

# **Cultural, Political, and Economic Barriers to Transportation Decarbonization**


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On my honor as a University Student, I have neither given nor received  
unauthorized aid on this assignment as defined by the Honor Guidelines  
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## **Introduction**

Climate change caused by the emission of greenhouse gases (GHGs) is one of the most prominent concerns in the modern world. Transportation accounts for a substantial portion of emissions in the United States, with about half of those emissions caused by light-duty vehicles. Globally, vehicle emissions are also increasing, with Teng et al. (2024) highlighting the substantial increase in passenger vehicles in China.

Greenhouse gases (GHGs) are a set of gases that spread out into the atmosphere and cause radiation from the Earth to be reflected onto the Earth instead of transmitting into space. This causes heat energy to build up, leading to a “global warming” effect.

Currently, many solutions are being explored, including electric vehicles, public transportation, and harsher fuel taxes. Several studies have been conducted on using cleaner energy sources to reduce GHG emissions. Comello et al. (2021) studied the costs of electric and fuel-powered buses on different routes. Capareda (2019) highlights that implementing systems for renewable energy would be expensive initially but would be competitive with non-renewable energy in the long run. One of the key issues with passenger vehicles in the United States is their emphasis on size and performance over fuel efficiency, according to Sperling and Cannon (2007). Unlike the United States, Europe has more fuel taxes that push the industry to produce more fuel-efficient vehicles and overall, less emissions.

GHG emissions have the potential to make Earth uninhabitable if not addressed. This study will analyze the social, economic, political, and cultural aspects of the increase in passenger vehicle fuel emissions at both local (United States) and global levels. This will enable the construction of thorough solutions that can address long-term concerns and help reduce GHG

emissions overall. Several potential solutions will be explored, such as whether public transportation is a viable alternative and how fuel taxes can benefit countries with high percentages of emissions from passenger vehicle transportation.

Using actor-network theory, these and other factors were combined to analyze and examine this problem, better contextualize obstacles to lowering transportation emissions, and provide potential solutions.

### **Methodology**

Analyzing why efforts to reduce GHG emissions from transportation have been impeded has been done using actor-network theory. Transportation emissions have several implications across many disciplines spanning across geographical, political, and economic viewpoints. Companies may wish to lobby against legislation that increases fuel taxes, this serves as one example of networks across different components that can prevent efforts against climate change. Thus, decompiling the issue into its various actors and understanding how they interact is imperative to develop a foundational understanding and formulate solutions.

My data collection consists of a literature review of existing concerns from several different perspectives as well as studies performed on potential solutions and mitigations towards climate change in the context of transportation. Policies, government efforts, the economy, geography, and culture will be analyzed to understand how they are interconnected and have impeded efforts to combat transportation emissions. By forming an actor network, the opposition from each of these actors can be minimized when developing new solutions. This can also be used to evaluate existing proposals against climate change for their effectiveness in meeting the requirements of these actors.

## Analysis

Transportation emissions have been the most difficult to transition compared to other sectors as detailed by Miller and Washington (2025). In 2023, the Greenhouse Gas Reporting Program stated that transportation in the United States accounted for 38.6% of national emissions, the highest of all sectors including electrical energy and industrial. Although all other sectors had decreases in emissions, transportation remained constant. This has led to four government agencies: the Departments of Energy, Transportation, Housing and Urban Development, and the Environmental Protection Agency to write the *U.S. National Blueprint for Transportation Decarbonization*. The strategies include increasing usage of public transportation, increasing sales of electric vehicles, and improving urban planning to provide convenience for dwellers. To execute these strategies, the blueprint highlights action plans that emphasize working with different perspectives to accomplish the overall reduction of carbon emissions in transportation.

One of these perspectives is the local and regional needs for green transportation accommodation as well as reforming the current city models to reduce transportation emissions. Miller and Washington (2025) describe the need to decrease the burden of commuting by vehicle and work at the local level to ensure an urban design that can scale up to larger cities and regions. Eyes (2025) also discusses how urban planning needs to lower the distance to where people need to go, enabling walking or biking as viable options. Current city models have been designed to accommodate highways making vehicular transportation required, however by increasing the density of cities, emissions can be lowered. Another aspect is increasing the usage of public transportation. For passenger vehicle drivers, the perception of price is not a large concern, whereas the price of public transportation and flying are. He argues that the cost of

using private vehicles should be increased to encourage people to use public transportation. City development needs to focus on creating tighter and dense cities that can provide basic needs and encourage the use of newly structured public transportation systems. Emissions from commuters can also be lowered by employers enabling remote work or sponsored public transportation methods. However, these projects are mostly considerations for long term solutions, and to address transportation emissions promptly, adoption of zero-emission vehicles is being promoted.

Increasing the sales and availability of electric vehicles is a primary concern, as the United States falls behind China and Europe in both sales and market share. Although reducing distances and promoting public transportation may decrease carbon emissions, adoption of such changes is difficult, and people are accustomed to owning private vehicles. Thus, electric vehicles can satisfy both environmental concerns and day-to-day life of the average person. Singh et al. (2024) discuss concerns regarding electric vehicles such as slow charging times, lack of public charging infrastructure, and emissions from other factors. Despite zero emission vehicles not being powered by GHG emitting fuels, producing the electricity needed to charge the vehicle and manufacturing the vehicle itself can cause emissions. According to data in the report by Miller and Washington (2025), about 6.9% of vehicles purchased in 2023 were purely electric vehicles and 9.3% of vehicles on the road are electric vehicles. Along with electric vehicles there are also hybrid vehicles that have had increased sales. Pal and Kunj (2024) highlight the need to strategically place charging stations based on driver trends and introduce their own set of problems if not properly planned with strain and outages of distribution networks. Although electric vehicles have much less emissions when in use, they have almost double the manufacturing emissions as shown by Eyes (2025) using data from 2021. Although

electric vehicles are increasingly proving to be a cleaner solution than internal combustion engine vehicles, the adoption of cleaner transportation technologies is mostly predicated on the government incentivizing consumers and producers.

Government regulation of GHG emissions in the United States has become a polarizing topic with states having clear divides on regulation policies. Pappas (2024, April 1) highlights how states have adopted one of four different strategies for emissions regulation: Active emission regulation, anti-regulatory, inaction, and those between active regulation and inaction. He also discusses several strategies the government has used to reduce emissions and of those, subsidies proved to be a way to encourage emission reductions and were less polarizing than active emission regulations. Under the new 2025 Trump administration, emissions regulations were rolled back, and clean energy vehicles were no longer encouraged by government incentives (Truett, 2025 February 10). Despite these setbacks, companies continued pursuing cleaner energy solutions for their vehicle fleets because of the overall lower costs in the long run and investment already put into setting up the infrastructure. This shows that government nudges such as the subsidies can lead to research and development into clean energy solutions that are overall cheaper than existing GHG emitting energy.

## **Results**

From viewing current government efforts, perspectives from political, urban, and technological aspects, an actor-network can be formed to better understand the current limitations in society, the economy, and technology. According to the blueprint formed by the U.S. government agencies, the action plan is over the course of 30 years and progress toward clean energy solutions will be an arduous process. Currently the major players are the technology that can support making cheaper options for private companies to produce electrical vehicles and

city planning supporting a localized and tight framework. Technology efforts are mostly focused on battery technology and according to Miller and Washington (2025), lithium-ion batteries are the dominant energy sources in electric vehicles with research being done on solid state batteries and semi-solid electrolyte batteries. Research and development of cheaper solutions will support stronger investment in zero emission vehicles as companies will lean toward the long-term options that cost less. This was seen similarly in the vehicle fleets that continued developing infrastructure to lower emissions despite regulations being removed. Because of polarization in the United States, federal regulation will be difficult, but at the state level, active regulation and subsidies can be used to lower emissions and governmental agencies such as the department of Urban Planning can work with cities to provide frameworks that can decrease the need for vehicle usage.

Because of the time frame, short term efforts should mostly be focused on not causing major cultural or geographical shifts and focus on solutions that can be mutually beneficial to the group in question and the environment and walk the path of least resistance. One of these instances is the vehicle fleets going green, which was done because of the overall economic benefits. So, by investing in research such as battery technology, adopting cleaner energy can be made easier and cheaper by incentivizing consumers and producers. However, long term efforts such as urban planning and public transportation can still play a significant role in the development of new cities that have lower emissions.

## **Conclusion**

Overall, transportation-based emissions are a problem that needs to be addressed with solutions tailored to the national government down to the towns and cities. With difficulties in enacting legislation for emissions reduction, alternatives solutions such as incentives and long-

term plans need to be the priorities. As shown by Miller and Washington (2025), there are already plans over the course of several decades in place attempting to address issues from technological, economic, and social perspectives. Agencies are working to increase the usage of zero-emission vehicles, create denser cities, and promote public or clean transportation. The purpose of this research is to compile information from several sources about current efforts and impediments to reducing emissions, and by doing so, we can formulate tailored solutions and explore the efficacy of existing efforts.

The implications of these results suggest that the focus and research done to reduce emissions is primarily up to technological advancement, urban planning, and the economy, which involves improving available infrastructure for zero-emission vehicles and making the available technology better and cheaper. These mostly serve to reduce the amount of emission emitting vehicles on the road and the other solutions involve urban city planning and reform. These are more difficult to implement into existing city structures but will be beneficial to build cities in the future. Some limitations of this study are its focus on transportation, as that is only a fourth of the emissions, and the research used does not give a good basis for actor-network theory, making conclusions more subjective and difficult to formulate. Research into how efforts to reduce GHG emissions are important because there needs to be a strong understanding of the implications of inaction as well as the efforts taking place now to prevent the degradation of the planet.



## References

- Capareda, S. C. (2019). *Introduction to Renewable Energy Conversions*. Milton: CRC Press LLC.
- Comello, S., Glenk, G., & Reichelstein, S. (2021, March 1). Transitioning to clean energy transportation services: Life-cycle cost analysis for vehicle fleets. *Applied Energy*, 285.
- Eyes, B. (2025). Technical Challenges of the Battery Electric Vehicle Transition: Emissions, Energy, and Policy Implications. Boca Raton, FL: CRC Press, Taylor & Francis Group.
- Miller, Richard K. (Richard Kendall), & Washington, K. D. (2025). Net-zero Transportation 2025. Miramar, Florida: Richard K. Miller & Associates.
- Pal, K., & Kunj, T. (2024). *Advancements in Electric Vehicle Infrastructure: From Development to Optimization: A Comprehensive Guide to Optimizing EV Infrastructure*. United States: River Publishers.
- Pappas, M. (2024, April 1). The Structure of U.S. Climate Policy. *Maryland Law Review*, 83(2), 347 - 401.
- Sperling, D., Cannon, J. S., Ebook Central - Academic Complete, Referex Civil and Environmental Engineering, & O'Reilly Online Learning: Academic/Public Library Edition (2007). *Driving Climate Change: Cutting Carbon From Transportation*. Amsterdam: Elsevier.
- Singh, V. P., Kumar, A., Meena, C. S., & Dwivedi, G. (Eds.) (2024). *Energy Efficient Vehicles: Technologies and Challenges*. Boca Raton, FL: CRC Press.

Teng W, Zhang Q, Guo Z, Ying G, & Zhao J (2024, July 1). Carbon emissions from road transportation in China: from past to the future. *Environmental Science and Pollution Research International*, 31(35), 48048 - 48047. Retrieved from <https://doi.org/10.1007/s11356-024-34344-0>

Truett, R. (2025, February 10). LOWER COSTS TRUMP POLITICS: Amid efforts to roll back emissions regulations, commercial fleets are sticking with electric power trains. *Automotive News*, 100(7181), 9.