Electric Vehicles and Equity: A Review Essay

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Abstract: The Biden Administration and major car companies tout electric vehicles as a transportation innovation that will substantially reduce greenhouse gas emissions thereby improving air quality, public health, and quality of life, especially for minoritized and marginalized communities that are disproportionately affected by vehicle emissions. In this review essay, we examine research on electric vehicles and equity from several disciplinary and interdisciplinary areas. We delineate the range of equity concerns about electrified transportation.

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Introduction

In 1835 Robert Anderson designed the first crude electric vehicle (Simpson and Van Barlingen, 2021). Despite this early development, it was not until the oil crisis of the 1970s and the emergence of climate change activism in the 1980s that scientists and governments pressured engineers to develop clean transportation ((Simpson and Van Barlingen, 2021). The pressure to curb irreversible damage to the climate system and decrease US reliance on foreign oil supplies resulted in the development of the modern electric vehicle. The 2015 Paris Climate Agreement (PCA) exponentially aided in the adoption of electric vehicles as member nations signed and pledged to electrify 20% of all road transportation by 2030 (UNFCCC, 2015). In accordance with the PCA, governments worldwide are promoting electric vehicle adoption, including the United States.

During his 2020 campaign, then-nominee Biden campaigned on an environmental plan which emphasized building charging stations and electrifying the federal fleet (C-Span, 1:16-1:24, 2020). Since taking office, the Biden administration has introduced the Justice 40 Initiative, which, when signed into law as Executive Order 14008, made it a federal goal that "40 percent of the overall benefits of certain Federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution" (The White House Justice 40, 2022). The Justice 40 initiative updated and transformed programs associated with eight areas of investment, one of which is clean transportation (The White House Justice 40, 2022). The Bipartisan Infrastructure Bill, effective November 15, 2021, works in connection with the Justice 40 initiative to fund the electrification and expansion of public transit systems across the nation, invest in electrifying and expanding passenger rail transportation, building $7.5 billion worth of public electric vehicle charging stations, and upgrading the U.S. power generation infrastructure to cleaner sources (The White House Bipartisan Infrastructure bill, 2022). The United States has a clear goal to increase electric vehicle adoption; however, there may be some bumps in the road.

As electric vehicle adoption has dramatically increased, scholars have investigated the equity issues associated with widespread electric vehicle adoption. Scholars have dug into equity aspects in every portion of electric vehicle production, adoption, usage, and destruction. In this essay, we review the literature on electric vehicles and equity to create a framework for examining this research.

To begin this process, we identified the Web of Science database as the core database for our search. We then conducted keyword searches to produce articles related to transportation electrification and equity. The search included filters for English language articles and academic publications. Each search produced a large batch of articles from which we read the titles and abstracts and pulled any result that directly mentioned electric vehicles or transportation-related equity. Articles were collected only once, on their first appearance, even if they appeared in multiple search results. The order of search results can be found in Table 1.

From this new list, we read every article and kept only the articles that either emphasized an aspect of electric vehicles and equity or had a connection we could easily identify. We also investigated the articles' citations to further explore potential relevant research, and we received some suggestions for articles from fellow scholars, Santa Cruz, et al. (2022). Once we identified the articles, we developed a typology to categorize and analyze the research.

Table 1: Key Words to Identify Articles on Electric Vehicles and Equity

Key Words (In Search Order)	Initial Return (Abstract and Title)	Articles Used in Typology
Electric Vehicles and Equity	33	14
Zero Emissions Vehicles and Equity	6	2
Zero Emissions Vehicles and Environmental Justice	5	2
Electric vehicles and Environmental justice	17	5
Renewable Energy and Equity	6	1
Renewable Energy and Environmental Justice	15	2
Transportation and Equity	39	0
Transportation and Environmental Justice	28	0
Santa Cruz et al. 2022	17	6

The inequities associated with electric vehicles are multilayered and multifaceted. This means almost infinite categories could be developed; however, we relied on notions of distributive justice to develop a typology of four types of inequities associated with electric vehicles: economic, health, infrastructure, and systemic. The remainder of this essay will explore each of these types and then suggest future areas of inquiry surrounding the intersection of EVs and equity. We conclude with a summary of our findings.

Distributive Justice

Equity is often discussed in coordination with the idea of justice and specifically tied to environmental justice. The idea of environmental justice is at the core of all the articles used in this study. Environmental justice emerged as part of a social movement in 1982 which began in response to a toxic waste facility polluting the predominantly Black and low-income community in which it was situated (Agyeman et al, p.323, 2016). Environmental justice has since greatly expanded to encompass many more areas than just toxic waste pollution. Environmental justice is based on the environmental justice paradigm (EJP). The EJP "explicitly links the environment to race, class, gender, and social justice, effectively reframing environmental issues as injustice issues" (Agyeman et al, p.326, 2016). The establishment of the environmental justice movement has led scholars to explore a multitude of injustices and inequities under the banner of environmental justice.

The breadth of topics covered under environmental justice has greatly expanded over time (Agyeman et al, p.327, 2016). Environmental justice and subsidiary justices like energy justice, "can be examined through the lenses of three philosophic tenets in social justice literature: distributive, recognition and procedural justice" (Zhou and Noonan, p.1, 2019) Distributional inequity is tied to the distributive justice tenet. Distributive justice can be defined as "the fair and equitable distribution of resources and burdens throughout a society" (Longley, 2022). In essence, "distributive justice deals with the distribution of material outcomes or public goods" (Zhou and Noonan, p.1 2019). Inequities arise when some resource or burden is not distributed equitably. "Standard environmental justice analysis investigates the disproportionate distribution of environmental hazards on minority and low-income communities" (Zhou and Noonan, p.8, 2019). Distributional inequities often arise from specific policy decisions and the distribution of policy costs may raise additional justice concerns (Zhou and Noonan, p.15, 2019). In our search, we found that scholars are predominantly exploring four areas of inequity that can be considered concerns of distributive justice. Those subsets are economic inequity, health impacts inequity, infrastructure-based inequity, and systemic harm inequity. Each of these subsets is still fairly broad and contains a range of inequities.

Economic:

Economic inequity is the most prevalent subset of distributional inequity discussed by scholars. We define economic inequity as any inequality, injustice, or inequity which has a strong focus on or connection to economics or financials. Half of the articles, in the final analysis, were concerned with economic inequities. These most scholars were chiefly focused on the inequities related to tax rebate schemes, income tax credits, infrastructure subsidies, and other tax schemes related to electric vehicles (Al-Qadi, 2021, Barton & Schütte, 2017, Carley & Konisky, 2020, Caulfield et al, 2022, Guo and Kontou, 2021, Hardman et al, 2021, Henderson, 2020, Kaizuka, 2021, Ku & Graham, 2022, Ku, Kammen, and Castellanos, 2021, Lee & Brown, 2021, Lui et al, 2022, Pyddoke et al, 2021, Vidyattama, Tanton, and Nakanishi, 2021, and Ju, Cushin, and Morello-Frosch, 2020).

Scholars were particularly interested in California's tax rebate systems. California has two rebate programs, the Clean Vehicle Rebate Program (CVRP) and the Enhance Fleet Modernization Program (EFMP). The CVRP in its original iteration mostly dispensed rebates to high-income, high-education, and low-minority communities with low levels of air pollution (Ju, Cushin, and Morello-Frosch, 2020). In 2010, CVRP installed income caps and a tiered rebate system based on income in which the higher the income the lower the rebate amount distributed.

While this change decreased the total amount of rebate dollars being distributed to high-income individuals, it increased the overall number of rebates going to high-income individuals (Ju, Cushin, and Morello-Frosch,020). The EFMP addresses many of the inequalities associated with the CVRP. The EFMP, when compared to the CVRP, distributes more money and rebates to low-income, low-education, high-minority communities with higher levels of pollution (Ju, Cushin, and Morello-Frosch,020). The EFMP made major headway in decreasing many of the inequalities created in the CVRP; however, the program was not limiting the income, education, and racial inequities associated with the rebate system, it was just lessening them (Ju, Cushin, Morello-Frosch, 2022).

CVRP also has other equity issues related to the income distribution of rebate beneficiaries and the inequity in that distribution (Ku and Graham, 2022). Often "the financial benefits of the rebates are concentrated in the high-income categories while the low-income categories receive virtually no benefit from the rebates" (Ku and Graham, 2022, p. 8). The rebates also do not offset the burden of the high purchasing cost enough to incentivize middle- and low-income households to invest in electric vehicles (Gou et Kontou, 2021).

Economic scholars (Ju, Cushin, and Morello-Frosch, 2020 and Guo and Kontou, 2021) also used geospatial analysis to analyze the distribution of rebates concerning pollution levels. They found inequity in that most rebates are going to areas with low levels of air pollution. This implies that electric vehicles are not being purchased in the areas where their lack of exhaust pollutants would be most beneficial. This intersection is a great example of the interconnectedness of distributional inequity as economic inequities are intertwined with health impact inequities.

Economic scholars are also concerned with income tax credits, specifically the US federal and state income tax credits available to electric vehicle owners (Lui et al, 2022). Low-income individuals receive fewer credits at both levels (Lui et al, 2022). Tax credits do seem to incentivize the adoption of electric vehicles; however, the population being incentivized is predominantly wealthy and already likely to own newer fuel-efficient vehicles (Lui et al, 2022). This makes the adoption of electric vehicles less environmentally impactful. Like the rebate system, scholars found that income tax credit systems are the most beneficial to the wealthy and are inequitably inaccessible to middle- and low-income populations.

Economic inequity is not just an issue associated with electric vehicles in the US, scholars also explored the inequities associated with fuel taxes and bonus malus tax schemes in other countries. More specifically, they explored the inequities associated with the Australian fuel tax, which is meant to push fuel consumers toward electric vehicles, (Vidyattama, Tanton, and Nakanishi, 2021) and the Swedish fuel tax and the bonus-malus scheme (Pyddoke et al, 2021). The Australian fuel tax was most burdensome to rural and suburban populations and populations that could not afford new fuel-efficient vehicles (Vidyattama, Tanton, and Nakanishi, 2021). The Swedish transportation board explains this scheme as "Bonus means good. Malus means bad. The idea of the bonus malus system is to reward vehicles that emit relatively small amounts of carbon dioxide (CO2) while burdening vehicles that emit relatively large amounts of CO2 with higher vehicle tax for the first three years: malus" (Transport Styrelsen, 2022). The bonus-malus system is meant to complement the fuel tax system. The inequities associated with fuel taxes were also analyzed in the US context (Lui et al, 2022). These scholars all found that fuel taxes and bonus-malus schemes disproportionately burden low-income and suburban and rural populations.

Another inequity associated with economic distribution explored by scholars is the electrification of bus systems. Electrifying busing would allow more low-income individuals to reap the benefits of electrification, like cleaner air, without the financials involved with purchasing a personal vehicle (Zhou et al, 2021). Scholars were particularly concerned with the high costs associated with electrifying current fleets of public buses (Zhou et al, 2021). They conclude that the high costs associated with electrification and the lack of public funds to pay those costs are major factors in delaying the electrification process (Zhou et al,2021).

These scholars represent academic work surrounding inequities associated with economics. They generally found that the rebate system and income tax credits are inequitably distributed to wealthy white communities, that fuel taxes and bonus-malus schemes inequitably distribute a financial burden, in the form of extra fees, to poor and rural populations, and that financial barriers are primarily preventing middle and low-income communities from owning electric vehicles and having access to an electrified public busing system.

Health:

The second major category of distributional inequity is the distribution of health impacts. Health impacts include both the positive and negative changes in health associated with changes in electric vehicle adoption. The majority of health impacts are associated with changes in air quality in high emissions areas. When discussing air quality, most scholars referenced the amount of particulate matter (PM) emissions concentrated in the air of a specific geographical zone. Poor air quality has a significant concentration of PM emissions. PM emissions are mostly produced from tailpipe emissions from combustion vehicles but can also be produced by friction between vehicle tires and the road (Requia et al, 2018). Poor air quality has been associated with increased health maladies and risks and mainly affects the heart and lungs. Exposure to these emissions has been connected to premature deaths in people with heart or lung disease, nonfatal heart attacks, irregular heartbeats, aggravated asthma, decreased lung function, and increased respiratory symptoms, such as irritation of the airways, coughing or difficulty breathing (EPA, 2022). Particulate matter can damage the health of the environment as well. PM emissions may make lakes and streams acidic, change the nutrient balance in coastal waters and large river basins, deplete the nutrients in the soil, damage sensitive forests and farm crops, affect the diversity of ecosystems, and contribute to acid rain effects (EPA, 2022).

In connection to the distribution of health impacts, scholars were interested in the relationship between areas with poor air quality and the distribution of electric vehicle ownership, the distribution of pollution associated with energy generation, and which types of electrification should be prioritized (Barton & Schütte, 2017, Dolšak & Prakash 2022, Ku, Kammen, and Castellanos, 2021, Lee et al, 2009, Penn et al, 2022, Zhou et al, 2021, Zhu et al 2022, and Requia et al, 2018). As discussed in the economic section, scholars found that electric vehicle ownership is concentrated in wealthy white neighborhoods despite the highest levels of pollution often being found in low-income and poor communities that are primarily Black and Hispanic (Ju, Cushin, and Morello-Frosch, 2020, Guo and Kontou, 2021). The geographical locations which most need to decrease air pollution levels are not adopting electric vehicles which would greatly reduce PM emissions (Ju, Cushin, and Morello-Frosch, 2020 Guo and Kontou, 2021). Some scholars argue that electric vehicle adoption can increase PM emissions in these areas because as electric vehicles are adopted their owners' used combustion engine vehicles are passed down to poorer communities (Penn et al, 2022). This increases the number of emissions-producing vehicles on the road in these communities and increases exposure to PM emissions (Penn et al, 2022).

Scholars were also concerned with the concentration of PM emissions surrounding bus routes and ports. The communities most heavily relying on bus routes are low-income Black and Brown communities. During their routes and while waiting for the bus, riders experience higher rates of exposure to emissions and increase the negative effects of exposure (Penn et al, 2022). The communities surrounding major port complexes are also typically low-income Black and Brown communities (EPA, 2016). Other scholars looked at the high degree of emissions stemming from port complexes and how those concentrations of pollutants are impacting the health of local communities (Zhu et al, 2022). Electrifying water vehicles, trains, and freight vehicles in ports significantly reduces greenhouse gas emissions and has the potential to significantly improve air quality (Zhu et al, 2022). Scholars make strong arguments for prioritizing the electrification of bus systems and port vehicles over the electrification of the private vehicle fleet (Penn et al, 2022, Zhu et al, 2022).

The idea of outsourcing emissions, which can also be thought of as outsourcing the negative effects of pollution, was also explored by scholars (Penn et al, 2022). Electricity generation can have a considerable number of pm emissions if the generation system is not "clean" (Penn et al, 2022). Above we established the negative health impacts of exposure to these emissions. In the United States, 60.8% of electricity is generated by fossil fuels, it is "dirty" energy (EIA, 2022). This type of energy is more likely to be generated away from urban populations compared to pm emissions generated by roadside traffic (Penn et al, 2022). Essentially, electric vehicle users outsource their pollution to low-income rural communities in the countryside, where the electricity is generated while benefiting from the lack of exposure to tailpipe emissions.

While PM emissions are mainly talked about regarding tailpipe emissions, they can also be created by the contact between vehicle tires and the road. Electric vehicles are heavier than traditional combustion vehicles and consequently produce more non-tailpipe emissions than traditional combustion engines (Barton and Schütte, 2017) Like tailpipe emissions from combustion vehicles, these PMs are also more likely to impact low-income Black and Brown communities due to higher residential exposure to traffic and congestion (Boehmer et al, 2013)

Similar to the distribution of economic benefits and burdens, these scholars found the benefits of electric vehicles are not being distributed to the communities most vulnerable to the harmful effects of air pollution. Low-income Black and Brown communities are most impacted by poor air quality while electric vehicle ownership is concentrated in wealthy white neighborhoods. The harm caused by electric vehicle adoption is not fairly distributed. The increased non-tailpipe PM emissions are impacting poor Black and Brown communities more than wealthy white communities. The pollution associated with electricity generation, for powering vehicles, is also being unfairly distributed to rural residents while the electric vehicle owners reap the benefits of driving without tailpipe emissions.

Infrastructure:

Scholars are also particularly focused on the distribution of vehicle charging infrastructure. Infrastructure scholars were chiefly focused on the location of public charging stations, costs associated with the infrastructure, and access to private and public charging stations (Al-Qadi, 2021, Barton & Schütte, 2017, Brockway, Conde, and Callaway, 2021, Henderson, 2020, Hsu & Fingerman, 2021, Kahn et al, 2022, Ku, Kammen, and Castellanos, 2021, Penn et al, 2022, Ju, Cushin, and Morello-Frosch, 2020).

Geographically, public charging stations are predominately located in more affluent areas (Caulfield et al, 2022). Access to charging infrastructure is a major determinant of electric vehicle adoption. If the vehicle cannot be charged it cannot be used. The inability of low-income communities to access public charging stations limits their ability to transition to electric vehicles. While building more charging infrastructure in less affluent areas can remove some access barriers to electric vehicle adoption, it can be a double-edged sword. Ill-planned charging station infrastructure can lead to the gentrification of Black and Bown communities (Henderson 2020).

Areas of higher affluence also have a higher density of household charging infrastructure (Caulfield, 2022). installation of home charging stations is very expensive, this creates an extra financial barrier to electric vehicle ownership (Lee and Brown, 2021). Home charging capabilities may also be determined not by the wealth of the individual but by the wealth of the community. Not every home has enough hosting capacity, defined as the ability to draw and maintain power from the electric grid, to support personally charging an electric vehicle (Brockway 2021). Higher-income communities are more likely to have higher hosting capacities than low-income communities (Brockway 2021). The option of an extra fee for a home charging station or forced public charging can deter middle and low-income consumers from investing in electric vehicles (Lee and Brown, 2021).

If an electric vehicle owner cannot afford their private charging station or cannot install the infrastructure due to limitations like living in an apartment, then electric vehicle owners are forced to rely on public charging infrastructure. This infrastructure can often be inconveniently located and may require the owner to spend a lot of time waiting for their vehicle to charge. This large cost of time may make it more difficult for low-income individuals to own electric vehicles as they do not have large swaths of time to sit around waiting on their vehicle to charge (Dolšak and Prakash, 2022). Along with the cost of time, public charging may have large fees associated with their usage (Dolšak and Prakash, 2022).

Systemic Harm:

Systemic inequities are tied to injustices in the lifecycle of EVs and are focused on the production and destruction systems. While some scholars may argue that system inequities should be a category independent of distributional inequity, we ultimately chose to categorize these inequities under distributional inequity because the broad issue here is the inequitable distribution of harm in these systems. Many scholars are interested in the inequities associated with the systems in the EV lifecycle (Calvillo & Turner, 2020, Carley, Sanya & Konisky, 2020, Dolšak & Prakash 2022, Henderson, 2022, Mulvaney, 2017, Sovacool et al, 2019, Sovacool et al, 2020, Sovacool et al 2021). The systemic inequities explored by scholars primarily focus on producing materials for electric vehicles and disposing of electric vehicles. Sovacool et al (2020) describe these inequities as upstream and downstream respectively and we have added a third location of midstream which represents the usage point in the lifecycle. Harm is inequitably distributed at all points of the lifecycle systems

<u>Upstream</u>**:**

The upstream inequities discussed by scholars are all associated with mineral mining. The largest source of inequity is specifically cobalt mining, which is largely concentrated in the Congolese Republic (Sovacool et al, 2020). Currently, electric vehicle battery production is the largest source of cobalt demand in the world (Sovacool et al, 2020). Cobalt mining is extremely dangerous and is tied to several layers of inequity. Many other types of mineral mining, like lithium or copper mining, have similar inequities and are analogous to cobalt mining. Cobalt mining significantly relies on the exploitation of children and women (Sovacool et al, 2020). Cobalt mining is extremely dangerous and child laborers are exposed to physical, psychological, and sexual abuse (Sovacool, 2020). Women near cobalt mining sites also suffer sexual exploitation and discrimination (Sovacool et al, 2020). Cobalt mining also creates environmental and public health risks through mineral degradation, land and soil erosion, water pollution, and air pollution (Sovacool et al, 2020). Cobalt mining practices are also tied to the subjugation of ethnic minorities (Sovacool et al, 2020).

Midstream:

Scholars also analyzed inequity in the “midstream.” The idea of midstream inequities can be associated with procedural issues incorporated into the energy generation system. Two significant issues are the improper acquisition of Native American land for solar farms and the lack of local representation when deciding the placement of energy generation facilities like wind farms. Native Americans in the southwestern US are unfairly losing culturally significant land as well as being forced to sell private land to large solar farms to produce electricity for California, which has the greatest number of EV users in the US (Mulvaney, 2017). Native Americans are not being fairly represented or protected by the bureau of land management in the land acquisition process (Mulvaney, 2017). Local resistance to renewable energy projects is also being ignored by state and federal officials (Mulvaney, 2017, Brommel and Hoffken, 2021) In the US, scholars focused on the lack of local and native representatives in the native land acquisition process which disproportionately harms Native Americans in the energy production system (Mulvaney, 2017). Outside the US, scholars have focused on the lack of local representation in the French placement of rural windmill farms (Brommel and Hoffken, 2021). Local communities are broadly against the building of these wind farms, but the larger government is not listening to their desires, and they are not represented in the decision-making process. By being left out of the procedural process in the energy generation system, there is systemic harm to native populations and local populations.

Downstream:

The downstream inequities associated with electric vehicles are mainly focused on the disposal of spent lithium batteries. Sovacool et al (2020) focus on the disposal of e-waste in Ghana, which disposes of 90% of all e-waste. By 2030, electric vehicles are predicted to contribute 11 million tons of battery waste with only 5% being recyclable (Sovacool et al, 2020). The disposal of lithium batteries has many of the same inequities associated with mineral mining that leads to battery creation. Battery disposal and recycling are extremely hazardous and toxic for laborers and the environment, often leaking lead oxide into water systems and poisoning laborers (Sovacool et al, 2020). Laborers are often children and women, and both groups are often physically and sexually exploited (Sovacool et al, 2020). Migrant laborers working in Ghana’s e-waste management also face extra discrimination based on their ethnicity or religion (Sovacool et al, 2020).

These articles clearly show that the systemic inequities, associated with the creation and disposal of electric vehicles and the energy generation process are falling on populations that have little to no access to electric vehicles or the benefits of electrification. The harm caused by the systems involved in electrification is not being fairly or equitably distributed. Many of the harms are outsourced to developing nations or minority groups while wealthy nations and wealthy white communities reap the benefits.

Future Areas of Inquiry

Despite the rise in popularity in recent decades, electric vehicles are still relatively new, and scholars are still in the beginning stages of exploring all the inequities associated with their lifecycle impacts. Through the course of this study, we have also followed media coverage on electric vehicles. Through this coverage and conversations with other scholars, we have come across five areas of inequity that are prevalent in the media or social discussions of electric vehicles but do not yet seem to be in focus for scholars.

Labor

The first potential area for research is the impact of EVs on auto manufacturer labor and employment. The manufacturing process of electric vehicles requires fewer personnel than the manufacturing of combustion engine vehicles. This is because the computer and battery system has fewer parts requiring manufacturing. Essentially, electric vehicles are decreasing the demand for manufacturing work and will likely, negatively, impact the automotive labor market. Electric vehicles could require as much as 40% less labor (White, 2022). This potential negative impact on auto manufacturer labor is becoming increasingly present in the news cycle, with the New York Times, Forbes, NBC, and more running articles on the topic throughout 2022. As EVS increases in popularity, an impact on the labor market becomes a more pressing concern that deserves academic attention.

Agriculture

In the electrification process, the discussion is almost entirely focused on the electrification of personal and public car fleets. Despite accounting for 11% of Greenhouse gas emissions, the agricultural sector has little to no presence in the current electrification literature (EPA, 2022). Electrification of the agricultural sector is a difficult topic. Electrification is a daunting and arduous task for both farmers and electrification engineers. Field equipment requires battery ranges that are not currently available. Farmers work on tight schedules and cannot take hours out of the field to charge machinery. Farmers also use heavy-duty trucks and semi-trucks to conduct work on farms and transport their crop yield and equipment. It is very difficult for these vehicles to maintain their current hauling capabilities with the available battery systems common in electric vehicles. There is also a political barrier at play in agricultural electrification. Rural Farming communities are overwhelmingly conservative, and a liberal stigma may be attached to electrification. More research is necessary to make the electrification of farming machinery possible and to understand, and potentially counter, resistance based on political leanings.

Rural Adoption

While the barriers to electrification faced by rural communities have been mentioned in some of the articles above, they are often little more than a footnote in a broader discussion. Rural EVs adopters face numerous challenges and there is a lack of research focused on increasing access to rural areas or the inequities specific to rural communities. If rural communities are not considered in the electrification plans, they will not be involved in the solution.

Procedural

In the current EV literature, there is little to no focus on procedural inequities associated with vehicle electrification. In the above research, the midstream articles are both concerned with procedural inequity; however, they both focus on energy generation rather than EVs specifically (Mulvaney, 2017, Brommel and Hoffken, 2021). Procedural inequities have long been a focus of other transportation justice inquiries and should be investigated concerning EVs. Mobility justice is one area of study that scholars could look for inspiration. In mobility justice, scholars are principally worried about the lack of community representation at the decision-making table. The communities most impacted by decisions are often left out of community planning decisions. This is representative of the decisions being made in the adoption and production of electric vehicles. Low-income Black and Brown communities are the most impacted by the negative effects of traditional vehicle emissions, but community representatives are not being invited to the table when discussing items like charging infrastructure locations, bus electrification, grid updates, or changing routes to diminish pollution near schools. For the transition to electric vehicles to be equitable, all people impacted by the transition need to have a voice and a seat at the table. EV scholars concerned with equity must investigate the procedural areas of EV adoption.

Accessibility

Accessibility for disabled users is the last area of inequity we suggest scholars begin exploring. As electric vehicles become more popular, an increasing amount of disabled car users are finding that the vehicles are not accessible to them. The floor-based battery system increases the height of the vehicle. The increased height makes it more difficult for users with limited mobility to physically enter the vehicle and converting the vehicle to be wheelchair accessible becomes more difficult and expensive (Reardon, 2021). The charging cables for electric vehicles are also very heavy and require precise alignment, which may be difficult for disabled users (Reardon, 2021). Disabled vehicle users are also a population being left out of the discussion in terms of inequitable economic access to EVs. Disabled drivers often rely on social security or low-wage jobs and cannot access EVs due to the increased economic barrier (Reardon, 2021). Scholars are not including disabled users in the research on electric vehicles and many prevalent inequities need to be researched and addressed in the question of widespread electrification.

Discussion and Conclusion

Electric vehicles are the transportation of the future. The United States and other leading nations have joined together in the endeavor to combat climate change through vehicle electrification. As governments around the world have successfully worked toward making electric vehicles more popular, scholars have increasingly focused on the distributional inequities associated with the electrification process. Scholars have been particularly focused on the distribution of inequities associated with economics, health benefits, charging infrastructure, and systemic harm. Current literature covers significant portions of the inequities prevalent in the electrification process; however, we still believe many areas need to be explored. Some inequities we believe are left to be explored are the inequities associated with EVs' impact on labor, agricultural adoption, rural adoption, procedures and representation in decision-making processes, and accessibility for disabled users. The road to electrification has many bumps, but electrification and equity scholars are rapidly on their way to filling the potholes with knowledge and research.

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