How Electric Vehicles Are Raising Ethical Concerns in the Name of Saving the Climate

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

John Link

Spring, 2024

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Advisor

Richard Jaques - Department of Engineering and Society

Introduction

The U.S. stands on the brink of a significant transformation in its transportation landscape, moving from a longstanding reliance on internal combustion engine (ICE) vehicles towards a future dominated by electric vehicles (EVs). Leading manufacturers are now prioritizing electric and hybrid vehicles, a move that aligns with government policies aimed at eliminating ICE vehicle production within the next decade. This shift also signals a pivotal transition in societal norms and practices with interesting long term effects. Together, these developments illustrate a comprehensive transformation in the global approach to transportation. However, the move towards sustainable transportation extends beyond the mere adoption of EV technology; it is intertwined in complex social barriers and ethical dilemmas, especially concerning the sourcing of battery materials and the environmental ramifications of such a transition.

Despite the clear environmental and public health benefits of reducing carbon emissions through increased EV adoption, the U.S. deep-seated dependency on road transportation presents unique challenges. These include not only technological hurdles but also significant social and ethical concerns. The extraction of materials necessary for EV batteries, such as lithium and cobalt, raises pressing ethical questions, particularly when sourced from regions plagued by labor exploitation and environmental degradation. Furthermore, the environmental impact of discarding old ICE vehicles and the energy requirements for producing new EVs add layers of complexity to the transition.

This paper aims to demonstrate that navigating the shift to electric transportation in the U.S. requires a comprehensive approach that extends beyond technological innovation to address the social barriers and ethical dilemmas head-on. By applying the STS framework, this analysis delves into the social and ethical dimensions of the EV transition, underscoring the critical need for a comprehensive strategy that encompasses both technological advancements and the resolution of ethical concerns. In doing so, this analysis aims to contribute to the scholarly discourse on sustainable transportation, offering new insights into how the U.S. can sustainably migrate towards EV transportation and realize the full spectrum of environmental and societal benefits. This narrative not only charts the current state of EV adoption and its challenges but also sets the stage for a detailed examination of how these challenges can be overcome through informed policymaking, corporate responsibility, and public engagement.

Literature Review

Big questions surround the EV transition for consumers such as why is progress slow and what is hindering rollout? To answer these questions, I must first discuss how modern electric cars store energy. Lithium-ion batteries are not a recent technology, but they have improved significantly in the past 20 years. For example, the original Tesla Roadster had an estimated range of 240 miles compared to nearly 400 miles for a similar sized battery today (Energy5, 2021). The cells that power these cars are manufactured from lithium (~11%), manganese (~17%), cobalt (~20%), Nickel (~30%), and other rare earth metals (Statista, 2018). The U.S. is not material rich in these elements (as of February 2024) and as such, relies on imports from other countries to satisfy consumer and industrial demand. There have been many ethical dilemmas raised regarding the sourcing of these materials from developing countries. For example, a recent NPR article describes how slave labor is being used to mine cobalt in the DR Congo (Gross, 2023). With the continued push to electrify vehicles around the country it is important to pause and evaluate if the current approach is the best. What is the cost of batteries used in electric vehicles now? Are there alternative ways to mine valuable minerals needed in EV production which do not exploit workers? Should the cost of anything be “slavery” in 2024? Of course not; but why do politicians and corporations avoid a firm opposing stance?

Despite these well-documented issues, there has been a noticeable lack of action from U.S. politicians to implement policies or regulations that ensure ethically sourced materials for EV batteries. This oversight is particularly concerning given the acceleration of EV adoption and the significant investments in EV infrastructure and manufacturing within the country. The U.S. government's focus seems to lean more towards achieving environmental goals and bolstering the domestic EV market (van der Steen, 2015), often overlooking the dire social implications of the supply chains involved in this transition. Human rights violations in the EV supply chain are not limited to mining. The entire chain, from raw material extraction to battery production and recycling, is complex and global, with significant environmental and human rights impacts at each stage (Badhwar, 2022). Forced labor concerns in China, where a sizeable portion of battery production occurs, and labor rights abuses in nickel mining in the Philippines, are among the issues that underscore the urgent need for a more ethical approach to sourcing EV battery materials.

The current situation demands a reevaluation of priorities by U.S. policymakers. There is a critical need for policies that not only promote environmental sustainability but also ensure the ethical integrity of the EV supply chain. This includes implementing stringent regulations on human rights and environmental protection in the sourcing of minerals, promoting transparency and accountability in the EV industry, and encouraging the development and adoption of alternative battery technologies that are less reliant on problematic materials. Some of which have already begun but not nearly to the scale needed to make lasting change (Pavel, 2017).

Another aspect of the EV transition is the environmental impact of material sourcing. The process of extracting these toxic minerals can lead to considerable damage to the land, loss of forest cover, disruption of ecosystems, and increased carbon dioxide levels in the atmosphere. Additionally, the water-intensive nature of mining, especially for lithium in regions like Chile, contributes to local water shortages (Jerez, 2021). Efforts to address these concerns include the development of alternative materials for EV batteries, such as solid-state batteries and sodium-ion batteries, which could reduce the dependency on problematic materials. For sodium batteries specifically, unlike lithium, sodium is abundant and widely available, which means its extraction is more sustainable and leads to a less environmentally damaging supply chain. Moreover, the production process of sodium-ion batteries can be more eco-friendly due to the lower energy requirements and the absence of scarce, toxic materials such as cobalt, often implicated in human rights abuses and environmental degradation. By leveraging sodium, which is more evenly distributed globally, sodium-ion batteries could decrease the carbon footprint of battery production and support the transition to renewable energy with reduced environmental impact. This approach aligns with global efforts to minimize emissions and mitigate climate change, offering a viable path towards cleaner energy storage solutions (Kim, 2012).

Mass production of lithium-based EV batteries contributes significantly to environmental degradation and public health risks. The manufacturing process itself is energy-intensive, emitting a considerable amount of greenhouse gases, which contradicts the environmental benefits EVs are supposed to offer. Factories producing lithium-ion batteries generate enormous quantities of waste, including hazardous materials that can contaminate water and soil. The chemical solvents used in battery production are volatile organic compounds (VOCs), which pose serious air quality concerns and health risks to workers and nearby communities. In addition, the thermal treatment of certain battery components can release toxic pollutants, including heavy metals and carcinogens, into the atmosphere. The scale of these operations often leads to significant carbon and pollutant emissions. For instance, the carbon footprint of producing a single electric vehicle battery is substantial, with some data suggesting that the production of batteries for an EV requires up to eight years of lifespan before the environmental cost of production breaks even (Lakshmi R B, 2023). This underscores the importance of adopting cleaner manufacturing processes and the role of renewable energy sources in powering battery production facilities to truly realize the carbon savings EVs promise over their lifecycle.

Moreover, the end-of-life management of EV batteries presents another set of environmental challenges. While recycling programs are in development, the current rates of battery recycling are low, leading to concerns about the disposal of lithium-ion batteries and the potential for environmental pollution. The accumulation of spent batteries without adequate recycling processes in place could lead to hazardous waste issues, with chemicals leaching into the environment and posing risks to ecosystems and human health. Additionally, initiatives focused on recycling and repurposing used batteries, as well as ethical sourcing and certification, aim to mitigate the environmental and human rights impacts associated with current battery production. Although these processes can be lengthy, costly, and environmentally damaging in themselves (Home Depot, 2023).

On the corporate side, the exploitation in the EV industry is evident. Companies, in their push for cost efficiency and market competitiveness, have often overlooked the ethical implications of their supply chains. Despite some EV manufacturers pledging to ethical sourcing and transparency, the reality often contradicts these commitments. Corporations benefit from the low-cost labor in the mining of minerals like lithium and cobalt, essential for EV batteries, without facing significant legal or reputational repercussions. This shady corporate behavior is enabled by the lack of stringent political action, creating a cycle where both corporations and political entities benefit at the expense of addressing serious human rights abuses. As the U.S. continues its transition to electric vehicles, there is an urgent need for both political and corporate leaders to reconsider their strategies and policies, ensuring that the advancement in green technology does not come at the cost of human dignity and rights.

The urgency of addressing climate change is another important ethical consideration surrounding the transition to EVs. This shift towards reducing greenhouse gas emissions and mitigating environmental impact (Lutsey, 2015), is arguably coming too late given the rapid pace of climate change. The ethical dilemma here lies in balancing the immediate need to reduce carbon emissions with the equally important necessity of ensuring human rights in the EV supply chain. The slow response from both political and corporate sectors to the ethical issues in mineral sourcing for EV batteries is particularly troubling in this context. It raises questions about the overall ethical approach to climate change mitigation strategies. Are we, as a society, willing to compromise human rights for faster environmental benefits? Or should the approach to combating climate change also encompass a commitment to ethical practices across all aspects of technology and industrial development? The urgency of the climate crisis demands swift action, but this action must be grounded in ethical practices that respect both the planet and the people living on it. The current situation, with delayed acknowledgment and action on these ethical issues, suggests a need for a more comprehensive approach to climate action that integrates environmental sustainability with human rights and ethical supply chain practices.

In engineering, especially in emerging fields such as battery technology and electric vehicles, adherence to ethical principles and codes is paramount. These principles include prioritizing public safety, welfare, and the environment by maintaining honesty and integrity in research and practice all while being aware of the social implications of engineering decisions. As an engineering student, these principles guide my research, especially throughout my technical report where I discuss safe and efficient battery management systems for electric and hybrid vehicles. Engineers often face ethical dilemmas that require balancing technological progress with societal and environmental responsibilities. To navigate these challenges, it is crucial for engineers to employ a framework that not only evaluates immediate technological benefits but also the long-term impacts of their decisions. This approach emphasizes minimizing harm, enhancing sustainability, and ensuring equity. A notable example of ethical oversight is the continued use of cobalt from mines that rely on slave labor, despite the existence of alternative battery technologies that do not require cobalt. This practice reveals a significant ethical lapse, prioritizing cost savings over human rights and environmental well-being. Engineers have a pivotal role in advocating for and adopting ethical alternatives, thereby ensuring that technological advancements contribute positively to society and the environment, without compromising ethical standards.

Another responsibility of engineers is to incorporate personal ethical standards and regulations into their work. Reliance on politicians and corporations alone to safeguard ethical principles in technological advancements can often lead to gaps in accountability and enforcement. Engineers, equipped with specialized knowledge and insight into the intricacies of their fields, are uniquely positioned to identify unethical practices and the potential for harm in emerging technologies. By advocating for stronger regulations, transparent practices, and the adoption of sustainable and ethical alternatives, engineers can lead the charge in ensuring that technological progress does not come at the expense of societal welfare and environmental sustainability (Karney, 2009). This entails not only the identification and mitigation of risks associated with technologies like battery systems but also the active promotion of research and development in areas that offer ethical alternatives. Engineers must engage in and foster a culture of ethical vigilance, where the calling out of malpractices and the push for regulatory frameworks become integral to the profession. This approach not only enhohances public trust in engineering but also ensures that technological advancements contribute positively to society, paving the way for a future where innovation and ethics go hand in hand.

Conclusion

The shift towards EVs in the US represents a pivotal move towards environmental sustainability. However, this transition demands careful ethical consideration within both the political and corporate sectors. Earlier, I raised two questions concerning the timeline and the broader implications of transitioning to EVs. Through my investigation, I uncovered a complex array of ethical and technological challenges that necessitate a comprehensive dialogue among political, corporate, and social spheres. Engineers must provide guidance to policymakers, contribute to corporate strategies, and engage with society at large to steer discussions in a positive direction.

The ethical dilemmas surrounding EV battery production, particularly the use of forced labor and the exploitation of vulnerable populations, underscore the urgent need for a reassessment of our current approaches. Engineers bear a significant responsibility to ensure that their contributions not only push the boundaries of innovation but also adhere to principles of social responsibility and environmental stewardship. By embedding ethical considerations into every facet of engineering research and decision-making processes, we can strive for a future where technological advancements are achieved with a keen sense of moral duty, effectively addressing the challenges of climate change without sacrificing human rights and dignity.

Although the future of ethical, sustainable, and technologically sophisticated electric vehicles remains uncertain, there exists a viable pathway to accelerate the adoption of this technology in a manner that is both rapid and safe. This path requires a collective effort to integrate ethical foresight into the development and implementation of EV technologies, ensuring that our pursuit of environmental goals is aligned with our commitment to social justice and human well-being. By embracing this approach, we can aspire to a future where the advancement of electric vehicles contributes positively to both our planet and its inhabitants, heralding a new era of sustainable mobility that respects both the environment and human rights.

If we do not address the ethical challenges of transitioning to electric vehicles, we risk exacerbating societal inequalities and worsening climate change, with those in power exploiting the situation for their own gain. This bleak future, however, can be avoided if engineers lead the way with integrity and innovation. By prioritizing ethical solutions and sustainable practices, engineers will steer us towards a balanced and just future.

References

C. E. Sandy Thomas, "'How green are electric vehicles?,'" *International Journal of Hydrogen Energy*, vol. 37, no. 7, pp. 6053–6062, Apr. 2012, doi: 10.1016/j.ijhydene.2011.12.118.

B. Leard and V. McConnell, "Progress and Potential for Electric Vehicles to Reduce Carbon Emissions".

"Tesla Battery Technology: The Evolution of Electric Vehicles," Energy5. Available: https://energy5.com/tesla-battery-technology-the-evolution-of-electric-vehicles

T. Gross, "How 'modern-day slavery' in the Congo powers the rechargeable battery economy," *NPR*, Feb. 01, 2023. Available: https://www.npr.org/sections/goatsandsoda/2023/02/01/1152893248/red-cobalt-congo-drc-mining-siddharth-kara

Wolfram, P., & Lutsey, N. (n.d.). Electric vehicles: Literature review of technology costs and carbon emissions.

How to Dispose of Batteries. Home Depot. (n.d.). https://www.homedepot.com/c/ab/how-to-dispose-of-batteries/9ba683603be9fa5395fab90124a115f1

“Energies | Free Full-Text | A Paradox over Electric Vehicles, Mining of Lithium for Car Batteries.” https://www.mdpi.com/1996-1073/15/21/7997 (accessed Sep. 19, 2023).

D. H. P. Kang, M. Chen, and O. A. Ogunseitan, “Potential Environmental and Human Health Impacts of Rechargeable Lithium Batteries in Electronic Waste,” *ACS Publications*, May 03, 2013. https://pubs.acs.org/doi/pdf/10.1021/es400614y (accessed Sep. 16, 2023).

van der Steen, M., Van Schelven, R.M., Kotter, R., van Twist, M.J.W., van Deventer MPA, P. (2015). EV Policy Compared: An International Comparison of Governments’ Policy Strategy Towards E-Mobility. In: Leal Filho, W., Kotter, R. (eds) E-Mobility in Europe. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-319-13194-8_2

Badhwar, T., & Galodha, A. (2022). Electric Vehicles: A Comprehensive Review on sustainable, financial, political-policy prowess and prospects in India with labor policies of China and Africa. 2022 IEEE International Power and Renewable Energy Conference (IPRECON), 1–6. https://doi.org/10.1109/IPRECON55716.2022.10059516

Pavel, C. C., Thiel, C., Degreif, S., Blagoeva, D., Buchert, M., Schüler, D., & Tzimas, E. (2017). Role of substitution in mitigating the supply pressure of rare earths in electric road transport applications. Sustainable Materials and Technologies, 12, 62–72. https://doi.org/10.1016/j.susmat.2017.01.003

British Geological Survey. (May 31, 2018). Share of raw materials in lithium-ion batteries, by battery type [Graph]. In Statista. Retrieved February 14, 2024, from https://www.statista.com/statistics/1203083/composition-of-lithium-ion-batteries/

Bárbara Jerez, Ingrid Garcés, Robinson Torres, Lithium extractivism and water injustices in the Salar de Atacama, Chile: The colonial shadow of green electromobility, Political Geography, Volume 87, 2021, 102382, ISSN 0962-6298, https://doi.org/10.1016/j.polgeo.2021.102382.

Kim, S. (2012). Electrode materials for rechargeable Sodium-Ion batteries: Potential alternatives to current Lithium-Ion batteries. Advanced Energy Materials, 2(7), 710-721.

Lutsey, N. (2015). Global climate change mitigation potential from a transition to electric vehicles.

Karney, B., & Colombo, A. (2009). Why Engineers Need Public Policy Training and Practice. Journal of Policy Engagement, 1, 9–12.

B, L. R. (2023, January 11). *The Environmental Impact of Battery Production for EVs*. Earth.Org. https://earth.org/environmental-impact-of-battery-production/