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OPPORTUNITY OR BETRAYAL?: THE PROMISE AND PERILS OF ELECTRIC MOBILITY

Mark Wilson, Ph.D.
Zeenat Kotval-Karamchandani, Ph.D.
Shane Wilson
David J. Burean
Gil Isaac E. Gabriel
Kendrick Xuan

Michigan State University
University Outreach and Engagement
Center for Community and Economic Development

EDA
U.S. Economic Development Administration

Opportunity or Betrayal?

The Promise and Perils of Electric Mobility

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Center for Community and Economic Development

EDA University Center for Regional Economic Innovation

Shane T. Wilson, Mark Wilson, Zeenat Kotval-Karamchandani, David J. Burean, Gil Isaac E. Gabriel, and Kendrick Xuan

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Executive Summary

The report explores the social justice implications of electric vehicle (EV) adoption in Michigan communities, emphasizing the potential disparities in benefits and costs across different socioeconomic groups. EVs offer sustainability and mobility advantages but may exacerbate existing inequalities if not implemented equitably. Charging infrastructure discrepancies, uneven accessibility for low-income and Asset Limited, Income Constrained, Employed (ALICE) communities, and diverse societal impacts (from reduced pollution to health concerns) are key focal points. Ultimately, the successful, safe, and fair implementation of EVs in Michigan necessitates addressing inequities in accessibility, health impacts, employment opportunities, and establishing protocols that prioritize fairness and inclusivity. Among the key findings are:

Part I: Introduction

- Considering the historical influence of technology on society, new innovations like EVs often favor certain interests, potentially overshadowing the needs of disadvantaged groups and raising the importance of social justice concerns in the EV transition.
- In 2021, nearly 40% of Michigan households experienced economic stress, with ALICE populations primarily concentrated in urban and rural areas, the latter showing higher rates of economic vulnerability. Analyzing EV impacts prompts critical questions about accessibility, health implications, employment opportunities, and the need for fair protocols.

Part II: Electric Vehicles, Health & The Environment

- Environmental and health concerns stem from the extraction of metals required for EV batteries, predominantly lithium-ion, used to power these vehicles. Criticisms include the intensive mining processes in developing nations and reliance on energy sources (like coal and natural gas) for EV charging, initially leading to higher emissions. This mining process, involving metals such as graphite, copper, nickel, cobalt, and lithium, raises issues related to land use changes, worker safety, and exposure to toxic elements.
- Disposal and recycling of EV batteries pose additional challenges. While recycling these batteries is possible, their design complexity and varied composition make efficient recycling difficult. Improper disposal could lead to hazardous waste sites closer to vulnerable communities, heightening exposure risks.
- Notable safety issues, such as battery fires and thermal runaway (rapid battery decay) often require specialized equipment and technicians to be properly managed. EV battery fires require up to forty times more water to extinguish, while emergency responders need to be able to manage new health issues associated with batteries.
- Addressing the impact of EVs throughout their life cycle requires a holistic approach, incorporating environmental management, waste processing, and community impacts. A circular economy perspective and life cycle approach are proposed to manage not just materials but also the social and environmental impacts on affected communities.
- The disproportionate risks for ALICE populations include material mining and production, exposure to hazardous waste, and heightened vulnerability in traffic incidents involving EVs.

Part III: Electric Vehicles & Labor

- Electric Vehicles will affect labor markets, particularly significant given Michigan’s historic auto industry and its evolution due to the transition towards EV production. Anticipated changes include shifts in job creation, skill demands, and geographical changes in manufacturing locations. With an overall reduction of 30% in labor requirements there will be both newer, high-skilled jobs and decreased labor demand.
- There may be opportunities for ALICE populations in the EV industry, including charging infrastructure installation, assembly, maintenance, and plant sanitation. The changing auto

industry landscape requires higher levels of education and specialized training that imposes costs on workers seeking entry level positions.

Part IV: Electric Vehicle Operations & Infrastructure

- Charging infrastructure plays a crucial role in EV adoption, affected by factors like location, energy cost, ease of use, and quantity. Various charging levels (Level 1, 2, 3) cater to different users but may pose limitations for ALICE residents due to housing and location constraints.
- Grid management leveraging EVs as energy storage tools offers a solution for balancing grid strain and optimizing resource allocation. Vehicle-to-grid technology allows EVs to supply energy back to the grid when necessary, indicating potential benefits for grid stabilization, flexibility, and renewable energy integration.

Part V: Electric Vehicle Use in Detroit

- A case study in Detroit highlights mobility challenges for ALICE households in predominantly low-income areas. High ownership costs, limited charging facilities, and concerns about dangerous drivers, congestion, and road conditions affect mobility. Limited access to EV charging stations, especially in low-income and diverse neighborhoods, poses obstacles for EV adoption.
- While EVs offer a solution to combat emissions and environmental harm, holistic mobility planning is essential, incorporating diverse options like walking, cycling, public transportation, and vehicles. Addressing affordability, accessibility to charging infrastructure, and considering a wider range of mobility options are crucial in ensuring equitable and sustainable mobility solutions.

Part VI: Policy, Planning & Equity

- Rural and urban ALICE communities face challenges related to limited charging infrastructure access, creating disparities in EV adoption. Action strategies outlined through the ALERT model (Awareness, Layers, E-Response, Responsiveness, Talk) urge systematic planning responses to anticipate and act on EV infrastructure.
- Federal policies include incentives, grants, and fleet requirements, encouraging EV adoption, research, and infrastructure development. The U.S. Department of Transportation provides resources, including equitable planning practices and mapping tools.
- Local policies in Detroit, predominantly influenced by state initiatives, involve fleet transitions and infrastructure development, aiming to convert municipal fleets to EVs. Michigan state initiatives encompass grants, awareness campaigns, and charging infrastructure funding.
- Social justice implications occur when EV ownership favors affluent homeowners due to uneven charging infrastructure availability and high entry costs. ALICE residents face far more cost and access barriers to adopting EVs.
- Policies need to address more than just EV access but should focus on the core issue of mobility, to ensure equitable access to transportation benefits across income and demographic groups, emphasizing the importance of affordable mobility options.

Part I: Introduction

There are several forms of electric vehicles, including battery electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and hybrid electric vehicles (HEVs) that all use electrical energy to promote efficiency. Plug-in and hybrid models are augmented by gasoline engines to generate power, while battery vehicles are fully electric and rely solely on direct charging. Central to the adoption of EVs is the availability of charging stations with standard connections that serve all vehicle brands (Mastoi, 2022). Charging station deserts are evidence of the uneven roll out of EV infrastructure that avoids low income and minority communities (Englund, 2021).

The growing adoption of electric vehicles (EVs) carries many potential benefits for sustainability and mobility, yet not all residents and communities may benefit equally. Electric vehicles reflect the ongoing evolution of mobility technology that carries both benefits and costs. New technologies disrupt current systems and behaviors that may include uneven impacts on communities based on income, race, identity, and location (Sheller, 2018). As EVs gain popularity, it is timely to consider the social implications of a new technology that has the power to entrench existing inequities or promote sustainability, clean energy economies, and equitable economic development (Alfasi & Margalit, 2021; Hardman et al, 2021; Sparrows & Howard, 2020; Sheller, 2018). This report addresses the social justice implications of EVs for Michigan communities in ways that promote mobility and diminish environmental damage.

Further, the interests of Asset Limited, Income Constrained, Employed (ALICE) residents are likely to be greatly overshadowed by promoters of the new technology. For example, economic and political forces shaped how the early automobile was introduced and its adoption facilitated. Streets changed from being the preserve of pedestrians to the realm of the automobile with associated laws and practices that privileged vehicles over people (Montgomery, 2013). As part of this process, many low income and minority communities were damaged or destroyed due to highway construction, an infrastructure investment that further segregated American cities. In more than a century since the automobile became popular, there have been many new technologies that were accompanied by persuasive action by interests with a stake in their adoption (Wilson & Corey, 2000; Inkinen et al, 2021).

Before continuing, it is also valuable to consider the nature of technological disruption in our lives. New technologies, such as the internet, electric vehicles, and artificial intelligence, each arrive with great promise that is frequently achieved. But the benefits need to be tempered by the uneven spread of advantages and disadvantages that are often determined by how they are implemented and who controls their use. Complex and often conflicting interests align around innovation and new technologies, adding power relations into the innovation and development process. New technologies are led by stakeholders with an interest in seeing their introduction and use, and as actors with early knowledge of both costs and benefits, their interests shape opinion and regulation. Messaging around new and disruptive technologies tends to be shaped by vested interests with the resources and knowledge to shape public attitudes (Wilson et al. 2022, 2023), while dissenting views lack the platforms and resources to provide a strong opposing narrative.

EVs can provide considerable benefits, including reduced purchase and operating costs; reduced pollution (depending on input choices and electric generation); and employment opportunities through vehicle and battery production, training/apprenticeships for maintenance and repair, and vehicle recycling/reuse. In contrast, environmental and health costs may be associated with battery production (lithium and cobalt); vehicle maintenance and disposal; collision damage due to heavier vehicles; and pedestrian injuries and fatalities related to quieter vehicles (Tintelecan, Dobra, and Marţiş, 2019). Each cost and benefit have a social and spatial element that illustrates social justice implications.

As a hub for automotive innovation and production, Michigan has long been central to advances in mobility. Michigan houses the technical capacity to research, produce, and implement EVs, but the shift to EVs in Michigan receives divided support. A May 2023 survey found 44% of the public had doubts, mainly due to concerns over access to charging locations, and the condition of the electric grid and infrastructure (Beggin, 2023). Prior research shows the uneven roll out of charging infrastructure in Michigan, including gasoline and electric charging deserts in Detroit that isolate many current residents (Englund, 2021; Wilson & Kotval-Karamchandani, 2023). Effective development of an EV based transportation system requires changes in outlook, behavior, and infrastructure.

Currently, policy discussions around the roll out of EVs focus on their environmental and potential operating benefits; yet frequently absent is analysis of how different groups, communities, and places will experience the new technology. Our focus, therefore, is on the experience of ALICE populations in urban and rural communities in Michigan with emphasis on a case study of Detroit residents. ALICE residents in Michigan have limited resources and are doubly disadvantaged by lower wage employment and higher costs of living in their communities.

It is important to consider the ALICE population, specifically to Michigan, in understanding the consequences of EVs on marginalized communities. In Michigan during 2023, the cutoff for ALICE populations was $59,016 for a family of four, or $26,500 for an individual. Stratified by ethnicity, in Michigan in 2021, 59% of Black households were below the ALICE threshold, as were 44% of Hispanic households, and 36% of White households. ALICE residents accounted for 26% of households in Michigan with an additional 13% below the poverty level, resulting in almost 40% of Michigan households facing economic stress. While ALICE populations are numerically concentrated in urban and metropolitan areas of the state, the highest rates tend to be found in rural areas (United for ALICE, 2023).

Analyzing the impact of electric vehicles in Michigan prompted the following questions: 1) Will residents have access to affordable electric vehicles and convenient charging stations?; 2) What health implications will residents face associated with the production, operation, and disposal of electric vehicles?; 3) Will residents share in the employment and economic opportunities that EV production creates?; and 4) What safeguards and protocols need to be established for the successful, safe, and fair use of electric vehicles?

In answering the questions responses were divided into Global and Local concerns. A Global perspective recognizes the broader context for EV implementation and the extensive supply chains and impacts associated with new technology. This perspective includes equity considerations that may occur outside a Michigan community, such as environmental and health issues associated with the mining and processing of materials used to produce EVs. A local view considers how communities might be affected by the roll out of EVs, such as changes in employment opportunities or access to charging stations. While many effects relate to each dimension, it is valuable to realize that local actions and decisions will affect how people live and work elsewhere on a national and global scale.

Part II: Electric Vehicles, Health, & the Environment

EVs are increasingly part of the mobility landscape (U.S. BLS, 2023); and as a new technology for the public domain, bring benefits and challenges associated with health and the environment. EVs do not use fossil fuels (unless hybrid) and avoid the many pollutants associated with internal combustion engines. However, even though EVs avoid some environmental issues they also introduce new challenges due to the sourcing, operation, and disposal of materials. Thus, a global view is adopted in this analysis because although EVs can bring benefits to the U.S. in some ways, low-income workers in source countries may be left further disadvantaged (Nakajima et al., 2017). Improvements to U.S. ALICE communities may come at the cost of ALICE communities in other countries.

Looking at a global perspective, EV makers are scrutinized for their mining practices of precious metals, often in developing countries; these countries lack safety standards and may end up using sources that EVs seek to minimize (like coal and natural gas) to obtain the sources. Initially, EVs are more emissions intensive due to their batteries (U.S. EPA, 2023), but this impact is reduced over the lifespan of the vehicle until batteries must be replaced (U.S. EPA, 2023). Usually, EVs use lithium-ion batteries (U.S. DOE, 2023), along with graphite, copper, nickel, manganese, and cobalt (IEA, 2023). EVs average approximately 207 kg of these metals per vehicle, compared to conventional vehicles using 35 kg/vehicle (IEA, 2023).

EVs also have health and environmental implications for communities within Michigan. Health and environment issues for Michigan's ALICE communities stem from two scenarios: battery fires and thermal runaway (rapid battery decay). These issues demand upgraded public safety preparation for urban and rural areas that may not have appropriate resources. Fires can occur in the wake of an accident when the battery is damaged and result in entropy changes around the vehicle (Sun et al., 2020). Due to the presence of lithium-ion batteries, EV accidents may be accompanied by toxic gases, fire, jet flames, and explosions (Sun et al., 2020). Due to the unique composition of EV batteries, approximately forty times the amount of water is needed to extinguish an EV fire compared to conventional vehicle fire. The estimates of how many gallons of water are needed range from 500-1,000 gallons for a conventional vehicle, and 30,000-40,000 gallons for a similarly sized EV (Ramanathan, 2021). Thermal runaway occurs when there is a damaged battery (Feng et al., 2018) that produces a self-accelerating process resulting in overheating and fire, often caused by vehicular collision, manufacturer defects, or short-circuits due to electrical, mechanical, or thermal abuse (Feng et al., 2018). Thermal runaway poses a risk to Michigan drivers and first responders alike (NTSB, 2023).

Health & Disposal Concerns

There are numerous potential negative health effects of mining conditions and exposure to EV-related metals themselves. While U.S. mines follow stricter guidelines than in other countries, there are concerns over health and disposal implications. Miners of these metals in the U.S. on average make more than the ALICE cutoff, so the main concern for ALICE residents would be living in proximity to mining sites, or related hazardous waste sites where manufacturing or disposal is occurring.

Among the concerns associated with EV material sourcing are the dangers of inhaling dust particulates (PM_x) as a part of the mining process, which can initiate or exacerbate asthma-like conditions. Workers with considerable exposure to copper can experience headaches, nausea, dizziness, vomiting, stomach cramps, and diarrhea. Nickel exposure can result in damage to organs such as the lungs, kidneys, and stomach, while cobalt can damage the heart, liver, kidneys and thyroid (ATSDR, 2023). Exposure-related worker health outcomes are further complicated by reduced access to sufficient healthcare in more remote areas. Michigan has many of the metals needed for EV production but must also balance public concerns over environmental quality (Campbell & Roberts, 2010).

Not only do mining practices impose health risks to the workers and surrounding communities, but metals can be recycled if isolated. EV batteries, however, are not necessarily designed for recycling. Whether batteries are recycled, put in a landfill, or incinerated, there will be exposure risks in all cases. In fact, the propensity of lithium batteries to cause fires means they cannot be disposed of through usual waste systems but must receive special treatment. The bulk of the environmental burden within EV batteries is due to the copper and aluminum (used for production of the anode and cathode), cables, and particular battery management setup used (Notter et al., 2010).

The best-case scenario for these batteries is to be deployed in secondary and tertiary markets to increase their lifespan, then recycled. Michigan Tech and Eagle Mine have partnered to create recycling opportunities for EV batteries (Michigan Tech, 2022). Unfortunately, it is quite common for EV batteries to end up in hazardous waste sites, which tend to be located closer to vulnerable groups (University of Michigan, 2016). Secondary markets for used EV batteries have already evolved in which they are used for energy storage in conjunction with the grid until their overall capacity drops by around 60% total (Neubauer et al., 2015). Repurposing and recycling opportunities will continue to be an important aspect of the role that increasing EV use plays in a low-carbon economy.

Yet, regardless of future repurposing and recycling opportunities, managing hazardous waste associated with EVs is likely to have a significant impact on low income and ALICE communities given historical precedent. Discrimination and exclusion from decision-making has meant that powerless communities are often chosen for the location of hazardous waste storage and processing (Harthill, 2020; Mascarenhas, 2021). In addition, they are more likely to live in neighborhoods housing industrial processing facilities. Currently, the scale of hazardous material processing is limited as EVs are a relatively new phenomenon, but as more vehicles are made, and more reach the end of their battery life, communities will face greater pressures on how to manage waste material.

EV policy needs to account for the impacts of EVs through their life cycle, with Richter (2022) promoting a circular economy perspective around EV use, and Berghorn et al. (2019) proposing a life cycle approach to environmental management of structures and buildings. That life cycle includes management of materials and the people and places affected by processing/storage of older vehicles.

Part III: Electric Vehicles & Labor

Michigan has long benefitted from the auto industry and its ability to provide career mobility to support a middle-class life. EV-related employment is often in unionized and high paying positions that average $33-42 per hour, ranging from vehicle production, charging infrastructure, energy production, and distribution. The production of EVs brings fundamental change to the production process in terms of the materials needed as well as in the occupations and amount of labor needed. Once operating, EVs require less maintenance, reducing labor needs for this task. Finally, while electricity offers potential to use renewable energy, the transition will also affect occupations and employment in fossil fuel production and delivery workforce. The 2023 series of auto industry strikes incorporated labor concerns over how the production of batteries and EVs will affect pay and conditions. EVs are disrupting the auto labor market as demand for skill and numbers of workers evolves to meet new needs (Silva et al. 2023).

Effects Of Electric Vehicles on the Labor Market

As EVs become more commonplace, they will have significant effects on the labor market, impacting production, maintenance, and disposal. Electric vehicles require at least 30% fewer parts than comparable combustion engine vehicles (Waters, 2022). While the typical combustion engine vehicle has approximately 2,000 moving parts, EVs have between 20 to 100 (McMahon, 2019). An automatic transmission alone can have 1,000 moving parts (Wilson, 2023). Fewer moving parts often means fewer parts that can wear out and break, meaning reduced need for repair. Due to the modular, simpler designs of EVs, aftermarket spending is expected to decrease substantially (Han et al., 2022).

EVs also have the potential to create newer, high-skilled jobs across the energy and automotive industries, but due to physical realities inherent in the technology itself, a shift to EVs would most likely mean a reduction in labor overall. This labor reduction is due mostly to the simpler electric drivetrain with fewer moving parts (and significantly fewer parts overall) compared to the drivetrain of a typical combustion engine (McMahon, 2019). Labor reductions are expected within automotive production (particularly engine production and transmissions themselves), fuel production and distribution, and repair/maintenance. The specific sectors which would see this reduction are manufacturing and engineering (McMahon, 2019).

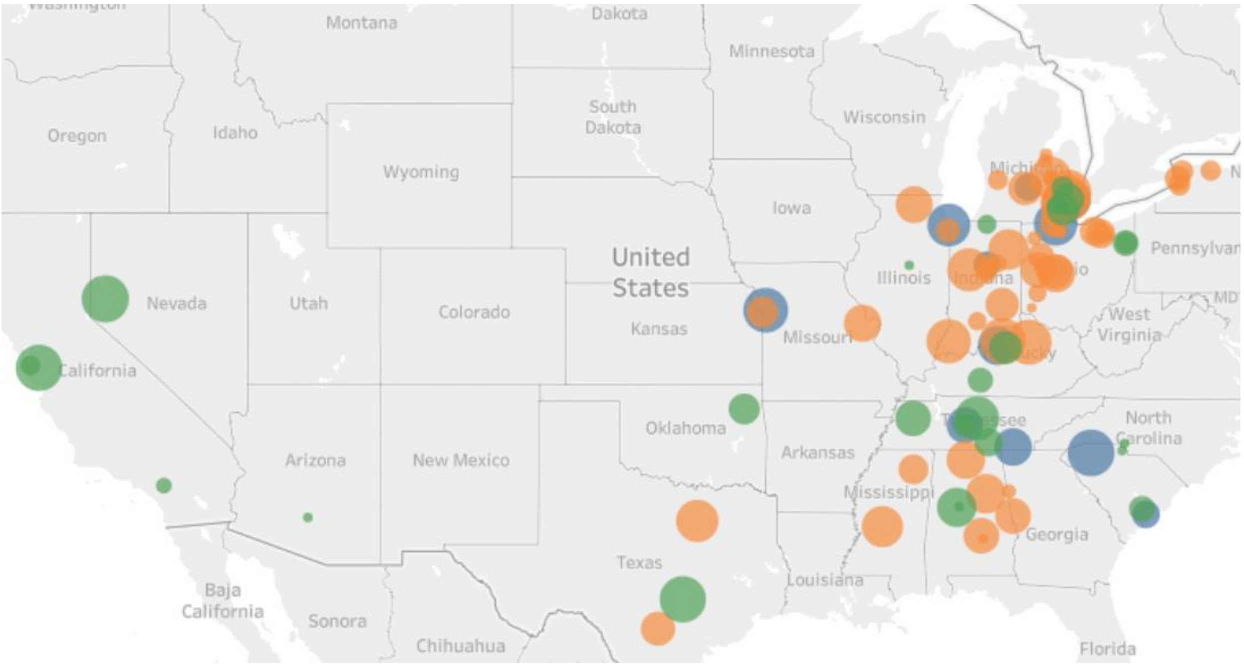
For example, electric automakers have laid off several thousand U.S. workers in 2022 alone (Levin, 2022). In August 2022, Ford Motor Company cut 3,000 jobs as part of a broader plan to cut as many as 8,000 to support the switch to EV manufacturing (Levin, 2022; Naughton & Ludlow, 2022). Lucid Motors recently laid off approximately 1,300 workers, which represents 18% of its workforce (Schulz, 2023). Some experts and consulting firms believe that a full transition to EVs would result in the loss of hundreds of thousands of jobs (Han et al., 2022).

Electric Vehicle Production in the United States

Over the past decades, changing production processes and inputs in the auto industry have led to greater need for plastics, aluminum, and electronics with new labor skills needed to produce vehicles with advanced components in highly automated environments. In Michigan, the auto industry has served as a gateway for careers to access the middle class, especially in the past when high school graduation was sufficient for employment. Today, the auto industry requires greater levels of education and training in its workforce that limit access to employment, especially when the cost of post-secondary education and training falls on the student rather than the employer. In her study of access to auto industry employment in southeast Michigan, Jackson (2022) found that community colleges provide Michigan workers with the technical skills needed for advanced manufacturing jobs but there is a divide between the skills businesses seek, the rate of vocational training, and the budget constraints facing community colleges.

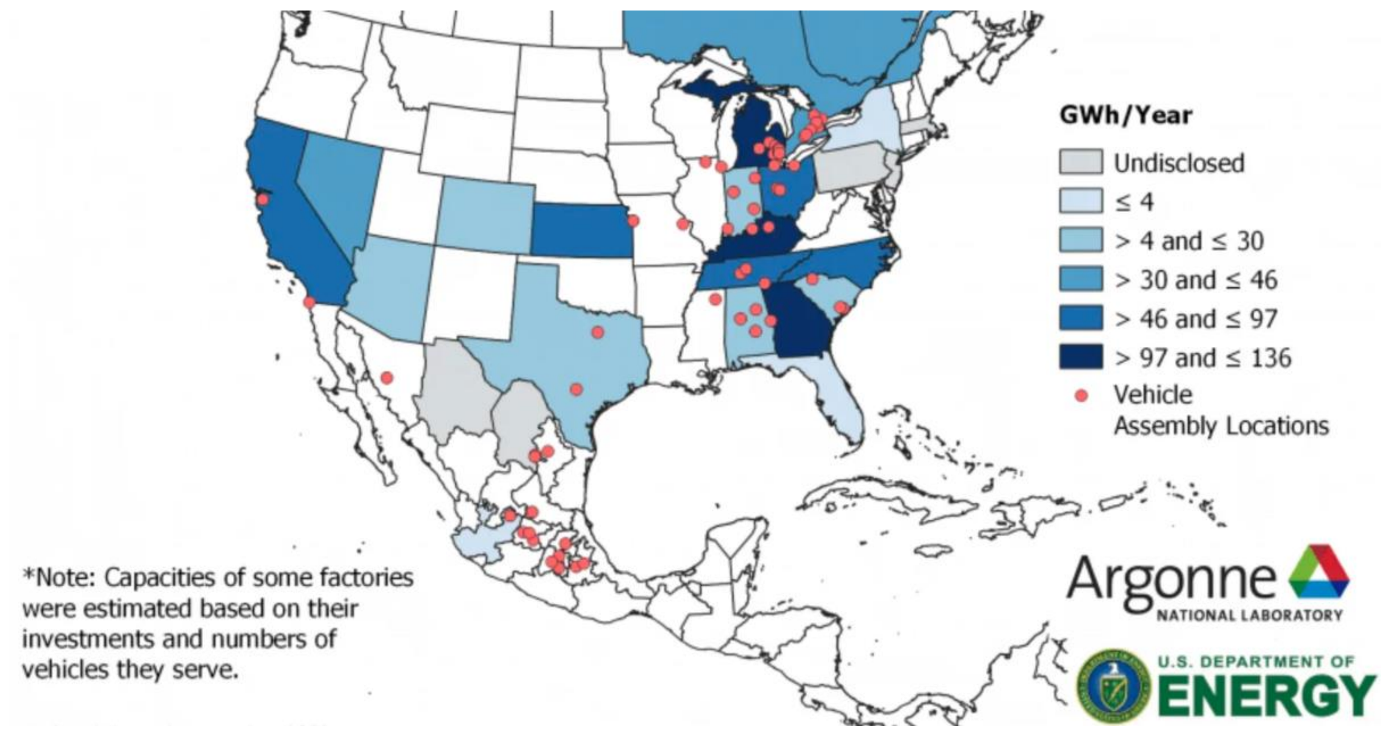
As auto producers reorganize for EVs they may also need new facilities that open the potential for relocation. In the United States, EV production (see Figure 1) occurs predominantly in the North and Southeast Central regions, with some notable exceptions such as those of Tesla in Northern California. Michigan has consistently been a center for auto production, and continues to include EV and battery production, often with support from state government, including recent investments in Big Rapids, Holland, Marshall, Lansing, Dearborn, Flat Rock, and Wayne County. These rural and urban locations contain many ALICE communities that may benefit from new employment opportunities, to be balanced by employment losses in traditional auto production. Since 2022, new EV related production facilities have been announced for Michigan at a cost of $18 billion by GM (2 locations), Ford (5 locations), Gotion and LG (MLive 2023). While remaining important, Michigan competes with several states as a current leader in EV production. Below is a graphic showing additional automotive manufacturing plants in the United States.

Figure 1: Automotive Manufacturing in the U.S. Green dots are electric vehicle plants, orange are traditional automobiles, and blue are plants which make both (*Source*: Hughes-Cromwick, 2021).



A map of planned EV battery production in the U.S. (Figure 2) looks similar to the map of EV production, with Michigan, Kentucky and Georgia leading the way (Gohlke et al., 2022; Clifford, 2023). Key secondary players include Tennessee, North Carolina, Kansas, and Ohio (Clifford, 2023).

Figure 2: Planned Battery Plant Capacity in North America by 2030 (*Source:* Gohlke et al., 2022)



Part IV: Electric Vehicle Operations and Infrastructure

The role that electric vehicles play will be influenced by the availability of charging infrastructure throughout the state. Charging location, energy cost, ease of use, proximity, and quantity will all affect the willingness of Michigan residents to invest in EVs. New technologies tend to target affluent concentrations of consumers as early adopters, with the roll out of charging facilities favoring more affluent communities and commercial centers. One challenge of note is that certain EVs have different charging systems in contrast to the universality of gasoline options for vehicles. Recently, Ford, GM, and Rivian announced plans to make their new electric vehicles compatible with Tesla superchargers (Bushard 2023), which will expand the options for EV owners.

There are several charging options available to EV users, with electric vehicle supply equipment (EVSE) ranging from:

- Level 1 (120 volts AC with no additional installation costs). This option is commonly used by homeowners who can access low cost overnight energy, but charging is slow, adding 4 miles of range per hour.
- Level 2 (240 volts AC & dedicated station cost of $1,200-6,000). This choice is also likely to be found in owned housing and some public facilities, offering faster charging of 25-35 miles range per hour.
- Level 3 (480 volts DC with installation cost of $30,000-80,000). This source is frequently found at public locations and offers a full charge in around 30 minutes, although the cost of fast charging can be costly.

Adding to EV anxiety is reliability of charging stations, with 15% to 39% of attempts failing in 2022 due to inability to connect to online payment networks, driver unfamiliarity with the charging process, and vandalism (JD Power, 2023). The most common locations for charging are shopping centers, grocery stores, parking garages, and hotels. In preparing infrastructure, the location and housing available to ALICE residents may limit their ability to have easy access to EVSE. Limitations would include rental properties that do not have or allow EV charging, the additional cost of level 2 EVSE, and the likelihood that commercial charging targets affluent areas or co-location with businesses.

Communities seeking to capitalize on an EV influx will also need to serve the maintenance needs of electric vehicle owners. An electric engine is a simpler design requiring fewer overall parts and maintenance (Waters, 2022), but there must be community businesses specializing in this type of EV maintenance. EV maintenance costs are cheaper overall and require less frequent checkups (Templeton, 2022). Yearly maintenance, for instance, would typically only include replacing windshield wiper fluid and adding air to the tires (Templeton, 2022). The tires are the single component on most EVs which are more expensive and wear out more quickly than a comparable combustion engine vehicle (Templeton, 2022). This is for a few reasons, (1) EVs are heavier than conventional vehicles, requiring heavy-duty tires, (2) EVs are low noise thus many owners opt for low noise tires as well, and (3) tire efficiency matters considerably more with EVs as it equates to longer vehicle range (Templeton, 2022).

Part V: Electric Vehicle Use in Detroit: Case Study by David J. Burean, Gil Isaac E. Gabriel, & Kendrick Xuan

Mobility is a significant determinant of quality of life as it affords access to health care, food, and employment. We analyzed the mobility conditions for 18 zip codes in the City of Detroit to understand mobility issues and the implications of electric vehicles for these neighborhoods. These areas comprise over 600,000 residents, many of whom meet thresholds for poverty or ALICE conditions. Data were collected as part of the Helping to Obtain Prosperity for Everyone (HOPE) Program, which is a federal program that distress. The project was led by Feonix Mobility Rising in collaboration with the Detroit Department of Transportation, Michigan State University, and area partners.

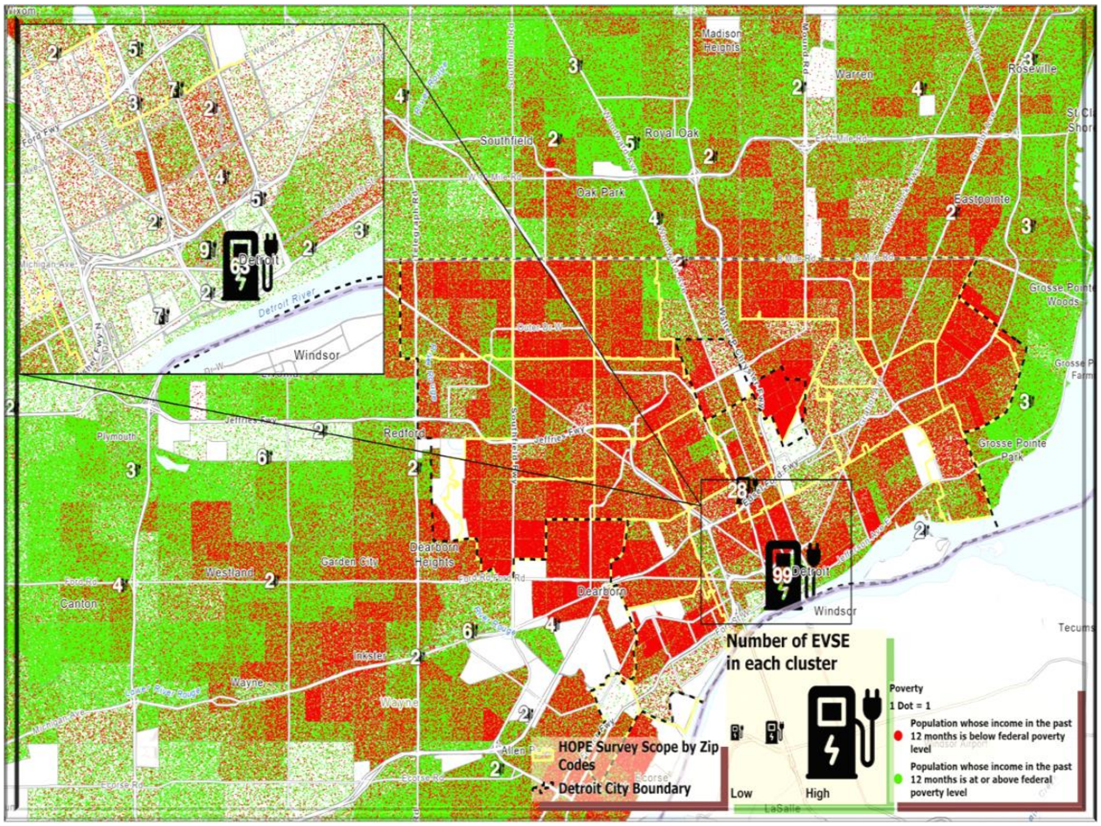
As part of the study, a survey of 521 households found a range of transportation challenges. The median income $35-49k overlaps ALICE thresholds, with 21% earning less than $20,000 and 25% more than $50k with 45% using SNAP/EBT to provide essentials. The population surveyed was 56% African American, 27% Caucasian, and 11% Hispanic. The population is young with 46% aged under 34 years and 11% over 55 years. While living in the center of a major city, many residents expressed concerns about their mobility with only two-thirds having access to a reliable vehicle.

One of the overall promises of EVs is to improve mobility through the lowering of operating and purchasing costs of the vehicle, but at this early stage of EV implementation, high ownership costs and limited access to charging facilities may limit the net benefit. Among the mobility challenges expressed in the survey are concerns about dangerous drivers, congestion and traffic levels, poor road conditions, and difficulty finding gas stations. Many neighborhoods in Detroit are an energy desert that cause residents to travel to the suburbs for fuel. A similar pattern for EV charging is evident from our study. Many residents reported a lack of alternative methods to motor vehicles, stating that public transportation is seen as uncomfortable, crowded, unreliable, and with limited to no service.

While many firms now produce electric vehicles, costs are likely to remain out of reach for many ALICE households. The average price for both new and used vehicles has increased significantly between 1990 and 2022. The average price for vehicle sales in 1990 was $16,350 for new vehicles and $5,857 for used vehicles. In 2019, the latest average used vehicle price was $20,600, an increase of 251.7%. In 2022, the average new vehicle price is $46,724, an increase of 185.8%. Those who cannot afford new vehicles may look to smaller or used vehicles that are more likely to require ongoing maintenance and repair. However, even the average used, or new vehicle is a significant share of income for an ALICE household. Additionally, accessing lower operating costs of an EV is limited by a lack of affordable options available on the market. For instance, the cheapest internal combustion vehicle in 2023 is the Nissan Versa with an MSRP of $15,000, compared to the Chevrolet Bolt, the cheapest EV, at about $28,000.

Access to EV charging and range anxiety are major concerns shaping the adoption of EVs. Residents who own a house can install charging stations but those who rent or do not have a garage or secure location for charging must rely on public stations. ALICE and low-income residents tend to rely more on rental properties that are slow to add EV charging, so in many areas the only option is to drive to a station and wait to recharge. Figure 3 illustrates the distribution of EV charging stations in Detroit and low-income population density. EV charging is highly concentrated in downtown and midtown Detroit, with its high density of corporate, educational, medical and entertainment facilities, yet outside these areas, most of the city lacks any charging stations. Just as gas stations are rare in the city, so are EV charging stations outside the downtown and midtown core. The map shows the dramatic and complete absence of EV charging in predominantly low-income neighborhoods in contrast to their dispersion throughout more affluent suburban areas.

Figure 3: EV Charger Placement and Poverty in Metropolitan Detroit

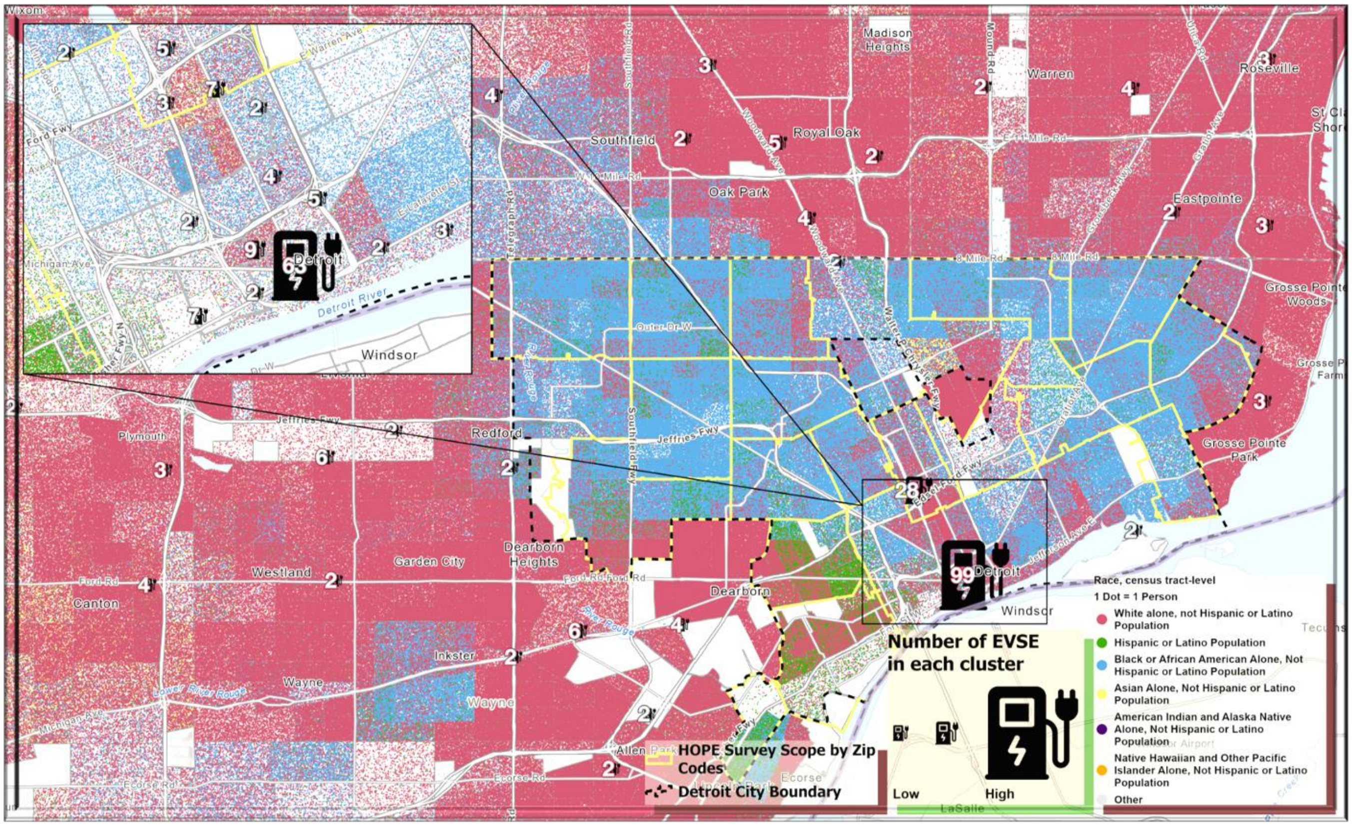


Source: Map by Gil Isaac E. Gabriel, Geospatial data courtesy of USDA, City of Detroit, U.S. Census Bureau, U.S. DOE, and Esri.

Another dimension of access to EV charging is shown in Figure 4 that maps EV charging and race in metropolitan Detroit. Neighborhoods that are predominantly Black or Hispanic lack any EV charging stations, while downtown and midtown areas with EV charging are more likely to be White or diverse in racial makeup.

In addition to purchasing costs, there are several obstacles preventing access to charging stations in Detroit as well as many communities in Michigan and across the nation. Some potential areas of conflict include low demand and density of users in rural areas, electricity rate negotiations with utilities, determining operation costs in shared residences such as multiple dwelling units, prioritizing existing public transportation over developing technology, and the risks of gentrification. Many of the transportation issues identified in our study will not be remedied by widespread use of EVs. Factors such as traffic and congestion, poor road conditions, dangerous driving, pedestrian safety, and access to gas/charging will continue with EVs. The planning issue is not about accommodating EVs, but considering mobility holistically, which means entertaining a wide range of options from walking, cycling, vehicles, and public transportation. The transition to EVs, while a well-intentioned solution to combat greenhouse gas emissions that contribute to climate change and other environmentally harmful pollutants, may not be the best option when other mobility options like public transportation is a consideration.

Figure 4: EV Charging and Race in Metropolitan Detroit



Source: Map by Gil Isaac E. Gabriel, Geospatial data courtesy of USDA, City of Detroit, U.S. Census Bureau, U.S. DOE, and Esri.

Part VI: Policy, Planning, & Equity

There are many aspects of EVs that will have profound effects on communities in Michigan. In this rising market, local communities will be affected by access to charging infrastructure, prices of electric vehicles, and the availability of EV maintenance services. ALICE residents of the state tend to live in low priority areas for EV implementation and charging. Rural counties have up to half of the populations ALICE or low-income residents and face fewer transportation options with public transportation being limited or non-existent. In these areas, EVs are likely to lack access to charging stations, which tend to cluster in towns and tourist destinations away from lower income households. Urban ALICE residents are also likely to be disadvantaged as their neighborhoods are less likely to receive charging services.

Action Strategies

New and disruptive technologies demand a systematic planning response at all levels. The ALERT model (Corey & Wilson 2006) sets out an approach for communities to prepare for new technologies in a comprehensive way. The ALERT model asks planners and communities to raise their Awareness of changing geographic (Layers) and technological (E-Resources) forces and to fairly react (Responsiveness) through information, collaboration, and discussion (Talk).

- Awareness: Implementing a process to remain cognizant of technological change and its implications for an organization. How do residents and communities understand new technology and use it to inform decision making? Are ALICE residents informed about EV implications for their community? Do communities recognize the unique needs of ALICE households when planning for EVs?

- Layers: Recognizing the spatial and jurisdictional boundaries that affect EV implementation and its legal implications, as well as the spillover influence of nearby communities, regions and states. Are surrounding operational jurisdictions included in planning for EVs? The Detroit case study shows very clearly that locations play an important role in charging accessibility.

- E-Resources: Uses online assets for the gathering of EV information, provision of communications and updates, and the delivery of training. Who is responsible for planning and coordinating EV infrastructure, and delivering information to ALICE residents?

- Responsiveness: Urges the continuation or creation of a futures-oriented community and planning culture that recognizes and adapts to EV implementation. Who is responsible for change management? Do current strategic plans incorporate a shift to EVs and its community implications? Are ALICE residents included in the planning process?

- Talk: Reminds all participants and stakeholders that communication is essential at a time of change, exemplified by the uncertainty of a post-Covid-19 environment. Do community stakeholders take time to meet and communicate about EVs? Do stakeholders listen to different perspectives change within and outside? Is information about EVs shared between communities and residents?

POLICY & PLANNING

The State of Michigan and federal government provide resources to prepare for common EV usage, usually taking the form of subsidies/tax breaks, grants/loans, and federal transportation fleet requirements. One incentive in place is the Clean Vehicle Tax Credit that reimburses $2,500-7,500 based on battery capacity (IRS, 2023). There is also the Alternative Fuel Infrastructure Tax Credit that encourages companies providing charging equipment (U.S. DOT, 2023). Michigan has led public awareness campaigns to inform potential buyers and combat range anxiety (Michigan Economic Development Corporation, 2023). The Charge Up Michigan Program builds EV charging infrastructure through funding for site preparation, equipment, and installation (Dept. of Environment, Great Lakes, and Energy, 2023).

ALICE residents of Michigan do not seem to be a core demographic for sales of EVs or a focus for EV sales and policies. EV owners tend to be affluent, white male homeowners (Hardman et al.,2021), in part due to the uneven distribution of charging infrastructure as well as the high cost of buying an EV. A further policy-based limitation is that EV incentives are usually received after purchase, so the full cost must be paid in advance and any rebates are received later (Hardman et al., 2021). The lack of cheaper EV options is the single biggest barrier, and since the Clean Vehicle Tax Credit is assigned based on battery capacity (IRS, 2023), there is an incentive to produce more costly eSUVs than smaller and cheaper EV offerings. Charging infrastructure is found predominantly near affluent suburbs and downtown areas, meaning it is not generally accessible in low-income and ALICE neighborhoods (Hardman et al., 2021), a finding confirmed by our Detroit study. Other aspects of EV ownership that limit adoption include the cost of home charging options and relative scarcity of apartment developments that include secure on-site chargers.

Part VII: Conclusion

The impact of electric vehicle (EV) adoption in Michigan offers a range of both benefits and costs that fall differently across households and communities in the state. Of concern is the potential social justice imbalances in benefits and costs across different socioeconomic groups due to disparities in charging infrastructure accessibility, health implications, and employment opportunities related to EV implementation. The transition to EVs, like past technological shifts, could disproportionately benefit specific interests, raising concerns about access and fairness. In 2021, nearly 40% of Michigan households faced economic stress, with ALICE populations (Asset Limited, Income Constrained, Employed) concentrated in inner urban and rural areas that receive less attention for EV use than other areas in the state.

Concerns regarding environmental and health impacts arise from metal extraction for EV batteries, especially lithium-ion batteries, which involve intensive mining in developing nations and initial reliance on emission-heavy energy sources for charging. Issues such as battery disposal challenges, safety concerns, and the need for a holistic approach to address community impacts need to be considered as they tend to occur in communities with fewer resources. ALICE populations may face disproportionate risks if their neighborhoods are chosen for battery and vehicle recycling. While developed countries like the U.S. may experience an overall reduction in green-house gas emissions as a result of adopting EVs into the nation's scope of transportation methods, developing countries will bear the brunt of the negative environmental health consequences that are brought on by the global transition to EVs.

EVs will transform labor markets, affecting job creation, skill demands, and manufacturing locations in Michigan's historic auto industry. Opportunities in the EV sector might exist for ALICE populations but may also require further education and specialized training, which could pose additional costs for entry-level workers or function as a barrier to career development. Despite expectations of job creation, the relative simplicity of electric vehicle operation and maintenance suggests an overall reduction in labor needs. It is important to be cautious about expectations regarding EV-related job creation, as some major automotive companies have already started laying off employees in traditional automotive manufacturing positions as they transition to EVs.

The critical role of charging infrastructure in EV adoption, influenced by factors such as location, energy costs, and ease of use, poses limitations for ALICE residents due to housing constraints. These residents may find that the housing they can afford limits their ability to adopt EVs. EVs as energy storage tools present opportunities for grid management and renewable energy integration, but these benefits primarily flow to homeowners who can gain access. In Detroit, mobility challenges for ALICE households, including high ownership costs, limited charging infrastructure, and safety concerns, hinder EV adoption. Equitable and sustainable mobility solutions require holistic planning that integrates various transportation options.

Federal and local policies aim to encourage EV adoption, infrastructure development, and equitable planning, however, the trend of EV ownership favoring affluent homeowners and communities accentuates disparities in access and costs for ALICE residents. Policies need to go beyond mere EV access to address the core issues of mobility in general to ensure equitable transportation benefits for all residents. A clear understanding of EVs underscores the importance of comprehensive, equitable planning to mitigate social justice disparities, ensuring fair, safe, and accessible EV implementation for ALICE communities in Michigan.

Will EVs be an opportunity or a betrayal for ALICE populations in Michigan? Our analysis demonstrates that most current EV options are out of reach for low-income and ALICE consumers, compounded by the lack of convenient charging and maintenance infrastructure. While the EV based future represents significant opportunities for ALICE populations, such as better environmental conditions, job opportunities, or more efficient public transit; there are also disruptions or exclusions due to vehicle cost, access to charging, recycling, and a focus on affluent neighborhoods. If the regulatory and planning atmosphere at the federal, state, and local levels were to pay more attention to the needs of ALICE populations, EVs could indeed become an opportunity, rather than a betrayal.

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