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13 October 2021

The Vitality of Autonomous Driving Simulation

(Technical Paper)

Increasing Social Understanding of Electric Vehicles Environmental Impact

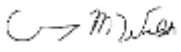
(STS Paper)

A **Thesis Prospectus** Submitted to the
Faculty of the School of Engineering and Applied Science
University of Virginia • Charlottesville, Virginia
In Partial Fulfillment of the Requirements of the Degree
Bachelor of Science, School of Engineering

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Fall 2021

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.

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Introduction

Carbon dioxide levels are growing rapidly every year and the desire for change is also socially spreading across the world. Social perception and influence are causing companies to enact deadlines and make a real change. The electrification of industries that rely heavily on high emission fuels has taken the reins of change. Specifically, the electrification of the automotive industry has been a major focus of societies' efforts. In 2019, 29% of all carbon emissions came from the transportation industry ("Sources"). In 2010, 90% of the transportation industry was supplied energy by crude oils with high emissions (Van Vliet). Society accepts electric vehicles (EVs) as a sweepingly better alternative to internal combustion engine (ICE) vehicles. While this can be true, the issue of comparing ICE to EVs is vastly more complex than the generalization of social understanding.

Types of EVs and Their Emissions

There are many kinds of EVs, but how does each of them rank up against a traditional car in terms of their Green House Gas emissions?

To investigate the technical differences when comparing EVs and ICEs a strong comprehensive understanding of how each work must first be achieved. First off, there are three different kinds of EVs that will be looked at. Plug in hybrid EVs (PHEV), battery power electric vehicles (BPEV), and series hybrid EVs (SHEV). A BPEV is the quintessence of a stereotypic electric vehicle. It runs solely on power from batteries in the car and does not rely on any gas-powered ICE. A SHEV is what most people think of as a traditional hybrid. Such vehicles have both an ICE and a battery powered engines that do not work together at all. First, the car will strictly use the electric power until it runs out which it will then switch into the ICE engine. SHEVs require charging the battery after it has run out and only use the gas-powered engine as a

Casey Welch
13 October 2021

backup. A less common type of hybrid is the PHEV for which the car runs only on electric, however, it has a small ICE that will recharge the battery of the vehicle while it is driving.

To determine which method of transportation is best for the environment, two main areas of focus must be looked at the following: the production of vehicles and the emissions of the vehicle. People typically think about emissions caused by the running of vehicles making EVs a clear winner because they release no emissions directly. However, the source of the electricity used in EVs is often neglected or simply assumed to be clean. While 29% of greenhouse gas (GHG) emissions in the United States resulted from the transportation industry in 2019, the second largest contributor was electricity at 25%. Some sources of electricity can cause worse emissions than the burning of natural gases. A 2015 study comparing the GHG emissions of different types of vehicles concluded that EVs charged from power plants that use coal have a negligible difference when compared to a traditional car. This shifts the argument away from the comparison of the vehicle types themselves and toward the energy generation methods for EVs. What makes EVs have greater potential than ICEs is that the source of energy is centralized in the infrastructure for charging. While it was concluded that there was little GHG emission difference when comparing EVs charged by coal to traditional vehicles, EVs have the distinct benefit of being able to change their energy source. The extent to which the electrification of the automotive industries will be beneficial relies heavily on a country's primary power source. Even today, before many drastic changes have been made, in terms of power supply, EVs will reduce carbon emissions in 95% of the world's countries. The only countries that will not see direct benefits from the introduction of EVs are those like Poland whose electric power grids are largely supplied by the burning of coal. Technological advancements that allow for the reoutfitting of electric power grids are the driving force behind the reduction of GHG emissions

Casey Welch
13 October 2021

through EVs. Countries that have already switched over to cleaner energy supplied like Sweden and France could see as much as a 70% reduction in automotive GHG emissions from the introduction of EVs. Even countries like the UK that are lagging France and Sweden's standard could still see a 30% reduction (Knobloch). Some power grids can even be sourced by extremely clean sources of energy like wind, solar, or hydro as their efficiencies continue to advance. This highlights that improvements in sources of electricity can quickly improve the entire EV fleet's emissions and cause drastic and meaningful change rapidly. While minor advancements in the efficiencies of specific and personal ICEs can reduce their GHG emissions on a micro-level, EV's abilities to affect change on a macro-level are a significant benefit.

The often-overlooked aspect when comparing emissions of EVs to ICEs is the production of vehicles themselves. When coming off the production line EVs have already generated substantially more emissions than the ICE. A 2021 Model 3 Tesla produces 65% more emissions than a 2021 Toyota RAV4 to be manufactured due to the higher amount of metal. It is not until 20,600 miles driven for each car that the amount of CO₂ emissions is equal. After that point the Tesla will continue to take a further lead for every mile and by 100,000 miles will have generated 77% less carbon emissions (Milovanoff). Another aspect of the production of electric vehicles that is often overlooked is the mining of lithium required for ion batteries. With the societal demand for EVs the lithium battery demand is increasing exponentially and the method for obtaining lithium uses substantial amounts of fresh water and harm the environment. Fresh water is also a growingly scarce resource, and the mining of lithium is taking it from areas primarily in South America. This practice not only takes water, but its discharge harms the soil and effectively destroys the land causing its native inhabitants to abandon their land (Devloping).

Casey Welch
13 October 2021

The lack of understanding the specific pros and cons associated with gas and electric vehicles is a problem because their impact is rapidly shifting and unknown. Without the proper precautions taken, rushing into a new method for doing things could cause repercussions as bad as the original way things were done. Extensive research will be conducted to determine the benefits and drawbacks associated with the electrification of the automotive industry. The technical advisor for this research is Tomonari Furukawa of the University of Virginia Mechanical Engineering Department.

Increasing Social Understanding of Electric Vehicles Environmental Impact

Modern society has a fascination with electric vehicles, but does not understand the impact and benefits of the electrification of the automotive industry. Why is the growing trend of EVs important for consumers to understand?

An educated consumer wields a great power to influence social change. It is just as much every person's responsibility as a company's to create impactful change in the world. There is no doubt that the sales of electric vehicles are rapidly growing in the United States. Just last year electric vehicles accounted for 2% of all passenger automobile sales, which has now risen to 20% (Skibell). The social demand is increasing extremely fast and the understanding of its impact and implementation is lagging. Electric cars are surrounded with a stigma of being very environmentally conscience alternatives to their gas counterparts. While it is possible that they may substantially help combat the increasing global emissions, many aspects of electrification are being overlooked and can harm the environment in different ways.

The increase in electricity demand will not only overwhelm current grid systems, but also could result in worse environmental impact than under a traditional automotive industry. Again, the issue comes down to the source of electricity, but there is no question that an increasing

Casey Welch
13 October 2021

penetration rate of EVs into the market will increase electricity demand by up to 7% during peak hours. High spikes in electricity at certain times could necessitate the use of less clean energy sources like burning coal. This phenomenon imposes an incentive for off-peak charging as crucial to the reduction of GHG emission (Van Vliet).

Where batteries come from and the energy that powers them originates are import aspects of a cleaner world. Intricacies like the sources of batteries and electricity are crucial for consumers understanding when they take on the responsibility of a greener lifestyle. A deeper understanding of GHG emissions and other environmental impacts of a shift to an electric automotive industry will prove a necessary backdrop to generating impactful change.

Casey Welch
13 October 2021

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