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Quantifying the Environmental Justice Impacts of Zero-Emission Vehicles

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Executive Summary

The research aims to identify the disparity in zero-emission vehicle (ZEV) ownership and quantify the environmental justice (EJ) benefits of ZEVs. The study analyzed ZEV registration data in California, Michigan, and England, and found that ZEV ownership is mainly driven by economic position, with regions of higher income and education showing higher ownership rates. There was no consistent relationship between ZEV ownership and race or ethnicity. Additionally, through extensive stakeholder engagement, the study revealed the major barriers to ZEV adoption among lower income regions and disadvantaged communities: affordability, lack of charging infrastructure, and limited mobility options. Through stakeholder engagement, the study has identified several policy recommendations. These include utilizing the growing pre-owned EV market, strategically locating charging and fueling stations, involving the community in decision-making processes, and providing targeted incentives for lower income regions.

Keywords: zero emission vehicles, environmental justice, charging infrastructure, policy interventions, community engagement

1 Introduction

Transportation emissions have a negative impact on air quality and public health, particularly in disadvantaged communities. ZEVs can significantly reduce transportation emissions, improve public health, and offer operational savings compared to ICE vehicles. However, ZEVs have been difficult to adopt on a widespread scale, especially in lower income regions. To address this, EJ policies should be developed to increase ZEV operation in these regions through objective analysis and collaborative engagements with EJ experts, regions, and governments. This report identifies key barriers inhibiting low-income and disadvantaged communities from benefiting from increased adoption of ZEVs and provides recommendations for policymakers to integrate EJ into ZEV policies for a more equitable transition to zero-emission transportation.

In collaboration with the International Zero Emission Vehicle Alliance (IZEVA), the project team selected three markets to conduct a comprehensive stakeholder engagement to solicit inputs on the barriers, as well as the potential solutions to enhance EJ outcome of ZEV policies. Additionally, through this research, the project team leveraged publicly available data sources and analyses to quantify and highlight the disparity in ZEV adoption across these three markets. With respect to the three selected markets, we chose Michigan and California in North America as two distinct markets due to their differences in ZEV uptakes and policies. The maturity of California's ZEV market is globally recognized due to the state's progressive policies, including programs that have allocated funding to increasing access to ZEVs for disadvantaged communities. Important to acknowledge is the fact that despite California's comparatively mature ZEV market, the state

does continue to struggle with air quality issues and stark inequality issues. Michigan is an interesting comparison to California because it has not adopted California's Clean Car Standards, has high influence from automakers, and has a long history of environmental injustice. The third market is England, which represents one of the largest European passenger vehicle sales and a comparatively broad spectrum of sociodemographic conditions relative to the rest of Europe.

2 ZEV Ownership and Sociodemographic

The team first looked at the distribution of ZEV ownership to develop an understanding of ZEV equity issues in disadvantaged communities. The team calculates ZEV ownership per capita by zip code for California, Michigan, and England and analyzed the correlations between ZEV ownership and four sociodemographic indicators: median income levels, population below poverty levels, percent people of color (POC) populations, and educational attainment.

2.1 Data Sources

EV Registration Data

For the U.S., the California Energy Commission (CEC) and Atlas EV Hub provide ZEV registration data at zip code level. The CEC's Light-Duty Vehicle Population tool reflects the total light-duty vehicle population "on the road" per zip code. Atlas EV Hub makes select state Department of Motor Vehicle (DMV) ZEV registrations publicly accessible and provides Michigan's 2020 ZEV Market Snapshot for the number of ZEVs per zip code. For England, we leveraged vehicle statistics from the U.K. Department of Transportation, which provides detailed vehicle registration data at Office of National Statistics (ONS) geographical index level. This data set includes vehicles counts per ONS geocode by vehicle type for both Ultra Low Emissions Vehicles (including ZEVs) as well as conventional ICE (e.g., petrol/gasoline and diesel) vehicles.

Sociodemographic and EJ Data

For the U.S., the U.S. Census Bureau's 2020 American Community Survey (ACS) offers year-to-year population statistics per zip code, such as median income, race and ethnicity, and educational attainment. In this analysis, the project team defined POC as individuals of any racial or ethnic group except *Not Hispanic, White alone* individuals. For England, sociodemographic data are obtained from the 2021 U.K. Census. Specifically, we extracted data from the Annual Survey of Hours and Earnings (ASHE), Population Estimates by Characteristics Research Report, 2019 English Indices of Deprivation, and 2011 Qualifications and Students. For England, we defined people of color as the population that are not white (regardless of whether they are British or not).

To conduct a comparative analysis across the three markets, the project team first calculated ZEV ownership per capita (i.e., the number of ZEVs per 1000 people) by zip code for California, Michigan, and ONS geocode (E06 through E09) for England. We then investigated relationships between ZEV ownership and four sociodemographic indicators: 1) median income levels, 2) population below poverty levels, 3) percent POC populations, and 4) educational attainment. Median income levels offer a better crossroads between poverty and affluence than average income, which can be dramatically inflated by small groups in certain geographic regions. With respect to POC, at least in North American markets, POC populations have historically faced environmental injustice. Assessing the relationship between ZEV ownership and POC populations could qualitatively surface ZEV benefits potential against historic inequity issues. Lastly, population's education levels, based on the number of 25+ year old with a high school education, can offer both quantitative evidence and qualitative suggestions on awareness of ZEV technology, as well as inform local governments that more can be done to kick off the local ZEV market. The correlations between ZEV ownership and the specified socio-demographic indicators are interpreted using percentile bins to better visualize trends in the data.

2.2 California

In California, there were approximately 30 million passenger vehicles at the end of 2021, with 87% being gasoline vehicles and only 3% being ZEVs, such as BEVs, PHEVs, and FCEVs. The project team cross-referenced the number of ZEVs per zip code with U.S. Census Bureau's ACS statistics per zip code. The team calculated the number of ZEVs per 1000 people for over 2600 zip codes, ranging from 0 to 385. The San

Francisco Bay Area and Southern California regions have some of the highest ZEV ownership rates and median incomes in the state relative to the rest of the state.

The number of ZEVs per 1000 people per zip code were compared to normalized median income and percent population below the federal poverty line (FPL) per zip code are shown in Figure 1. The results suggest that ZEV ownership in California is significantly influenced by overall economic position. At high median income levels (e.g., 80 through 100 percent) average ZEV ownership is approximately 92 ZEVs per 1000 people, whereas at low median income levels (e.g., 0 through 20 percent), average ZEV ownership is approximately 12 ZEVs per 1000 people. There are over seven times as many ZEVs per 1000 people in the highest income zip codes as there are in the lowest income zip codes. Similarly, at low percent populations in poverty (e.g., 0 through 10 percent), the average ZEV ownership is approximately 24 ZEVs per 1000 people. At high percent populations in poverty (e.g., 50 through 60 percent), the average ZEV ownership is approximately 2 ZEVs per 1000 people.

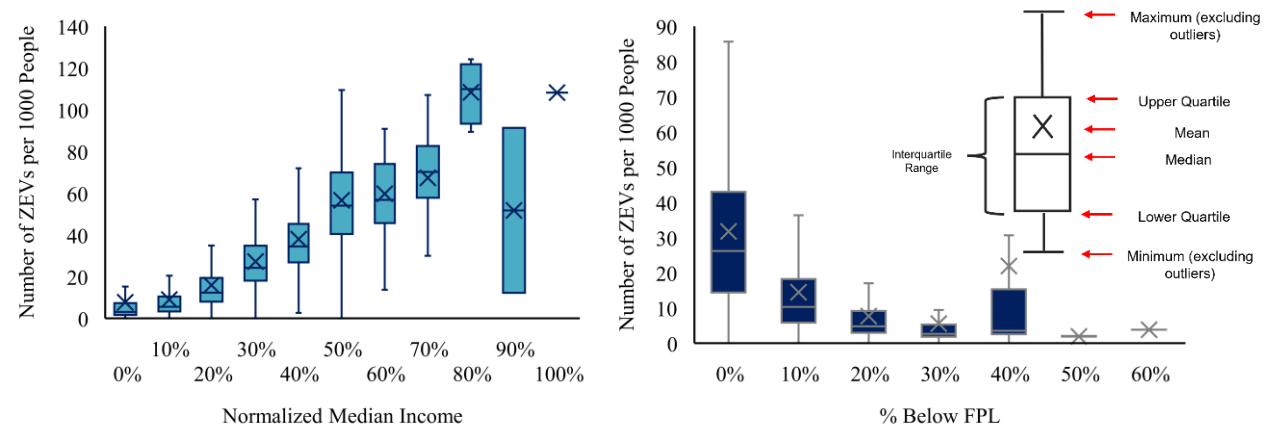

Figure 1 - ZEV Ownership Compared to Income Statistics by Zip Code in California

In addition to income and FPL, we compared ZEV ownership to percent POC populations and percent populations with less than a high school education per zip code, as shown in Figure 2. The results suggest that ZEV ownership is partially influenced by percent POC population. As the percent POC population increases (e.g., 30 through 100 percent), ZEV ownership tends to decrease. However, ZEV ownership within low percent POC populations (e.g., 0 through 20 percent) is observed to grow incrementally. In terms of educational attainment, the results suggest that ZEV ownership is influenced by percent population with less than a high school degree. At low percent populations with less than a high school degree (e.g., most of the population is high school educated, and between 0 to 10 percent are not high school educated), the average ZEV ownership ranges between 0 to 87 ZEVs per 1000 people. At high percent populations with less than a high school degree (e.g., at least half the population is not high school educated, between 50 to 60 percent), the average ZEV ownership ranges between 0 to 3 ZEVs per 1000 people.

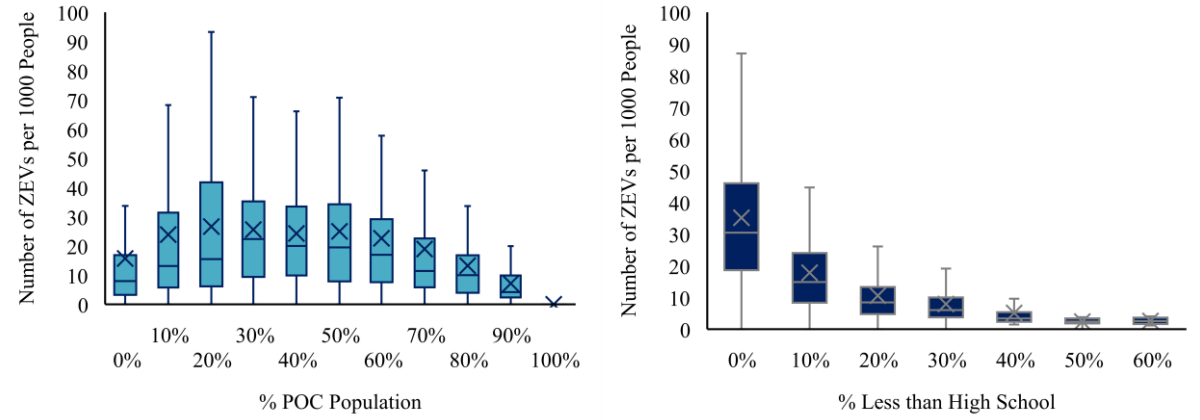

Figure 2 - ZEV Ownership Compared to Percent POC Population and Education by Zip Code in California

The assessment of California's ZEV market found that there are still gaps in accessibility to electrified transportation, even in markets with accelerated ZEV adoption and supporting infrastructure. ZEV ownership is correlated with income, and education but less correlated with race or ethnicity. Zip codes with high median incomes own as many as seven times more ZEVs per 1000 people compared to zip codes with lower median incomes. Disadvantaged communities, due to lower educational attainment, environmental burden, or acute health effects, are less likely to have ZEV ownership rates greater than 5 ZEVs per 1000 people. ZEV ownership initially increases with an increasing percent POC population, peaking at 93 ZEVs per 1000 people in zip codes with 20 percent of the population being POC, then decreases as the percent POC population increases. Factors such as affordability and accessibility to ZEVs and their infrastructure, ZEV charging permitting processes across zip codes, and EJ factors that limit infrastructure development may contribute to the variation in ZEV ownership across racial and ethnic groups in California.

2.3 Michigan

In Michigan, the total passenger vehicle population and the end of 2021 was approximately 8.3 million, 85 percent of which are gasoline vehicles, and ZEVs are just 0.4 percent of the light-duty vehicle population. For Michigan, we calculated the number of ZEVs per 1000 people per zip code for over 950 zip codes. The number of ZEVs per 1000 people varies between 0 through 71. The Detroit metropolitan area in the south-east has the highest ZEV ownership rates compared to the rest of the state; zip codes within Livingston, Oakland, and Wayne counties (all in the Detroit metropolitan area) reflect almost all ZEV ownership rates between 1 through 71 ZEVs per 1000 people. High median incomes relative to the rest of the state of Michigan can be observed near the Detroit metropolitan area, as well as in the western Grand Rapids area of the state. The majority of Michigan's POC population take residence near the Detroit metropolitan area. Statewide, the ACS estimates a total population of 9,975,900 people, where POC represent 25 percent of the total population.

For Michigan, the results for the number of ZEVs per 1000 people per zip code compared to the normalized median income and percent population below FPL per zip code are shown in Figure 3. The results suggest that ZEV ownership in Michigan is influenced by overall economic position. At high median income levels (e.g., 80 to 100 percent), average ZEV ownership is approximately 7 ZEVs per 1000 people, whereas at low median income levels (e.g., below 20 percent), average ZEV ownership is approximately 1 ZEV per 1000 people. Similar ZEV ownership rates can be observed when compared to percent populations below the FPL. At low percent populations in poverty (e.g., below 10 percent), the average ZEV ownership is approximately 2 ZEVs per 1000 people. At high percent populations in poverty (e.g., 50 to 70 percent), there is no observable ZEV ownership. These results highlight a significant disparity in ZEV ownership for people in Michigan.

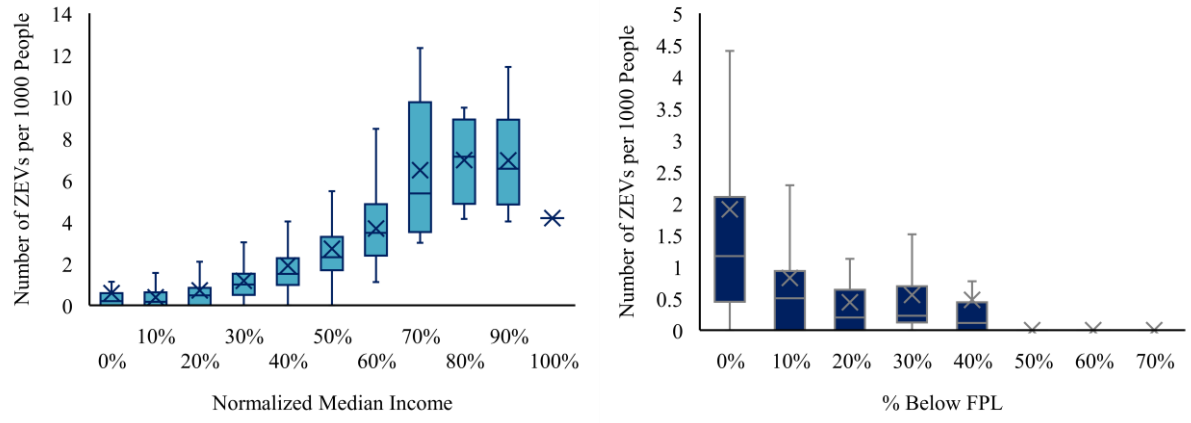

Figure 3 - ZEV Ownership Compared to Income Statistics by Zip Code in Michigan

EV ownership rates, as they relate to the percent POC population and educational attainment, are shown in Figure 4. The results between ZEV ownership and percent POC populations are less indicative than those of California. At low percent POC populations (e.g., below 20 percent), ZEV ownership is observed to grow incrementally up until mid-percent POC populations (e.g., 30 to 60 percent), and decreases at high percent POC populations (e.g., between 70 and 90 percent). In terms of educational attainment, the results suggest that ZEV ownership is significantly influenced by the percent population with less than a high school

education. At low percent populations with less than a high school degree (e.g., below 10 percent), the average ZEV ownership is approximately 2 ZEVs per 1000 people and can be as high as 5 ZEVs per 1000 people. At high percent populations with less than a high school education (e.g., 40 to 50 percent), there are nearly 0 ZEVs per 1000 people.

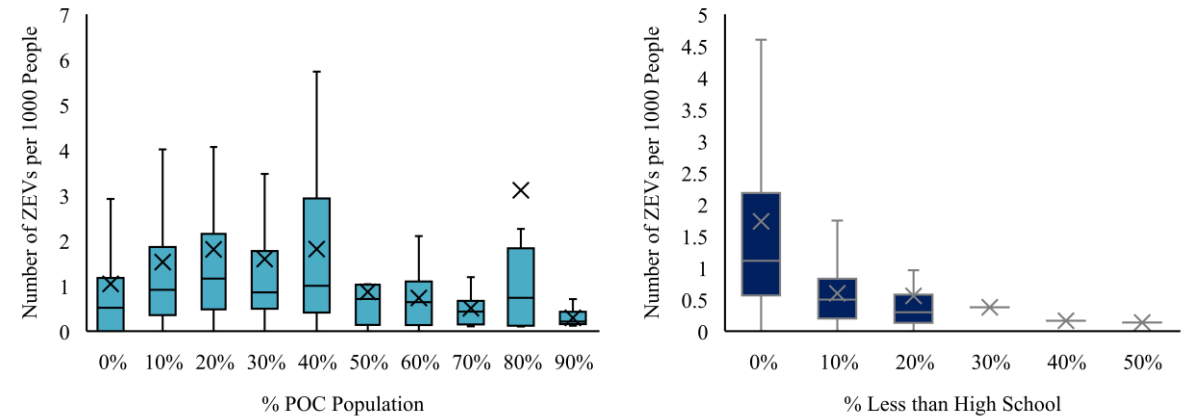

Figure 4 - ZEV Ownership Compared to Percent POC Population by Zip Code in Michigan

The assessment of Michigan's ZEV market provides some evidence of gaps in the ZEV market across the U.S. and North America. In Michigan's case, the overarching barrier to entry into electrified transportation and infrastructure is tied to socioeconomics – at lower median income levels or high poverty levels, ZEV ownership rates do not surpass 2 ZEVs per 1000 people. Although overall ZEV ownership rates in Michigan are several times lower than California, it can still be observed that low-income and less-educated people are much less likely to own ZEVs than even the higher-earning or higher-educated populations. Michigan's ZEV ownership rates are uncorrelated to percent POC populations, especially when considering Detroit metropolitan demographics. Not only is 75 percent of Michigan's overall population white, the majority of Michigan's POC population can be found within just the Detroit metropolitan area. Cross examining the percent POC population with the distribution of ZEV ownership, it can be inferred that certain sociodemographic metrics, such as urbanization, job markets, and possibly even seasonally inclement weather play complicated roles in the overall ZEV market. Another important consideration for Michigan's market is that overall ZEVs have not experienced widespread adoption, meaning that any uptick in the number of ZEVs per zip code, regardless of racial or ethnic diversity, will present initially askew data resulting from early adopters, as seen with the Detroit metropolitan area. Similar to California, there may be discrepancies between where ZEVs are registered and where people live relative to the state's most major urban area.

2.4 England

For England, the total passenger vehicle population (i.e., vehicle stock) at the end of first quarter of 2022 was approximately 27 million, 94 percent of which are gasoline (petrol) and diesel vehicles, and ZEVs represent just 2.6 percent of the population. For England, we calculated the number of ZEVs per 1000 people for over 330 ONS. The number of ZEVs per 1000 people varies between 1 through 105. On average, there are approximately 13 ZEVs per 1000 people in England (700,000 ZEVs for a total population of more than 56 million in England). Generally, the southern part of the country has the highest ZEV ownership with almost 19 ZEVs per 1000 people. For example, the South Gloucestershire region near Bristol and Swindon have ZEV ownerships of 84 and 142 per 1000 people, respectively. High ZEV ownership rates can also be observed running along the center column of England, where regions like Milton Keynes in Buckinghamshire or Peterborough have a ZEV ownership rate of approximately 110 per 1000 people. Located in Greater Manchester, the city of Stockport has the highest ZEV ownership rate at 207 ZEVs per 1000 people. Lower- to medium-level median incomes relative to the rest of England can be observed within the same center column, and higher median incomes are seemingly dispersed in the south-east, within counties such as Berkshire, Hertfordshire, and London. Different boroughs within London, such as Newham, Brent, and Redbridge, have POC populations that reflect more than 60 percent of the total population in each. In other cities, such as Luton and Birmingham, POC represents nearly half of the total population. For England, the results for the number of ZEVs per 1000 people per ONS compared to the normalized median income and

normalized income deprivation per ONS are shown in Figure 5. The results suggest that like Michigan and California, ZEV ownership in England is influenced by overall economic position. At high median income levels (e.g., 80 to 100 percent), average ZEV ownership is approximately 16.5 ZEVs per 1000 people, whereas at low median income levels (e.g., below 20 percent), average ZEV ownership is approximately 6 ZEVs per 1000 people. Similar ZEV ownership rates can be observed when compared to normalized income deprivation. At low percent populations in poverty (e.g., below 5 percent), the average ZEV ownership is approximately 12 ZEVs per 1000 people. At high percent populations in poverty (e.g., between 20 to 25 percent), the ZEV ownership drops to less than 3 ZEVs per 1000 people. These results highlight how lower income regions are the ones that have the least ZEV ownership. To ensure that the correlation of ZEV ownership versus income is not solely due to the lower vehicle ownership in low-income communities, we also compared the overall vehicle ownership (ZEV and Non-ZEVs) versus income. We did not find a strong relationship between car ownership and income level, and in fact, our analysis demonstrated that regions with higher income levels tend to have lower car ownership rates. Of course, when compared to income deprivation, we did observe lower vehicle ownership in regions with higher income deprivation, however, the correlation is not as strong as for ZEVs. For example, in regions with more than 20 percent income deprivation, vehicle ownership is approximately 400 vehicles per 1000 people, whereas in regions with less than 5 percent income deprivation the vehicle ownership is around 600 per 1000 people.

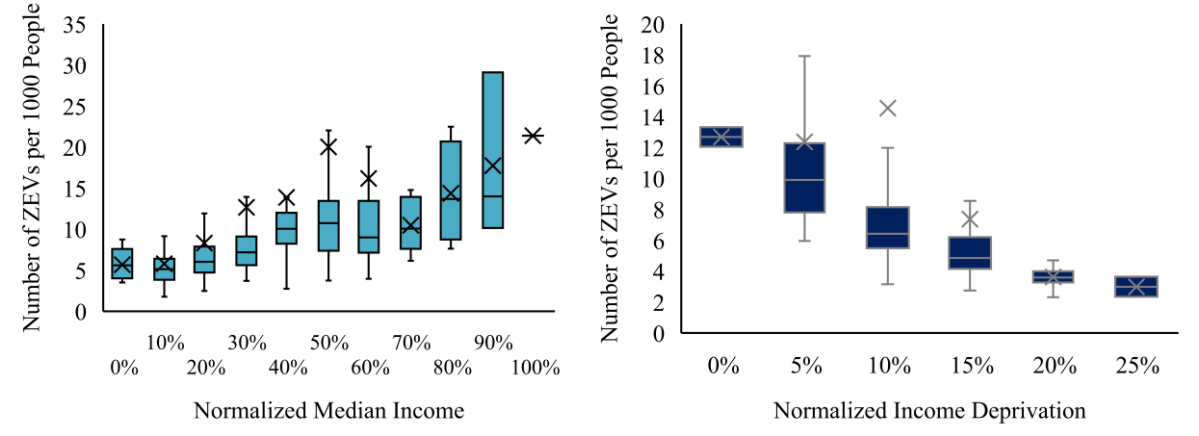

Figure 5 - ZEV Ownership Compared to Income Statistics by ONS in England

ZEV ownership rates as they relate to the percent POC population and educational attainment are shown in Figure 6. The results between ZEV ownership and percent POC populations are less indicative than those in North America. As shown, the ZEV ownership does not seem to have any direct correlation to percent POC at the ONS geographic index level. In terms of educational attainment, the results suggest that ZEV ownership is significantly influenced by the percent population with less than an A-Level education. At low percentages (e.g., below 35 percent), the average ZEV ownership is approximately 13 ZEVs per 1000 people. At high percent populations with less than an A-level degree (e.g., above 70 percent), there are less than 5 ZEVs per 1000 people.

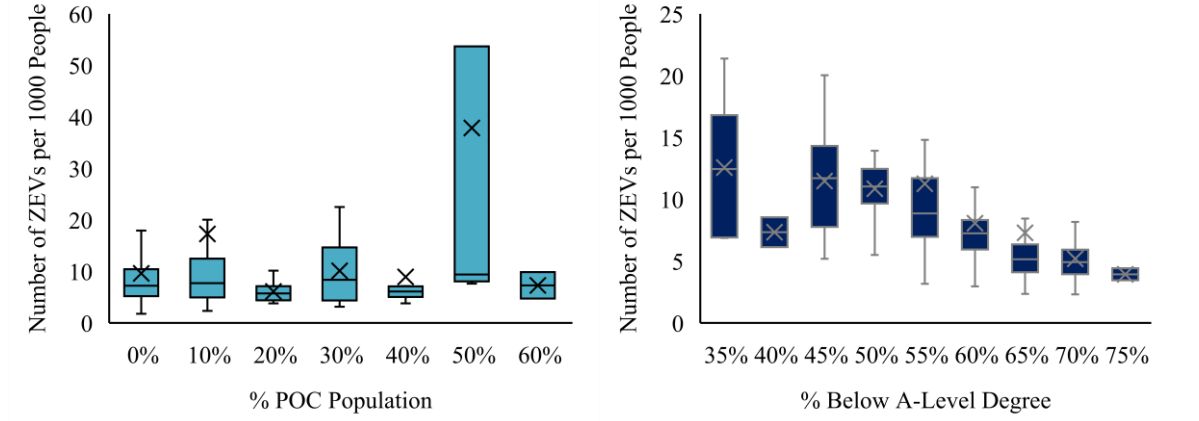

Figure 6 - ZEV Ownership Compared to Percent POC Population and Education Level by ONS in England

The assessment of England's ZEV market provides some evidence of gaps in the ZEV market across the country. According to our assessment, income and education seem to be the overarching barriers to entry into electrified transportation – at lower median income levels or high poverty levels, ZEV ownership rates do not surpass 5 ZEVs per 1000 people. Despite England's relatively high ZEV ownership compared to individual states in the U.S. (except for California), there is a significant gap in ZEV ownership between lower and higher income regions. Similar to Michigan, ZEV ownership rates in England are seemingly uncorrelated to percent POC populations. Not only is 86 percent of England's overall population white, but most of the non-white population reside around the London and Birmingham metropolitan regions, leaving the white population to reflect the rest of the country. Cross examining the percent POC population with the distribution of ZEV ownership, it can be inferred that certain sociodemographic indicators, such as urbanization, job markets, and possibly even alternative transit systems may play complicated roles in the overall ZEV ownership.

It is also noteworthy to mention that the public transportation system in England, and the U.K. overall, is much more developed than U.S. According to U.K. Transportation Statistics, of the 953 trips that each person made in 2019, more than 10 percent of those were using public transport while in the U.S., only 2.5 percent of the trips are made using public transportation. The availability of transit system in England certainly impacts overall vehicle ownership rates. For example, data for England shows that in urban areas with dense transit system, the vehicle ownership is much lower than rural areas with less transit system availability. Specifically, while on average there are 482 vehicles operating in England for every 1000 people, in Greater London the vehicle ownership is 40 percent lower than the national average. This clearly shows that there might be a sizable fraction of households in the England, especially in urban areas, who may not own any vehicle let alone ZEVs which could certainly be one of the factors influencing the ZEV ownership analysis conducted in this report.

3 Role of Policies in Enhancing Environmental Justice

ZEVs can help alleviate public health and economic burdens in lower income regions and POC communities, but adoption is mostly in higher income and educated areas. ZEV policies are needed for equitable access. To better understand barriers to ZEV adoption and recommend policies, we conducted semi-structured interviews and online workshops with 15 EJ experts and engaged with 24 organizations dedicated to EJ. Through each workshop, we discussed various policy scenarios (e.g., financial incentives, mandates for manufacturers, ZEV infrastructure policies, etc.) and allowed EJ stakeholders to provide their feedback based on general thoughts around policy, economic, access, and indirect impacts of ZEVs. The following section explores key concerns and policies to address barriers in disadvantaged communities.

3.1 Barriers

Affordability

North American EJ stakeholders expressed that ZEVs remain unaffordable for many low-income households. According to ZEV new vehicle sales data from the CEC and ICF's proprietary EV library, the sales weighted average MSRP for ZEVs sold in California was approximately $56,000, or $13,000 more than the average gasoline vehicle sold in the United States. To better illustrate this point, we took the sales data both at the California and U.S. level and combined them with the price data from various sources, including ICF's ZEV library to show the sales distribution as a function of vehicle price. Through this analysis, we were able to show a comparison of vehicle sales as a function of MSRP for new ZEVs sold in California in Q1 2022 versus new ICE vehicles sold in the U.S. in 2021. As shown in Figure 7, prior to applying federal, state, and local incentives, ZEVs are generally more expensive than their counterpart ICE vehicles.

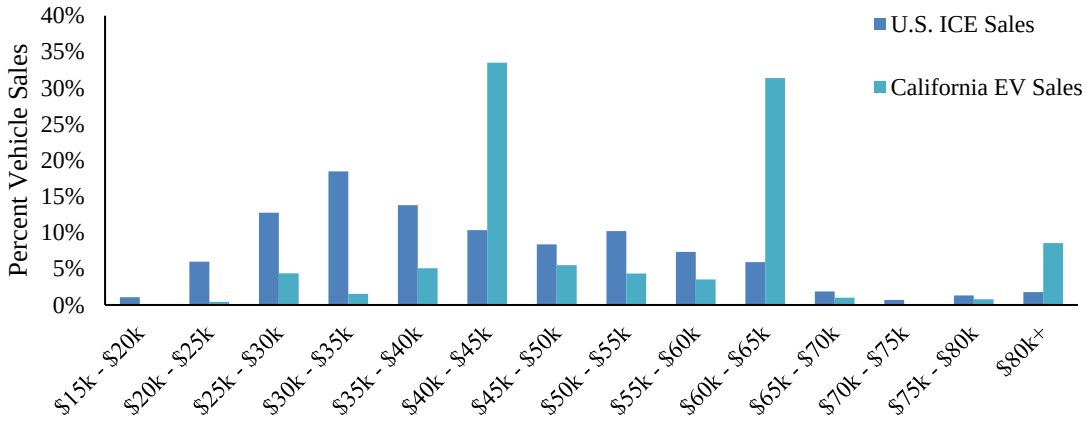

Figure 7. Percent of passenger vehicle sales by MSRP range

High upfront vehicle costs and insurance costs make ZEVs unaffordable for many low-income households, particularly in regions with high auto insurance rates such as Detroit. Financial incentives have been used in the past to make ZEVs more affordable, but they have often benefited affluent groups more than disadvantaged groups. Existing federal ZEV tax credits are non-refundable, meaning that low-income households often do not qualify for the full benefit, making ZEVs even less affordable for them. The recently proposed Inflation Reduction Act (IRA) puts an income cap eligibility criteria for federal ZEV tax credit, but it is still not enough for low-income households to afford ZEVs.

European EJ experts suggest that loans and financing options for qualified individuals, rather than grants for all, are needed to make ZEVs more affordable. They acknowledge the potential risk of putting more debt on those who cannot afford ZEVs but argue that the running cost of a ZEV helps to offset the impact of unaffordable debt. However, it is essential to make ZEVs affordable in the first place to access their in-life benefits.

Access to Charging Infrastructure

Lack of access to charging infrastructure is also one of the key barriers to increased ZEV adoption in low-income and disadvantaged communities. Lower income regions, especially those living in multi-family housing or those who rent their places, often do not have access to home charging, and instead have to rely on either workplace or public charging infrastructure if they decide to transition to ZEVs. A recent study conducted by Hsu and Fingerman (2021) [1] which demonstrated that public charger access is lower in block groups with below-median household incomes and in those with a Black and Hispanic majority populations. These public charger access disparities are more pronounced in areas with a higher proportion of multi-family housing, where they are critical for ZEV operation due to a lower likelihood of residential charger access.

While lack of access to charging infrastructure is a significant barrier, EJ experts shared that there are also concerns with charging infrastructure being a factor that causes gentrification and displacement in disadvantaged communities. This is especially important when considering that disadvantaged communities are challenged by increasing rent and basic needs costs. Indeed, discourse on electrified transportation can sometimes fail to consider indirect impacts on regions meant to benefit from expansion in the first place. EJ groups also advise to be wary in how we approach the prospect of investing in electric mobility with people who may not have the privilege to “care” about ZEVs. Thus, policy options for ZEV uptake and charging infrastructure deployment cannot be viewed as separate from the everyday struggles of community members; any policy considerations for ZEVs should consider the realities that impacted residents face.

Availability of Mobility Options

The California and Michigan EJ experts emphasized the need for a range of mobility options beyond single occupancy ZEVs to address public health, air quality, and climate crises. They suggested expanding access to micro-mobility, transit, and ZEV carshare, particularly in areas without basic access to public transit and rural regions. The lack of infrastructure for safe micro-mobility use is also a concern, with community feedback indicating a preference for riding on sidewalks instead of sharing the road with high-speed traffic.

In the European workshop, EJ experts agreed that improving access to zero-emission mobility is key, rather than increasing ZEV ownership. This involves electrification of the wider transportation system and access to new and shared mobility, particularly for lower income and marginalized communities who are more likely to use public transport or low-cost shared mobility alternatives. Indirect incentives for ZEVs, such as allowing them to use bus lanes, can have negative impacts on public transport, and large investments in ZEV subsidies may divert funding away from improving public transport. Scotland's approach integrates its ZEV strategy with sustainable transport systems, prioritizing active modes, public transport, and shared transport before private cars, to reduce car use, invest in safe public spaces, and address transport poverty.

3.2 Role of Policies and Programs

With representative concerns expressed by engaged EJ experts and groups in mind, we evaluated the role of policies and mechanisms that will be most effective to enhance EJ outcomes of ZEV policies. We offered our overview of equity and EJ programs hosted by utilities, local and state governments supporting efforts to make transportation and ZEVs more accessible. Many of these equity and EJ ZEV programs offer grant or incentive structures to provide immediate cash assistance towards the purchase of passenger ZEVs, such as NV Energy's proposed low-income ZEV rebates in Nevada. Some broader efforts are in the form of regulations that seek to ensure grid infrastructure is adequately fortified for more ZEVs on the roads, such as New York's Climate Leadership and Community Protection Act. Local efforts also play a key role in the accessibility to ZEVs by providing e-mobility options, such as the Twin Cities' HOURCAR or Rancho San Pedro's Electric Car Share ZEV programs, which offer access to ZEVs on a rate basis. More on proposed and current programs promoting equitable access to ZEVs and their infrastructure are described below.

Incentives

In the United States, several programs have been implemented to promote equitable access to zero-emission vehicles (ZEVs). One such program is the Economic Recovery Transportation Electrification Plan (ERTEP) offered by NV Energy in Nevada. The program aims to advance economic recovery and accelerate transportation electrification by deploying more than 1,000 charging ports at highway stops, urban areas, public buildings, transit bus depots, and recreation and tourism destinations. ERTEP will prioritize the needs of disadvantaged communities by focusing on providing low-cost energy for publicly available charging infrastructure, strengthening strategic outreach and partnerships to increase participation in the clean energy economy and workforce, and prioritizing historically underserved regions where feasible.

Another program in California, the Clean Vehicle Assistance Program, provides grants and affordable financing to help low-income Californians purchase or lease a new or used hybrid or electric vehicle. Qualified residents of California's disadvantaged communities are eligible for up to $5,000 in grants for a new or used battery-electric, up to $2,500 in grants for plug in hybrid ZEVs, and up to $2,000 in grants for at home charging station and installation support. The program also closely examines applicants based on their income and the CalEnviroScreen score to ensure that residents of disadvantaged communities are the ones who benefit the most from electrified transportation opportunities.

Clean Cars 4 All (CC4A) is another program in California that aims to enhance equitable access to ZEVs. The program provides incentives to help lower-income consumers living in and near disadvantaged communities replace their old higher-polluting vehicles with newer and cleaner transportation by reducing the purchase price. Participants can choose an alternative mobility option such as an electric bike, a voucher for public transit, or a combination of clean transportation options allowed under the program in lieu of purchasing a replacement vehicle. Participants must have a household income of less than 400 percent of the federal poverty limit and live in a zip code containing a disadvantaged community census tract.

ICCT's Annual Update on the Global Transition to Electric Vehicles: 2021 briefing highlights other notable efforts to support ZEVs and charging infrastructure outside of the United States. In several countries across Europe, much has already been done to achieve record-setting ZEV penetration levels within the single passenger and transit vehicle sectors. As a result, incentive structures have begun to prioritize different goals reflecting progress made to date. For instance, the U.K.'s ZEV purchase subsidy, originally £3,000, has been phased out for most standard passenger vehicles. The reason for this decrease is because the U.K. had seen increased sales of plug-in cars, vans, and motorcycles through December 2021, which was when the government announced that the grant scheme for ZEVs was updated to target less expensive models to stretch

the funding further and to help more people make the switch to a ZEV. Similarly, the new government of Germany announced changes to their ZEV purchase subsidies due to the ZEV market's steady success. Under the plan, the incentives for ZEVs priced below €40,000 will fall from €6,000 to €4,500 by next year, and then fall again to €3,000 in the following year. For cars priced over €40,000, incentives will drop to €3,000 and €2,500, respectively.

Regulations

The policy landscape also features regulations that are directed to address ZEV accessibility more systematically. In California, the Advanced Clean Cars (ACC) II regulation mandates all new passenger vehicles sold in the state to be ZEV by 2035, with increasing sales requirements each year. The regulation also provides EJ credits to car manufacturers who increase the affordability of ZEVs for low-income communities, and who retain pre-owned ZEVs in California. The European Union's (EU) Fit for 55 package includes a proposal to reduce light-duty fleet CO2 emissions to 0 g CO2/km by 2035, with a requirement that 100 percent of new vehicle sales be ZEVs (only BEVs and FCEVs). The proposal also calls for minimum requirements for charging infrastructure across Europe to increase access to ZEV infrastructure in low-income communities.

The U.K. government has proposed £1.6 billion in funding to develop up to 300,000 public charging stations by 2030, with a special focus on supporting consumers without access to off-street parking. The Local Electric Vehicle Infrastructure (LEVI) fund, with £450 million in committed funding, has been established to initiate public on-street charging projects that benefit regions without at-home charging solutions. Nine local authorities in England, including North Yorkshire, have been allocated a share of the funding to create over 1,000 public charging stations for residents.

New York's Climate Leadership and Community Protection Act (CCPA) aims to achieve net-zero greenhouse gas emissions by 2050, with a requirement that at least 35 percent of the benefits be realized by historically disadvantaged communities. New York is also a signatory to the Multi-State ZEV Memorandum of Understanding, committing to have 850,000 ZEVs on the roads by 2025. The state's Public Service Commission has directed staff to develop a report on New York's infrastructure needs over the long term to support widespread transportation electrification.

4 Recommendations

Through our EJ stakeholder engagement, it became evident that EJ is about centering justice, addressing the disparities in air quality, and ensuring community access to green investments. EJ stakeholders emphasized that EJ is a response to environmental racism; environmental health disparities are linked to discriminatory practices such as redlining and the citing of major pollutant sources near communities of color and lower income regions. Additionally, EJ stakeholders shared that EJ is not only about preventing environmental harms but also ensuring that green investments benefit disadvantaged communities is an equally important aspect of EJ. Here in this section, we will summarize some of the recommendations from the EJ stakeholders as well as those of ours based on the quantitative and qualitative analysis conducted in this study on how governments could enhance the EJ outcomes of ZEV policies.

Leverage the Expanding Pre-Owned ZEV Market – The pre-owned vehicle market can provide great opportunities for access to more affordable ZEVs. Governments should leverage such opportunities and create targeted programs to subsidize pre-owned ZEVs for purchase by lower income households. For example, the U.S. government recently enacted the IRA, which results in new and revised incentives for clean vehicles, including pre-owned ones. Currently, the IRA offers up to $4,000 in a tax credit or 30% of the vehicle sale price (whichever is lower) for pre-owned ZEVs for purchasers with income less than $75,000 (or $150,000 for a joint return). The efficacy of such a program will be considerably tested, especially as inflationary impacts of the COVID-19 pandemic continue to unfold.

Public Charging and Fueling Infrastructure – Access to ZEV infrastructure (e.g., charging stations) is a key barrier to ZEV adoption in lower income regions, especially for households without home chargers. While many government agencies are investing in deploying ZEV infrastructure within lower income regions, deployment of ZEV infrastructure within regions often does not translate to increased accessibility.

Governments should leverage data analytics and work collaboratively with community members to determine strategic placement of charging and fueling stations to increase accessibility to the ZEV infrastructure.

Community-driven decision-making – One of the common themes that we heard through our EJ stakeholder outreach was the lack of engagement on the part of decision and policy makers. Governments and other representative agencies need to better engage with community members early on and communities need to be an on-going part of the decision-making process for policies and programs to realize the most equitable outcomes. Residents within low income and disadvantaged communities offer invaluable perspectives on what needs can be fulfilled by local governments and authorities, such as charging station placement within neighborhoods. Engagement at this level may also lead to local job creation, workforce development, and mitigation of certain burdens, such as reduced parking and rent increases. Governments should consider targeted outreach to regions (e.g., presenting in town hall meetings, conducting community surveys) throughout the policy and program development.

Targeted Incentives toward Lower Income Regions: As clearly communicated by the EJ experts, the high upfront cost of ZEVs is one of the major barriers to adoption of these clean technologies in lower income regions or communities. This emphasizes the significant role that incentive programs will play over the next 10 – 15 years in transitioning the on-road vehicle market away from fossil fuels to zero-emission technologies. Of course, incentive funding is finite, so there would need to be more self-sustaining funding sources and subsidies developed in parallel. While general public access to incentives has helped with the initial commercialization of ZEVs, some programs have unintentionally benefited affluent groups more than disadvantaged communities. Now might be time for federal, state, and local governments to have programs specifically for lower income communities, whose current access to ZEVs is almost impossible due to significantly high upfront costs. Of course, such policy changes should come with more streamlined processes to ensure that funds can be expended as effectively and expeditiously as possible. Complex processes to verify eligibility could inhibit the successful implementation of incentive programs and thus reduce their effectiveness.

Support Regions' Mobility Alternatives: As discussed earlier, many lower income regions and disadvantaged communities have limited mobility options, and even fewer zero-emission options. Through our EJ stakeholder engagement, we learned that not every community member is interested in owning a car if there are alternative mobility options that are preferable. Within the European market, many cities have adopted comprehensive approaches to establishing transit networks or more efficient passenger traffic. The North American market, on the other hand, often shifts focus to just passenger vehicle mobility, significantly inhibiting development of alternative transportation. We believe there is great opportunity for governments to invest in clean alternative modes of transportation, which not only will enhance mobility, but lead to reduced traffic congestion and air quality improvements.

The Role of Electrifying Medium- and Heavy-Duty Trucks: Medium- and heavy-duty (MD, HD) vehicles are one of the major emissions sources contributing to public health issues in lower income regions and disadvantaged communities. Therefore, transitioning these vehicles to zero-emissions could go a long way in reducing emissions and improving public health in these regions. Much of the overall approach taken to introduce more zero-emission passenger vehicles onto the roads can be applied for medium- and heavy-duty vehicles, where grants and incentives can address immediate needs of drivers and zero-emission oriented policies can direct zero-emission truck supply and expectations. For example, U.S. EPA's Clean School Bus Program prioritizes the deployment of zero-emission school buses in high need and low-income areas. In addition to policies that incentivize/require adoption of zero-emission MD/HD vehicles, zero-emission infrastructure could also play an important role in increasing the operation of zero-emission trucks within disadvantaged communities. When siting charging infrastructure for MD/HD vehicles, we need to ensure that the deployment of these infrastructure will have direct benefits in lower income regions and disadvantaged communities and will lead to increased operation of these ZEVs in lower income and disadvantaged communities.

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6 References

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7 Presenter Biography

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