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Research on the Long-Term Sustainability of a Transition Towards Private Electric Vehicles

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Abstract. In recent years, a conflict has arisen between the urgency of fixing climate change and the reliance on cars as the primary mode of transportation. Electric vehicles have the potential to satisfy both conditions. With the accelerating growth in the EV market, it would seem as if they will soon become the future of transportation. Before a complete transition is made to EVs, it is necessary to assess the true sustainability of an EV. Due to the massive scale of the change in transportation, consequences for mistakes are significantly amplified. This paper sets out to research and evaluate EVs' sustainability compared to fossil-fule vehicles. Contrary to popular belief, EVs are nowhere near as beneficial to the environment as people had hoped. First, the concept of privately owned vehicles is unsustainable. In addition, EVs may emit more pollution than the fossil-fule vehicle. The exploitation of rare earth minerals is also causing heavy environmental damage while involving child labor. Despite this, if the issues are recognized and acted upon, it is reasonable to believe EVs still have the potential to act as a stepping stone to sustainable transportation for all.

Keywords: Electric vehicles, sustainability, fossil fuel, long-term, emissions.

1. Introduction

In recent history, developed countries have gained dependence on fossil fuel private vehicles as the primary mode of transportation due to their speed, convenience, and privacy, among many other benefits. Unfortunately, cars are not perfect, and the problems that arise with fossil fuel cars are causing many to turn to electric vehicles as the option for sustainable travel by car. Promotions for electric vehicles convey a compelling argument in favor of EVs, which has convinced the vast majority of the public. However, advertisements have led to misinformation about the true sustainability of EVs. For example, many consider EVs to have zero emissions though roughly 80% of energy comes from non-renewable sources worldwide. This essay will explore and evaluate the long-term sustainability of electric vehicles. The research will clarify common misconceptions about EVs and reveal areas of improvement for more sustainable use of EVs.

2. Limitations to fossil-fule viecles

First, it is essential to understand the problems that electric cars intend to resolve. To do so, we should consider the negative impacts of what electric cars intend to replace, fossil fuel vehicles. The most well-known downside of vehicles is their significant greenhouse gas emissions. According to the EPA(environmental protection agency), transportation emissions in the US have grown from 26% in

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2014 to 28% in 2018, overtaking the generation of electricity as the highest emitting economic sector[1,2]. In the US, cars owned per person have more or less plateaued due to a thriving economy. There is no need for one to have more than one car, and since over 90% of adults already own at least one car in the US [3], average car ownership has remained relatively stable. However, around 18% of people worldwide own at least one private vehicle as of today [4]. As living standards rise and cities expand, both supply and demand for vehicles will increase significantly. If the world had the same ratio of cars to people as the US, there would be roughly 5.982 billion more cars worldwide which is about a 423% increase in cars owned worldwide. It would be near impossible to provide cars for that many people, and even more impossible to fule all the cars with the current supply of fossil fuels in the world. Sound pollution is another limitation for cars. Cars are usually the primary source of noise in cities. According to the WHO, the maximum acceptable average noise level is 55 decibels, which, when surpassed, has been observed to cause health implications over time. In Karachi, Pakistan, noises have measured over 140 decibels near roads during rush hour, an insane 360 times higher than the limit set by the WHO. Car-dependent cities also tend to have significant social inequalities. Low-income households without a car will have difficulty earning an income due to time-consuming traveling, making it impossible to buy and maintain a private vehicle. Lastly, congestion is a massive problem due to privately owned cars in most large and dense cities. A bus can carry from 40 to 80 people in rush hour. If everyone on a single bus drove their car, it would take the duration of a green light for everyone to pass most small to medium junctions around the city. A common misconception lies in the belief that more road capacity will reduce traffic. As the Katy Freeway in Houston, USA, has shown, even with a 2.2 billion dollar expansion in 2011, traffic congestion has barely improved because the number of cars that used the road increased about as much as the road has expanded. People will take advantage of the faster transit times to travel more by car, which will end up resulting in more traffic. In economics, a rise in supply causing an increase in consumption is called induced demand. In this case, increased road supply and quality have caused increased road consumption. An under-considered limitation of cars is the space used to provide their infrastructure. Returning to Houston as an example, the city is planning another seven billion dollar project for highway expansion around the city. The project would demolish four religious buildings, two schools, one hundred sixty-eight homes, one thousand sixty-seven multi-family units, and three hundred thirty-one businesses that employ almost twenty-five thousand people.

It is important to realize that private vehicles are not essential for a thriving economy. In countries like the Netherlands, good city planning has allowed most people to rely on walking and public transport. According to Eurostat, the number of registered passenger cars is only eight million, with a population of seventeen million, meaning that at least half of the Netherlands does not own a vehicle. With the proper infrastructure and services, reliance on private vehicles is not imperative to sustain a thriving economy. Developed cities such as Barcelona, Ghent, and Berlin are already making significant changes to reduce cars in the city. But to evaluate the long-term sustainability of electric vehicles compared to the fossil-fule vehicle, an assumption is made that most societies will continue to use cars as the primary mode of transportation.

3. Long-term sustainability of EVs

Of the negative impacts of gasoline cars mentioned, EVs only have the potential to lower greenhouse emissions. They may slightly reduce sound pollution, but the vehicles will still have horns. Also, despite the electric car being very silent when traveling at low speeds, after surpassing roughly 55k/h, the sound created from the friction between the car's tire and the road exceeds the sound generated by the average fossil fuel-powered engine. Low availability, traffic, and high space demand are issues that need to be resolved in the near future and will not be solved by the transition toward electric cars. Fixing these issues may be crucial to achieving the goal of sustainable transportation for all. EVs were designed for the sole purpose of reducing the damage to the environment. If accomplished, this could be a significant leap toward sustainable transportation. But how well do electric vehicles reduce damage to the environment?

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The defining aspect of an EV is its consumption of electricity rather than fossil fuels. Many electric vehicle brands have taken advantage of this and labeled their cars as having "zero emissions." Though electric vehicles do not emit CO_2, a large part of the energy they consume comes from non-renewable sources like coal or natural gases. Decreasing EV emissions requires a country to increase clean energy production as a percentage of total energy production. A reliable measure for this is the carbon intensity of electricity, which measures the CO_2 emissions in grams for a kilowatt hour of energy. For example, according to research by 'Our World in Data,' Sweden, a country that produces almost all its power from renewable sources, has a carbon intensity of only 12 grams per kilowatt hour [5]. In comparison, the US emits 357 grams of CO_2 per kilowatt hour, and Poland, which emits 74% of its energy from coal, has a carbon intensity of 728 grams per kilowatt hour [5,6]. The carbon intensity is so high in Poland that driving an electric car will produce more emissions than driving a fossil fuel car [7].

It is also essential to recognize that most greenhouse gas emissions generated by an EV are produced from its manufacturing process. Due to the high competition for range in the EV market, firms prioritize maximizing battery capacity over almost all other aspects of the vehicle. The battery used in EVs is the lithium-ion battery. As the name suggests, the battery needs lithium to be constructed. As the quantity and size of EV batteries get larger and more prevalent, so does the demand for lithium. Like all other minerals, lithium needs to be mined, and the mining process of lithium is one of the most emission-intensive processes of all minerals. Due to the need for lithium, a medium-sized EV produces roughly 17 metric tons of CO_2, compared to 7 metric tons for the production of an entire fossil fuel car. Because of this, for an EV to have a lower carbon footprint than a gasoline car, it first needs to be driven around for six months to two years, depending on the frequency that the driver drives.

The negative environmental impacts are not the only limitation of EVs. Cobalt production is a growing ethical concern, an essential component in an EV lithium battery that regulates heat. The Democratic Republic of Congo is the world's leading producer of cobalt, producing over 70% of the world's cobalt supply. Because of the lack of machinery and expertise for operating machinery at mining sites, there are not enough large industrial mines to satisfy the growing demand for cobalt nor the supply of workers. Consequently, many informal mines have opened up where there is even less safety and mining equipment. Workers often need to fit into small spaces, always in danger of collapse while exposing themselves to deadly cobalt poisoning. Child labor is often exploited in these mines to take advantage of the trim physique of children who can more easily fit into the mines. Even though many EV manufacturers openly source their cobalt from informal mines, they have not taken any action to improve the working conditions of these places and instead rebranded these mines as 'artisanal mines' for the sole purpose of sounding more friendly. One issue they will have to address in the future is that cobalt, like all rare minerals on the planet, is finite and will run out. By the time the source of cobalt has run dry, it is crucial to have another developed battery to take the place of the lithium-ion batteries.

Though there is a lot of work to be done before EVs become sustainable, there is plenty of reason to be optimistic about their development. In addition to reducing emissions in general, because EVs do not produce emissions directly, they can significantly reduce pollution within densely populated cities. Around 9 million deaths are caused by pollution annually, approximately 15% of total deaths globally [8]. Because most pollution within cities is produced by fossil fuel vehicles, a transition to EVs will significantly improve public health. We must also not forget that clean energy is developing rapidly, meaning that EV emissions will continue to decline. Regarding the exploitation of rare earth minerals, many are already being recycled in large quantities. For example, more than 80% of gold and over 40% of cobalt are already being recycled from EV batteries. Furthermore, other forms of batteries are in the infancy of their developing processes that could forever solve the carbon-intensive process of mining lithium and cobalt. One of these batteries is the lithium-iron-phosphate battery.

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4. Conclusion

Due to the limited concept of private vehicles, all private vehicles, including EVs, are unsustainable in the long run. There is simply not enough raw materials and space for the other 82% of the world's population to own a vehicle. Resources are even more limited for EV production due to cobalt and lithium being necessary ingredients in all EV batteries. Also, for EVs to be carbon neutral, global carbon intensity needs to drop, which would slow economic growth. However, this paper does not consider possible technological advances due to unpredictability. New technologies will likely solve many of the current problems with EVs. For example, the limited rare earth materials necessary in producing EV batteries are already forcing the development of efficient recycling and alternative forms of batteries. Though technological advancements can significantly improve the sustainability of EVs, they are also unpredictable and unreliable. It is risky to assume that technological progress will always be made. To secure a more sustainable future, changes and sacrifices need to be made with the tools that are currently available.

References

[1] "Sources of Greenhouse Gas Emissions." United States Environmental Protection Agency, edited by Micheal Regan, 5 Aug. 2022, www.epa.gov/ghgemissions/sources-greenhouse-gas-emissions#:~:text=In%202020%2C%20greenhouse%20gas%20emissions,increased%20by%206%25%20since%201990. Accessed 25 Sept. 2022.

[2] "Sources of Greenhouse Gas Emissions." United States Environmental Protection Agency, edited by Michael Regan, 19 Jan. 2017, 19january2017snapshot.epa.gov/ghgemissions/sources-greenhouse-gas-emissions_.html. Accessed 25 Sept. 2022.

[3] Chesterton, Andrew. "How Many Cars Are There in the World?" CarsGuide, 20 Sept. 2018, https://www.carsguide.com.au/car-advice/how-many-cars-are-there-in-the-world-70629.

[4] Sham, June. "Car Ownership Statistics." Bankrate, 1 Sept. 2022, https://www.bankrate.com/insurance/car/car-ownership-statistics/.

[5] Roser, Max. "Carbon intensity of electricity, 2021." Our World in Data, 2022, ourworldindata.org/grapher/carbon-intensity-electricity?region=Europe&country=~USA. Accessed 25 Sept.2022.

[6] Derski, Bartłomiej. "Electricity production in Poland lowest in a decade. The smallest share of coal in history." Wysokien Apiecie, 31 Jan. 2020, wysokienapiecie.pl/en/26023-electricity-production-lowest-decade-smallest-share-coal-history/. Accessed 25 Sept. 2022.

[7] Waldersee, Victoria, and Ally Levine. "Is your electric car as eco-friendly as you thought?" Reuters, 10 Nov. 2021, www.reuters.com/business/cop/is-your-electric-car-eco-friendly-you-thought-2021-11-10/. Accessed 25 Sept. 2022.

[8] Fuller, Richard. "Pollution and health: a progress update." The Lancet Planetary Health, 17 May 2022, www.thelancet.com/journals/lanplh/article/PIIS2542-5196(22)00090-0/fulltext#:~:text=Despite%20declines%20in%20deaths%20from,has%20not%20changed%20since%202015.&text=More%20than%2090%25%20of%20pollution,income%20and%20middle%2Dincome%20countries. Accessed 25 Sept. 2022.