewed by authors in this space are those within the transportation system. Hennessy and Syal (2023) contend that the current transportation system is inequitable while highlighting the intersection of transportation policies and environmental injustices. Gabbe

et. al point out the health disparities caused by near roadway air pollution, since the residents who reside in those communities are predominantly low-income and people of color (Canepa, Hardman, and Tal, 2019). Authors note that the location of transportation infrastructure, such as freeways or busy streets is an environmental injustice. Gabbe et.al recognize and highlight health disparities in relation to transportation infrastructure proximity. The literature reminds readers that low-income and minority communities have been at the frontlines of environmental injustices, through housing and transportation policies for decades. Since low-income populations have disproportionately borne negative outcomes, the literature recommends that future environmental policies, such as the transition to ZEVs account for these failures and instead work towards correction.

Correcting Past Failures: Why The State Should Prioritize Low-Income Adoption

Previous policies such as redlining and transportation infrastructure location have resulted in minorities being more likely to reside in communities that neighbor hazardous waste, heavy industries, vehicle traffic, and construction (Racism in Environment and Infrastructure). It should not be surprising that the close proximity to these pollution sources have resulted in negative health disparities for minorities, that are true today. These populations of low socioeconomic status are more likely to be exposed to air and noise pollution, from vehicles and transportation infrastructure. Because of the high level of pollution and lack of clean air, minorities are more likely to suffer from asthma, cardiovascular diseases, infant mortality rates, and more (Alvarez, 2022). Additionally, the traffic proximity exposes households to greater air and noise pollution which can result in raspatory issues, coronary heart disease, and even premature death (Gabbe, Oxlag, Wang, 2019). As such, low-income communities stand to benefit the most from electric vehicle adoption since adoption would yield better air quality and

cost savings in the long run.

Early Adoption Trends

Existing literature has examined early adoption trends since ZEV technologies first became available and provide important glimpses into the populations and demographics who are purchasing ZEVs. A common theme within the literature is that early adopters of ZEVs in California tend to come from certain demographic types, particularly higher income groups. Li et al. (2017) emphasize that available studies suggest that well educated and young to middle aged males are more likely to have stronger feelings towards adopting a ZEV. Tal et al. (2020) examine early ZEV adoption trends in California and through their work demonstrate that 49% of early adopters (from 2012-2017) were high-income earners. Canepa et al. (2019) add that early adopters were more likely to have completed postsecondary study. Berliner et al. (2018) build on previous literature, adding that apart from being well educated, early adopters also tend to have higher incomes and have positive views towards trying out new technologies, such as ZEVs. Hardman et al. (2021) emphasize that another important characteristic of early adopters is that they tend to be homeowners and have charging infrastructure built in their home. Available survey data from ZEV owners confirm these demographics are the early adopters, particularly men. (Feigenbaum, 2016). Further, Lee et al. (2019) add that early adopters of ZEVs in California tend to have a preference for vehicles that have a higher mile per gallon range. Finally, authors within this space note that while early adopters tended to be older and have high incomes, more recent trends reflect a growing interest in ZEV adoption for younger families who are middle to high income.

Challenges to Adoption

Existing literature also stresses challenges to zero emission vehicle adoption. Many authors understand and recognize there are still various challenges with zero emission vehicle adoption. Among the key challenges are charging infrastructure, electrical grid capacity, and a shift of traditional consumer behaviors.

Various authors recognize that charging infrastructure is one of the largest barriers to zero emission vehicle adoption. Li et. al (2017) suggest that the current state of charging infrastructure is inefficient, while Jenssen et al. (2013) underscore that charging inefficiency creates a barrier to adoption. Tal et al. (2020) suggest that individuals are more likely to have a positive attitude towards ZEV adoption if they have access to charging infrastructure at work or at home. Maness and Lin (2019) build on the accessibility of charging infrastructure, and their work suggests a positive correlation between free charging and electric vehicles. Apart from the lack of available charging infrastructure, the amount of time it takes to charge a vehicle is also a present barrier. Unlike traditional combustible engine vehicles which can be refueled within minutes, the same cannot be said for all zero emission vehicles. Since charging time impacts consumer's convenience and flexibility, it creates a barrier to adoption (Kumar and Alok, 2020). The literature indicates that an increase in accessible, free, and especially fast charging infrastructure may create positive attitudes and increase desirability towards adopting a ZEV.

Another challenge that is especially important in the context of California is the capacity of the state's electrical grid. Jenn and Highleyman (2022) analyze California's electrical grid impacts from electric vehicles and find that adoption of these vehicles have the potential to strain existing electrical grid infrastructure. They correctly emphasize that California is in the midst of transforming its energy portfolio to account for greater renewable resources. They are wise to

point out that the transition to ZEVs is happening simultaneously with the grid's transition from historically reliable, albeit dirty sources of power, to cleaner and less reliable sources of energy. Elmallah et al. (2022) importantly note that in order for California's grid to support the transition to ZEVs, including residential charging, significant investments and upgrades will be required. These upgrades will undoubtedly be costly, and their completion will depend on a variety of factors. As a result, authors note that the grid may experience difficulties with supporting the charging of these vehicles, since this change will significantly increase total electricity demand, at a time when legacy sources of power are being retired.

Consumers take into account a variety of factors when considering the purchase of a new vehicle. This is unsurprising since it is not an everyday purchase. However, the considerations given during a car purchase may present a barrier to ZEV adoption. While this challenge may be harder to conceptualize, Krishna (2021) notes that because zero emission vehicles are substantially different from traditional gas-powered vehicles, consumers may have unique points of view that affect their desire to purchase these types of vehicles. Krishna notes that because zero emission vehicles are not as common, consumers may not trust these types of technologies yet. In this regard, Kenneth et al. (2016) underscore that ZEV awareness, familiarity, and experiences are important considerations. Li et al. (2017) note that ZEV exposure matters, especially exposure by family members which may improve consumers' perception. Without exposure or familiarity, consumers may be misinformed and believe that zero emission vehicles are less reliable and may question the efficacy of batteries. Franke and Krems (2013) underscore that an increase in familiarity and experience are positively associated with adoption. Therefore, limited exposure or understanding of how the technologies operate may create hesitancies for consumers and therefore are a present barrier to adoption.

Low-Income Drivers May Face Additional Barriers

Hardman et.al (2021) suggest that low-income drivers may face additional barriers in transitioning to zero emission vehicles such as high upfront costs, access to charging stations, and limited understanding of existing subsidies or financial assistance from the government. Sperling (2019) highlights that low-income consumers tend to be wary about purchasing new, and expensive products, such as a new vehicle. Since zero emission vehicles are relatively new products on the market, it makes sense for this population to have reservations about purchasing a zero emission vehicle. Hsu and Fingerman (2021) note that the high cost of zero emission vehicles and the lower availability of technology is a particular barrier for low-income drivers. Hardman et al. (2021) suggests that low-income drivers are much less likely to have charging capabilities at home. This is partly because low-income drivers are more likely to live in multi-family housing such as apartment buildings or condominiums where charging infrastructure is rarely installed. Hsu and Fingerman (2021) also appropriately note the high associated costs with installing charging infrastructure at home which in turn makes adoption more challenging for those with fewer resources. When compounded, these challenges present real barriers to low-income ZEV adoption.

The literature reminds readers that previous housing and transportation policies created environmental injustices. These injustices are visible by the prevalent health disparities which exist in the present day. While there are present challenges for the general population adopting a ZEV and low-income populations are not reflected in current ZEV adoption trends, the government owes it to this population to prioritize their needs. Specifically, the government needs to address the adoption challenges specific to low-income populations, to ensure they are not left behind in this transition. Afterall, these Californians stand to gain the most

environmentally and economically in the long run by transitioning over to a ZEV.

Section II: Background Regarding California ZEV Policies and What ZEV Requirements Entail

CA Leads on Environmental Policies: How Did We Get Here?

California is recognized internationally as a leader in the fight against climate change and has consistently led in climate policies. These aggressive policies have come to fruition because of California's special authority under Section 117 of the Federal Clean Air Act of 1967 (Bosh, 2022). Under Section 117, California is able to apply for special waivers and set more aggressive climate emission standards and policies than the Federal Government (Bedsworth and Taylor, 2007). California earned this special authority due to its early leadership in the area of environmental policy regarding vehicle emissions, as well as its severe air quality problems (Bedsworth and Taylor, 2007). Five decades later, California has consistently taken advantage of this authority and has set higher standards for emission reductions, compared to the rest of the nation (Sperling and Eggert, 2014).

With approval from the federal government, California has passed critical climate policies. Such policies include but are not limited to, the California Global Warming Solutions Act, Low Carbon Fuel Standard, and the Advanced Clean Car Program (Becker, 2020). An early piece of legislation that set the foundation for future climate policies is the California Global Warming Solutions Act, otherwise known as AB 32 of 2006. AB 32 created the first requirement for California to reduce its overall greenhouse gas emissions to 1990 levels by 2020 and 40% below 1990 levels by 2030 (Sperling and Eggert, 2014). Additionally, AB 32 directed the

California Air Resource Board (CARB) to create a Low Carbon Fuel Standard (LCFS) for transportation fuel (Berkeley Law). The purpose of the LCFS is important in this context because it is intended to reduce the carbon intensity of transportation fuels, mainly diesel and gasoline, by 20 percent by 2030 while providing a range of low-carbon and renewable alternatives (Berkeley Law).

Ten years after AB 32, the Legislature once again increased California's goal for total emission reductions. SB 32 of 2016 increased and extended the emission reduction mandate to 40 percent below 1990 levels by 2030 (Berkeley Law). Most recently, the Legislature passed the California Climate Crisis Act in 2022 which sets in place a goal of the state to achieve net zero GHG emissions by 2045 (Balaraman, 2022). Finally, in October 2022, the CARB codified the executive order banning combustible engine cars with the Advanced Clean Cars II regulations. The new Advanced Clean Car II regulations set the foundation for the transition to ZEVs. The regulations state, "By 2035 all new passenger cars, trucks and SUVs sold in California will be zero emissions." Further, the regulations mandate that beginning 2026, 35% of all new vehicles sold in California be either battery electric, plug-in hybrid, or hydrogen-powered to begin phasing in the new technology (De Leon, 2022). That requirement increases to 68% in 2030 and 100% by 2035 (De Leon, 2022). With these adopted regulations, California has once again committed to transforming its transportation sector in an effort to reduce GHG emissions.

Not All ZEVs Are Created Equal: Distinguishing Technologies

It should be noted that the transition to ZEVs encompasses various technologies, and drivers have options in terms of vehicle technologies that can achieve the zero emission mandate. Specifically, there are three common types of zero emission vehicles in California's market.

According to the California Air Resources Board, the technologies include battery-electric vehicles (BEV), plug-in hybrid electric (PHEV), and hydrogen fuel cell (FCV). While each technology has benefits and tradeoffs, the majority of vehicles available in the market and on the road in California are a type of electric vehicle (EV), meaning they are either BEV or PHEV. BEVs are a type of vehicle that runs completely on rechargeable batteries while PHEVs have both rechargeable batteries and a gas engine (Advanced Clean Car Fact Sheet). This project will specifically examine the adoption of BEVs and PHEVs or in other words, those fueled by electricity (EVs). Therefore, this paper acknowledges that FCV is an accepted technology in the transition to ZEVs, but because the FCV market is not mature and still has a way to go in consumer adoption and availability, this technology will not be examined in the context of ZEVs.

Section III: Problem Context

Current EV Adoption Status

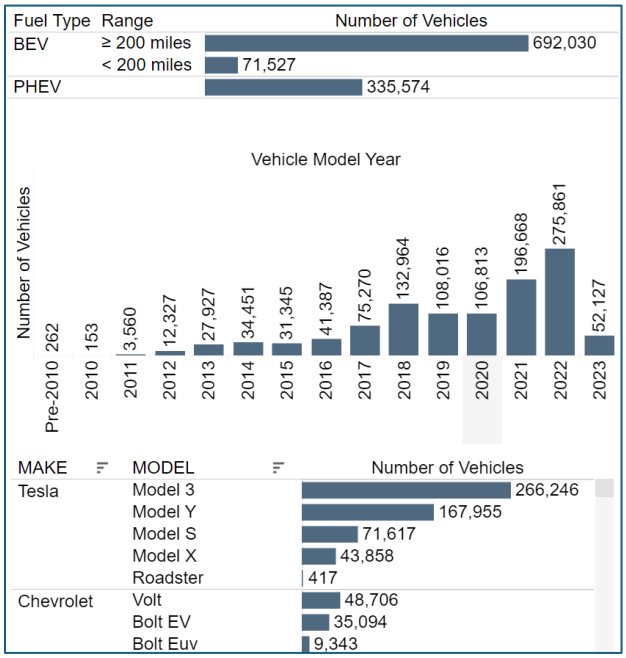
Compared to the rest of the nation, California is leading the way in electric vehicle adoption. This is not surprising considering that California was the first state in the nation to set such an ambitious ZEV adoption target. According to California Energy Commission (CEC) dashboard, where ZEV statistics are publicly available, there were 1,111, 082 light duty ZEVs at the end of 2022. Of the 1,111,082 total vehicles, the vast majority of the vehicles were either BEV or PHEV, signaling that consumers continue to prefer electric type vehicles. The breakdown of total light duty electric vehicle and types is shown below in figures 1 and 2.

Table 1: Light Duty Vehicle Population in California

ZEV POPULATION		
Total Light-Duty Vehicles end of 2022		
1,111,028		
Battery Electric (BEV)	Plug-in Hybrid (PHEV)	Fuel Cell (FCEV)
2.61%	1.15%	0.04%
763,557	335,574	11,897

Source: California Energy Commission Dashboard)

Figure 1: Number of Vehicles by Fuel Type

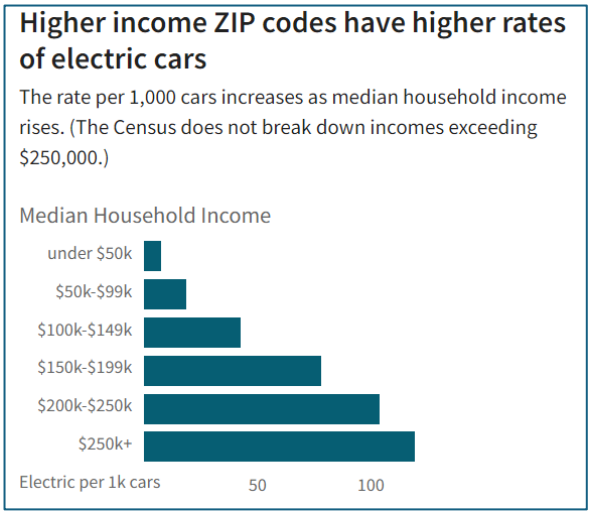


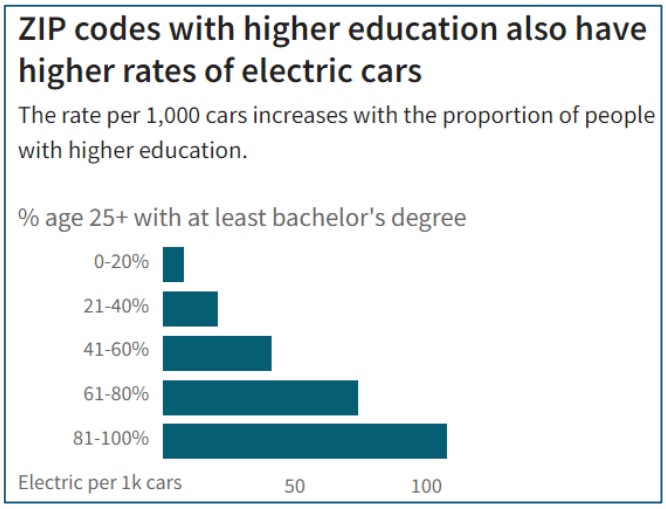
Source: California Energy Commission Dashboard

Additionally, the CEC reported that in the final months of 2023, Californians purchased 103,127 electric vehicles, representing an 8% increase from the same period in the prior year. These electric vehicle additions denote that electric vehicles now represent a quarter of the total market share in California (Lazo, 2024).

According to a 2021 analysis conducted by CalMatters, the highest concentration of electric vehicle adoption is in San Mateo County, a county whose average household income is over half a million dollars. In San Mateo County, electric vehicles are every 1 in 7 cars in the area, or an average of 14% of their total vehicles are electric (Lopez and Yee, 2023). The CalMatters analysis further details that the highest electric vehicle rates are located in communities that have high rates of college educated and high income households. Such counties are concentrated in the Bay Area, Silicon Valley, and coastal areas of Los Angeles and Orange counties (Lopez and Yee, 2023). Importantly, these communities' residents are largely white and Asian. This analysis confirms the correlation between having a high income and driving an electric vehicle.

Figures 2 and 3 (left to right): Who Owns an Electric Car





Source: Calmatters Who Owns an Electric Car (Yee, 2023)

Interestingly, if there are certain economic and racial populations that are acquiring ZEVs, the analysis also demonstrates who is left out of the current picture, low-income and racially diverse populations.

Current Low-Income Adoption

Current available data demonstrates low-income drivers are not adopting electric vehicles as commonly as their high income counterparts. While there is limited evidence on electric vehicle adoption by income or zip code, there is some available reporting that is illuminating to help understand where the current state of low-income adoption in California is. According to a 2023 CalMatters article on electric vehicle adoption, electric vehicles are basically non-existent in the state's lowest income communities. For example, in the City of Stockton, only 1.4% of the total population has adopted an electric vehicle. This is notable considering the median income in the City of Stockton is $16,976, well below the state average (Yee and Lopez, 2023). The statistics worsen in the City of Fresno where only 0. 5% of the total population has adopted an electric vehicle. Of notable importance, the City of Fresno's median income is about $25,905 (Yee and Lopez, 2023). These two examples demonstrate that in low-income communities, drivers are not adopting electric vehicles. Additionally, in a separate CalMatters analysis of 20 different zip codes where Latinos make up over 90% of the population, only 1% of the cars are electric (La, 2023). This finding is considerably low and signals that the government has a role to play in increasing adoption of electric vehicles for these community members.

The Cost of an Electric Vehicle

According to Kelley Blue Book, a vehicle valuation and research company based out of California, the average cost of an electric vehicle in 2023 was $53, 469, compared to the cost of a gas powered vehicle which was $48,334 (Valdes, 2023). This signals that the cost of an electric vehicle is closer to that of a luxury vehicle, versus a traditional gas powered vehicle. The cost of an electric vehicle, therefore, is not that affordable, particularly for those who have fewer

financial resources. Furthermore, this demonstrates that the electric vehicle market is still in its developing stages since overall costs are expected to decrease. The most cost effective electric vehicle on the market is the Chevrolet Bolt, averaging a cost of $28, 104 (Kane, 2024). While there are government rebates and incentives, nevertheless, the current cost of an electric vehicle is a barrier to low-income adoption since this population tends to purchase more affordable vehicles.

Types of Electric Vehicle Chargers

With regards to charging infrastructure for PHEV, there are three main and different types of chargers. Level 1 chargers are the most affordable and the easiest to adopt because they can be plugged into a traditional 120-volt outlet. Level 1 chargers are convenient in that they do not require upgrades or configurations to the home. They do, however, take a longer time to recharge vehicles. On average, level 1 chargers can take 40-50 hours to recharge a dead battery (Lindwall, 2022). Moving up the charging infrastructure ladder, level 2 chargers are the most common. Level 2 chargers do require a 220-volt outlet, such as those that connect washer and dryer machines, and they can recharge a vehicle in 4-10 hours depending on battery level (Lindwall, 2022). Level 2 chargers are especially common in areas where individuals spend a considerable amount of time such as workplaces, commercial parking lots, and parking garages. Finally, the highest rated chargers are level 3 chargers or commonly referred to as DC fast chargers (DCFC) are the most time effective. DCFCs can recharge a dead battery in as little as 20 minutes (Lindwall, 2022). DCFC chargers, however, are the most expensive to install and may require additional upgrades. Nevertheless, access to affordable and fast chargers continues to be a barrier to adoption, so the state still has a ways to go in increasing charging infrastructure ahead of the 2035 mandate.

Table 2: Types of EV Chargers

Low Power AC (Level 1)	Mid-High Power AC (Level 2)	DC Fast Charging (DCFC)
• 120 VAC • Up to 1.4 kilowatts • About 4 miles range added per hour at 1.4 kilowatts	• 208/240 VAC • Up to 19.2 kilowatts • About 32 miles range added per hour at 9.6 kilowatts	• 200 - 500 VDC • Up to 350 kilowatts • About 139 miles range added in 10 minutes at 250 kilowatts

Source: Assembly Select Committee on Electric Vehicles and Charing Infrastructure

Current Status of Charing Infrastructure

According to the CEC, in 2023 there were 94,000 public or private shared charging stations. On March 1 2024, California reached a milestone by surpassing 100,00 charging stations. This milestone has been met with positive feedback as California continues to make progress with electrifying its transportation sector. According to the CEC dashboard, which tracks the number of ZEVs on the road and available chargers, currently there are 105, 012 available chargers throughout the state. However, in 2018, then-Governor Brown set a statewide goal of 250,000 chargers by 2025 (Jackson, 2021). With just one year left to go, it seems unlikely that that charger goal will be achieved on time. While the state has made notable progress towards increasing its charging infrastructure, it is important to underscore that the reliability of the infrastructure is inconsistent and does not always meet performance standards.

A recent informational hearing conducted by the Assembly Select Committee on Electric Vehicles and Charging Infrastructure shed light on the issue of charger reliability. The hearing confirmed that in 2022, roughly 24% of EV owners faced issues with nonfunctional or broken DCFCs in the public network (Assembly Select Committee, 2024). Unfortunately, in 2023 that number increased to 43%, demonstrating that not only will California not achieve its 2025 goal of 250,000 chargers, but the chargers that are online are faulty, inconsistent, and negatively

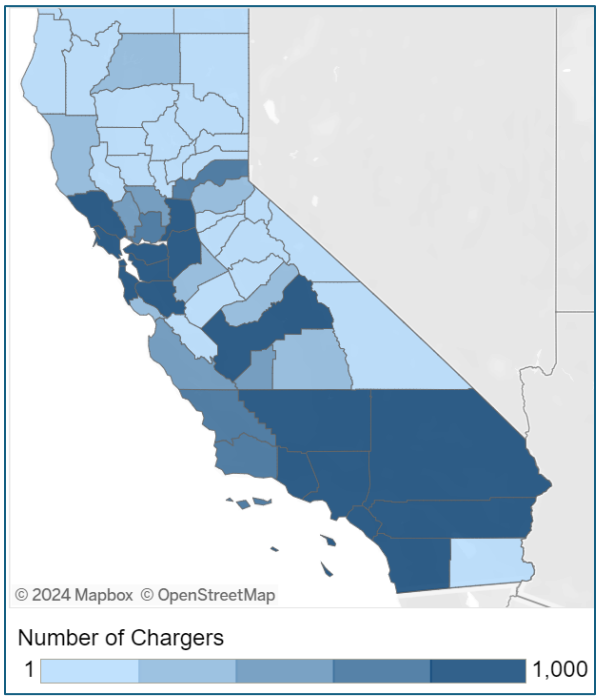
impact the EV experience. This is to say that when drivers are finally able to find a conveniently located charger, they run a high risk of it not being operational. This reduces the number of chargers that are available which drive up waiting times and frustrations for consumers who are in need of a charge. This problem is especially acute for DCFC chargers that are right off major highways, causing long wait times and disruptions. Unless the installation of chargers is quickly streamlined and scaled, this problem will only be exacerbated as more EVs come online.

Table 3: Electric Vehicle Chargers as of March 28, 2024

ELECTRIC VEHICLE CHARGERS		
Total Public and Shared Private Electric Vehicle Chargers		
105,012		
Public		Shared Private
41.28%		58.72%
43,344		61,668

Source: California Energy Commission Dashboard

Figure 4: Number of Chargers by County (California Energy Commission Dashboard)



Source: California Energy Commission Dashboard

Inequitable Access to Charing Infrastructure

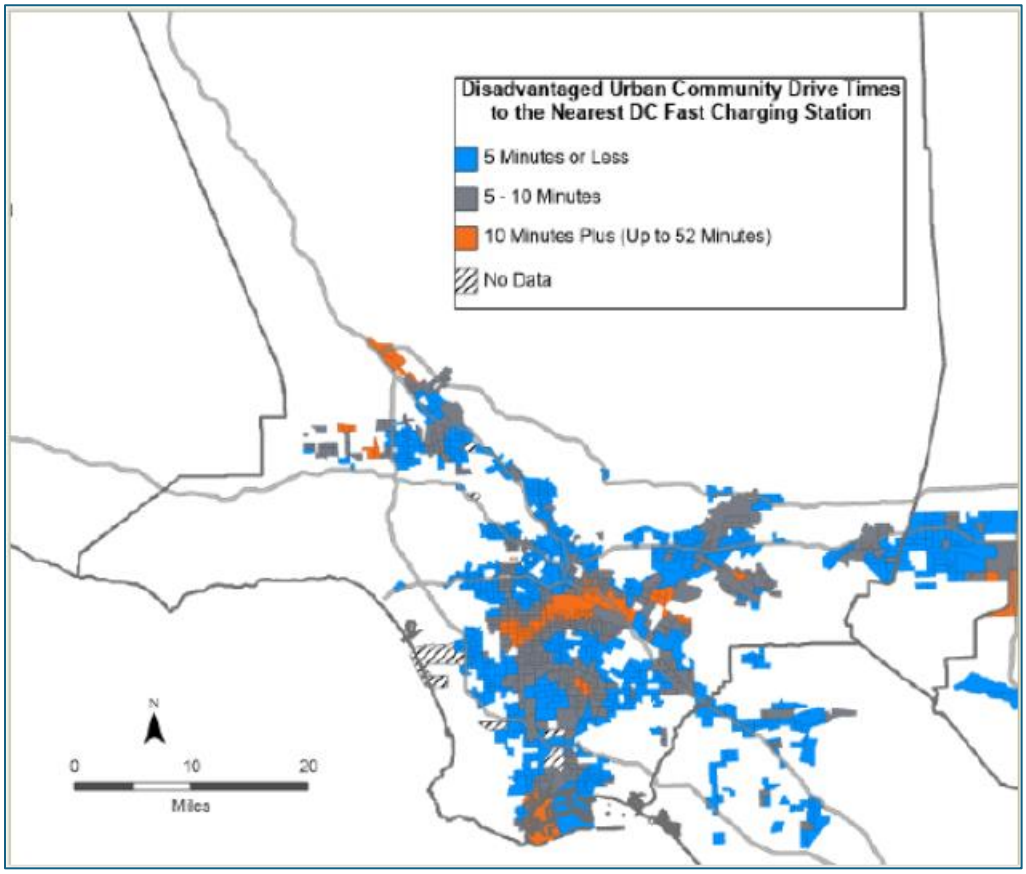
The Informational Hearing also shed light on the distribution of charging infrastructure. In 2020, the CEC conducted a study required by previous legislation (SB 1000, 2018) to assess whether charging infrastructure is deployed appropriately by population density, geographical area, or population income level, including low, middle, and high income levels. The study was based off survey information from 1,300 participants in July 2020. While the survey information is outdated at this point, it highlights important considerations for the state as it continues to electrify its transportation sector. Unsurprisingly, the CEC concluded that public chargers are unevenly distributed geographically, with fewer available chargers in high population density areas and fewer chargers per capita in low-income communities (Alexander, 2022). Further, the study found that people who identify as White have the greatest access to charging, usually within their home, while those who identify as Black, African, Latino or Hispanic have lower access to charging infrastructure (Alexander, 2022). At the time of publication, some counties did not have access to even one charging station. Further, there are generally more available public chargers with lower population density and public chargers available per capita increases with income level (Select Committee). Additionally, the report noted some of the present challenges with increasing access to charging infrastructure in densely populated areas where low-income households tend to reside.

The CEC identified zoning as a contributing factor to why low-income densely populated areas have limited access to charging stations (Alexander, 2022). In addition to zoning, the report found that installing charging infrastructure in multifamily housing is especially difficult, which is where low-income households usually reside. A key challenge in installing charging infrastructure in multifamily housing is the limited number of available parking spots. For

instance, single family homes usually have a garage or driveway, or access to free street parking which creates home charging opportunities. On the other hand, low-income residents who live in multifamily housing have limited access to parking, thus limiting their ability to install or increase home charging infrastructure (Alexander, 2022).

These CEC report confirms that the state of charging infrastructure is already inequitable, even though low-income and minorities stand to benefit the most by transitioning to an EV. While the findings are adverse, the CEC will continue to provide updates due to recently passed legislation that requires an update of this study every two years. The findings will continue to shed light on the understanding of the issue so drivers, policymakers and regulators can make necessary adjustments of charging infrastructure.

Figure 5: Map of drive times from disadvantaged urban areas (Los Angeles)to the nearest DCFC



Source: Assembly Select Committee on Electric Vehicles and Charging Infrastructure

Section IV: What Does Public Opinion Indicate?

To gain a better understanding of how low-income drivers feel about the transition to zero emission vehicles, including the biggest barriers they are facing towards adoption, I examined public opinion data from a recent public opinion survey about attitudes related to environmental policy. While this information is from a single poll, it is based on a representative sample of California adults, and includes variables related to income and other relevant factors such as education level and political party affiliations. Importantly, the survey was conducted by the Public Policy Institute of California (PPIC), a data-driven nonpartisan think tank which is well regarded and often cited by academia.

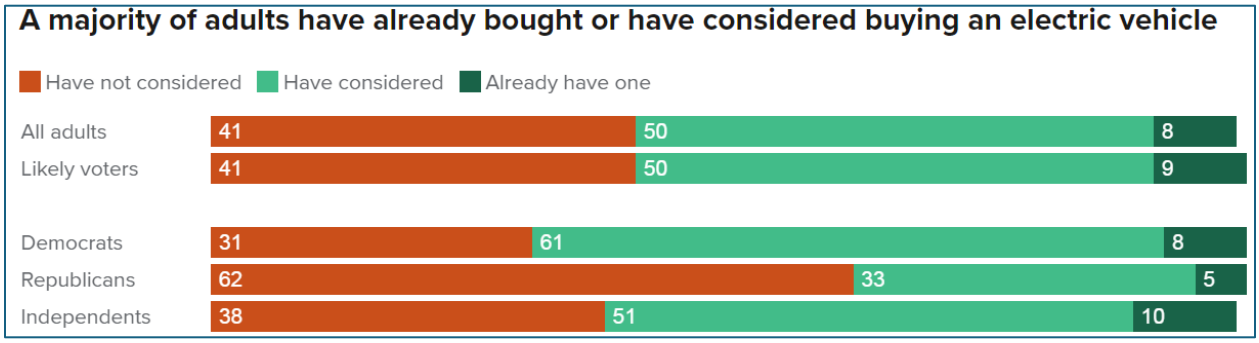
PPIC Survey

I examined data from the 2023 PPIC Statewide Survey on Californians and the Environment. These results are helpful in understanding Californians' general opinions on environmental issues, including the adoption of electric vehicles, relative to income. The survey results indicate that the majority of Californians, 55%, believe adopting electric vehicles will curb climate change impacts, compared to 15% who believe adopting an electric vehicle will do nothing to address climate change. Others surveyed believe that EVs will only help a fair amount. Interestingly, registered Democrats and Independents are more likely to believe EVs help a great deal towards addressing climate impacts while 44% of Republicans believe it will not help at all. This is in line with how the two main political parties view climate change overall and suggests political party affiliation plays an important role in EV adoption and that political party leaders may have a great influence over swaying public opinions on the matter. Another interesting takeaway is the share of those saying the use of EVs helps a great deal declines as income level increases (Balaraman, 2022). This is interesting considering the early adopters of

EVs are high income earners. In the vein of that finding, one could speculate that high income earners are adopting EVs not because of the environmental benefits in reducing climate change, but perhaps for other self-serving reasons.

When asked whether they have considered purchasing an EV, half of participants indicated they have seriously considered the purchase, while 8% already owns an EV and 41% have not made that consideration. Additionally, of those who are Democrats or Independents, 61% have considered purchasing an EV while 8% already own one. This is in line with how Democrats view actions on climate change overall. On the other hand, only 33% of Republicans have considered an EV while 5% already own one. This finding is curious considering that low-income earners tend to be Democrats while high income earners lean Republican. As with the previous findings, it suggests that there may be additional considerations taking place with adopting an EV.

Figure 6: Survey results of who has considered purchasing an EV.



Source: PPIC 2023 Statewide Survey on Californians and the Environment

Deeper Into the PPIC Survey: Cross-Tabulating EV Opinions with Other Variables

To further unpack the survey results with greater focus on low-income populations, I produced my own cross tabulations, using the data set from the PPIC. With regards to understanding how seriously this population has considered an EV purchase, compared to others, I ran cross tabs

with that survey question and reported income.

Table 4: Author calculations on EV considerations cross-abulated with income

Q48. Would you say that you have or have not seriously considered getting an ele	Income								
	Under $20	$20,000 t	$40,000 t	$60,000 t	$80,000 t	$100,000	$200,000	9	Total
Have considered	95 48.72	130 46.93	118 53.15	136 51.52	89 48.11	212 53.40	99 57.89	5 41.67	884 51.31
Have not considered	87 44.62	135 48.74	93 41.89	104 39.39	78 42.16	131 33.00	42 24.56	6 50.00	676 39.23
Already have one	8 4.10	8 2.89	11 4.95	24 9.09	18 9.73	54 13.60	30 17.54	1 8.33	154 8.94
Don't drive/don't hav	4 2.05	2 0.72	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	6 0.35
Don't know	1 0.51	2 0.72	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	0 0.00	3 0.17
Total	195 100.00	277 100.00	222 100.00	264 100.00	185 100.00	397 100.00	171 100.00	12 100.00	1,723 100.00

Source: PPIC 2023 Statewide Survey on Californians and the Environment

Table 1 is interesting because those who earned $40,000 a year are not substantially different than those earning $100,000 a year in terms of considering an EV pruchase. The table shows that 53.15% of those making $40,000 have considered purchasing an EV compared to 53.40% of those making $100,000. This finding may also suggest that low-income populations are not fully aware of the challenges in using EV's documented earlier in this paper. Additionally, the finding may suggest that low-income people are taking cues from Democratic leaders since this population leans Democratic.

Another interesting survey question is the one that asks respondants how they feel about the state ban on gas powered vehicles. In sharing how they feel about the gas ban, respondants may be revealing how they feel about other types of technologies. Once gas powered vehicles are no longer part of the market, zero emission vehicles will be the available option for consumers.

Table 5: Author calculations on gas ban support cross-tabulated with income

Q38. Do you favor or oppose the state banning the sale of all new gasoline-power	Income								
	Under $20	$20,000 t	$40,000 t	$60,000 t	$80,000 t	$100,000	$200,000	9	Total
Favor	100	127	101	120	85	166	90	4	793
	51.28	45.85	45.50	45.45	45.95	41.81	52.63	33.33	46.02
Oppose	95	148	119	142	99	230	81	6	920
	48.72	53.43	53.60	53.79	53.51	57.93	47.37	50.00	53.40
Don't know	0	2	2	2	1	1	0	2	10
	0.00	0.72	0.90	0.76	0.54	0.25	0.00	16.67	0.58
Total	195	277	222	264	185	397	171	12	1,723
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: PPIC 2023 Statewide Survey on Californians and the Environment

This table reveals that respondents from the lowest income category, those under $20,000, *slightly favor* the gas ban. This is an interesting finding considering the high costs associated with adopting an EV and associated infrastructure described earlier in the paper. On the other hand, high income respondents, those in the $100,000, range *oppose* the gas ban. Considering higher income households are the population purchasing EVs, the finding may imply that while this population is purchasing EVs, they do not favor getting rid of gas powered vehicles. This may suggest that high income individuals are more in tune with what the gas ban means or perhaps if they lean Republican, they do not like taking cues from the government on what they can and cannot purchase. This may indicate there is a disconnect with their understanding of what the ZEV transition entails. Further, this crosstab demonstrates that there is not a clear pattern of support for the gas ban across income categories. This reinforces the notion that low income populations may not understand the ZEV transition, appreciate the implications, and may have a knowledge gap, which is an interesting consideration for policymakers.

Section V: Recommendations

Californians are only 11 years away from the ZEV transition, and even though low-income populations stand to benefit the most from this transition, they are already being left behind. To ensure the transition to ZEVs does not disproportionately overburden low-income drivers, equity must be at the center of all regulatory and legislative decisions. The transition to ZEVs presents Californian leaders with a unique opportunity to correct past environmental injustices and uplift low-income populations.

Recommendations for the Legislature

Expand Curb Side Charging

The Legislature is essential in the ZEV transition and has the unique ability to craft policies and budget solutions that will increase low-income adoption. One of the main challenges preventing low income EV adoption is the lack of charging infrastructure, especially in multifamily housing. This is an area ripe for legislation and can be approached by carrot or stick incentives. Since there are limited options to building charging infrastructure in multifamily housing, the Legislature should incentivize the building of infrastructure in nearby and conveniently located areas by offering financial incentives to local governments who install curb side charging. This would be an example of a carrot or incentive approach. Recently, a few localities have authorized pilot programs to install curb side charging, particularly in areas where low-income populations reside. Curb side chargers are those attached to streetlights or other utility poles and can be an avenue for increasing charging access. Curb side chargers are beneficial in multiple ways because they may not require upgrades to existing electrical systems, can reduce installation costs compared to traditional charging locations, and may not require a permit which can accelerate the installation process, compared to other public chargers.

For example, in 2021 after adopting a resolution to increase the amount of publicly available chargers, the City of Sacramento partnered with an EV charging station operator to install curb side chargers at local parks (McGough, 2021). These chargers are conveniently located and are affordable options for charging an EV. Curb side charging is beneficial in that it is conveniently located and does not require upgrades to consumers' housing units. Instead, curb side charging is similar to parking meters and can usually be installed with existing lighting pole infrastructure (Elkind et al., 2022). Additionally, curb side chargers are some of the most accessible since they are situated in popular public areas.

Curb side charging is an important tool that the Legislature should incentivize to increase EV adoption, and this would be especially helpful to low-income residents who do not have the ability to charge at home. Further, the Legislature should build in equity by encouraging localities to prioritize the building of curb side charging in areas that are densely populated by low-income residents. Finally, it would be wise for policymakers to study the efficacy of these curb side chargers to better understand consumer behavior and satisfaction. To that end, the Legislature can require reporting requirements following the pilot period. This information can help inform future discussions around curbside charging locations and consumer preferences, since the number of EVs on the road is expected to substantially increase in the coming years.

While there are multiple benefits to curb side charging, this potential policy solution presents challenges that should be considered when determining the appropriateness of installing this type of charging infrastructure. For example, a downside of curbside charging is that it reduces the number of available parking spaces for vehicles that do not require charging capabilities. This may exacerbate parking constraints and could cause tension between EV drivers and non EV drivers, particularly in densely populated areas where parking is already

limited. To this end, the deployment of curbside charging should be implemented in a way that minimizes displacement for residents who use those parking spaces, especially with overnight parking. Curbside charging may also impact urban planning designs if it requires changes to sidewalks. Finally, since curbside charging is exposed to the public, locals should be mindful of potential vandalism and theft and should have measures in place to deter this behavior.

Penalize Unreliablability

On the other hand, the Legislature should consider stick approaches for increasing the reliability of existing charging infrastructure. As discussed during the Assembly Informational Hearing, the lack of charging reliability presents a major barrier to EV adoption. Too many chargers are not operational at any given time, and this is causing a strain on the available infrastructure, causing longer wait times and driver dissatisfaction. Therefore, the Legislature should task regulators with auditing existing charging infrastructure and explicitly authorize them to penalize EV companies whose charging infrastructure is not properly operating or if they are taking too long in troubleshooting existing issues of unreliability. This punitive approach would incentivize companies to better manage their equipment and correct existing issues in a timely manner so that charging is optimal. Any fees collected from penalties can be used to incentivize the building of curb side charging. This approach could be beneficial in multiple ways because it would force charging station operators to quickly resolve issues and could assist with the building of future curb side charging stations.

On the other hand, one criticism of punitive approaches such as imposing penalties, is that they are often met with opposition. Companies who are resistant to this approach can decide they no longer want to do business in California and move to other states or reduce their infrastructure in the state. Therefore, this approach should be utilized with caution and should be

reserved for EV companies who have a bad reputation for fixing their infrastructure in a timely manner. As a way to balance this approach, the penalties could be on a tiered system. After a certain number of violations, the penalties could be increased. Further, as part of the existing maintenance plans that companies are required to submit to the Air Resource Board, the Legislature could require that companies specify their plan for optimizing reliability. This can be a requirement that is added to their maintenance plan. This seems like a reasonable approach to incentivize companies to repair their equipment in a timely manner and can help increase infrastructure with fees collected.

Partner with Community Based Organizations and Create Educational Campaigns

As demonstrated with the aforementioned cross tabs, low-income drivers likely do not fully comprehend the changes that the ZEV transition will bring forward. To address this large knowledge gap, the Legislature should set aside funding from the general fund for community based organization to conduct ground level educational campaigns and EV demonstrations. A recent UCLA report on improving EV equity highlighted this recommendation and underscored that it is especially important for low-income Californians who often lack exposure to EV technologies and may not fully understand their capabilities (Elkind et al., 2022). Further, low-income populations tend to rely on trusted messengers from their community for receiving information. To that end, it is important for community based organizations to be armed with the appropriate resources, so they have the ability to set up community educational events and reach out to community members. As part of the funding, the Legislature could require that community based organizations set up EV demonstrations in areas where low-income residents reside. This would provide low-income drivers with an opportunity to examine and drive an EV. This hands-on experience would allow low-income drivers to interact with the vehicle and get a sense of

what owning one would feel like. Seeing and experiencing an EV in person could influence their perception and allow them to envision what owning one could be like. These community events could also introduce low-income drivers to EV drivers and provide them with an opportunity to talk with one another and hear about their experiences first-hand. Since low-income drivers stand to benefit the most from the ZEV transition, it makes sense for our state budget to reflect funding actions and programs that will assist in this transition.

Unfortunately, California's budget is experiencing constraints with the Legislative Analyst Office (LAO) estimating the state is facing a $73 billion dollar deficit. The current budget presents difficult realities in all areas of state government spending. To make up for the budget shortfall, legislative leaders and the Governor's Administration are proposing to delay, shift funding, or simply cut programs and services. One of the largest areas of funding proposed to be cut from the budget are from the climate and energy space, which include programs and funding for expanding ZEV technologies. While the Legislature and Administration will finalize the budget in June, they will likely prioritize key funding in education, healthcare, social services, and public safety. Therefore, the current budget deficit makes it challenging to set aside funding for community based organizations to conduct EV educational campaigns and outreach.

For Regulators

Amending the Clean Vehicle Rebate Program

The California Air Resource Board (CARB) is the lead agency responsible for overseeing and implementing climate change programs, including those related to ZEV adoption. Therefore, CARB is responsible for administering the Clean Vehicle Rebate Program (CVRP) and creating its program guidelines, including income eligibility. The CVRP is one of the most important programs for increasing ZEV adoption because it provides financial incentives in the form of

rebates to individuals transitioning to a ZEV. Regarding income eligibility, those eligible are single filers with an income of up to $135,000, head of household filers with an income of up to $200,000 and joint filers with an income up to $300,000 (Center for Sustainable Energy, 2020). According to the program fact sheet, the CVRP provides eligible individuals with a $2,000 dollar rebate for the purchase of a BEV and a $1,000 dollar rebate for the purchase of a PHEV. To better target low-income individuals, CARB should lower the income cap to capture more low-income individuals. Specifically, CARB should mirror poverty guidelines used for other state safety net programs, such as Medi-Cal, and cap the income level for single filers at $105,000 dollars and $170,000 for joint filers. Furthermore, CARB should increase the amount for the additional rebates that low-income individuals can take advantage of. Currently, low-income individuals may receive an additional $2,000 if they are 400 percent above the federal poverty level (Center for Sustainable Energy, 2020). To increase low-income adoption, CARB should increase the additional incentive by an extra $2,000 dollars. The UCLA report on improving EV equity highlighted this recommendation because it would be especially impactful for low-income individuals who may need greater financial assistance with purchasing an EV (Elkind et al., 2022). However, if CARB were to amend the CVRP and lower the income cap, moderate income individuals would be unable to take advantage of rebates. This program change could intentionally slow down the adoption of EVs for moderate income individuals.

Another way CARB could better support low-income populations would be by amending the CVRB and allowing previously owned EVs to be eligible for rebates. Currently, the CVRP cannot be used for the purchase of used EVs, as they are deemed ineligible. It is important to remember that low-income individuals are more likely to purchase a used vehicle than a new vehicle. Therefore, the CVRP would be more beneficial to low-income populations if they could

apply the rebate towards a used vehicle, since that is what they are more likely to purchase. However, a potential criticism in amending the CVRP to allow for used vehicles to be purchased is that the vehicles longevity will not go as far as a new vehicle. Given the current fiscal challenges, there is a strong desire to yield the highest result with our state's financial incentives.

Streamline Electrical Grid Upgrades

To avoid blackouts and ensure energy reliability to support EV charging, the California Public Utilities Commission (CPUC) should streamline grid upgrades. As previously mentioned, California is in the process of transitioning its energy portfolio to account for greater renewable and cleaner sources of energy. This energy transition is occurring at the same time the state is electrifying its transportation sector, which presents unique challenges. Ironically, shortly after Governor Newsom announced the Executive Order on ZEVs, the state experienced a prolonged heat wave in which state leaders asked EV owners to not charge their vehicles during peak energy hours (Ripka, 2022). The state avoided blackouts during that heatwave, but extreme weather events may become more common as climate change intensifies. In order to support the additional electrical load that will be added to the state's energy portfolio, the transmission and distribution systems must be enhanced to support the increased load and the delivery of it. Often times, the CPUC is too slow in approving permits that are required for the building of new transmission and distribution lines.

The CPUC must streamline its permitting process to not delay transmission and distribution projects. A recent analysis of California's progress in advancing transmission planning and permitting highlighted the amount of time it takes for the CPUC to approve transmission related projects. Of notable concern, the report noted that the CPUC took "an average of 1,206 days or 3.5 years to approve three applications submitted by Southern

California Edison" (Center for Energy Efficiency and Renewable Technologies, 2023). Given the significant need to make upgrades to the electrical grid, the CPUC should review its existing procedure for permitting approval and adopt a mechanism that will standardize and thus streamline the approval process. It is unreasonable to expect a utility company to wait over three years for their project to be approved by their regulator. The CPUC should create a standardized process for approving projects within a reasonable timeline, so projects are not delayed.

While many stakeholders criticize the time it takes for the CPUC to approve projects, the CPUC thoroughly reviews applications to understand a project's need, economic impact, and environmental impact (Center for Energy Efficiency and Renewable Technologies, 2023). Given the significance of these projects, it is important to understand how the upgrades will impact the region in the long term. Therefore, the CPUC should look for ways to standardize its existing permitting process while balancing the need to understand the impact of these projects.

Most Politically Feasible Recommendation

Of the previously mentioned recommendations, the most politically feasible recommendation is for the Legislature is to penalize EV companies whose charging infrastructure is consistently unreliable. Due to the present budget challenges and the need for creative budgeting, the recommendation to penalize EV companies seems like the most realistic recommendation. Since fees recouped would be used for the building of additional charging infrastructure, this proposal has the strongest chance of making its way through the legislative process and being signed into law. During difficult budget years, it is more palatable for legislators to support proposals that penalize industry players, even though those stakeholders will likely be opposed to such a measure. Further, since the ZEV mandate is only 11 years away, legislators can justify their support of the proposal by underscoring the quickly approaching deadline to transition to ZEVs.

Conclusion

California is once again leading the nation in climate policies by transitioning its transportation sector to completely zero emission by 2035. This laudable goal will yield positive climate and health benefits, with low-income Californians standing to benefit the most. Since low-income Californians have historically been disproportionately impacted by environmentally unjust policies, the government must prioritize the needs of this population. As the literature highlighted, the transition to ZEVs must be centered around equity and justice and low-income populations must be empowered to undertake this transition. Considering the findings from the PPIC cross tabs, low-income individuals may not fully understand what the upcoming changes entail. To that end, the government is well positioned to fill these knowledge gaps and support low-income Californians EV adoption. Since the budget is currently experiencing a deficit, legislative leaders will need to be creative with how they support the adoption of EVs for low-income Californians, likely by taking more punitive approaches such as penalizing EV companies. It is important that California set an example for the rest of the nation, because where California leads, other states follow. Therefore, California must prioritize low-income EV adoption and demonstrate to the rest of the nation that it is possible to remove emissions from the transportation sector, without leaving low-income populations behind.

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