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Increasing Social Understanding of Electric Vehicle's Environmental Impact

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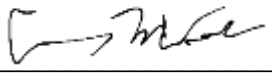
On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments.

Signature  Date 09 May 2022

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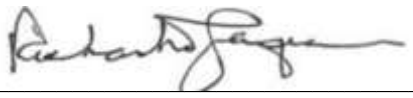
Signature  Date 03 May 2022

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Part I - 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 oil 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.

Part II – Review of Literature

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 distinct 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 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 principal areas of focus must be looked at the following: the production of vehicles and the emissions of the vehicle. People typically think about the 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. Although 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 industry 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 supplied by burning coal. Technological advancements that allow for the reoutfitting of electric power grids are the driving force behind the reduction of GHG emissions 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 the sources of can quickly improve the entire EV fleet's emissions and cause drastic and meaningful changes 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.

An often-overlooked aspect when comparing the 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 $C0_2$ 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 harms the environment. Fresh water is also a growingly scare resource, and the mining of lithium is taking it from areas primarily in South America. This practice not only takes up water, but its discharge harms the

soil and effectively destroys the land, causing its native inhabitants to abandon their land (Developing).

The lack of understanding the specific pros and cons associated with gas and electric vehicles is a problem because their impact is rapidly shifting are unknown. Without the proper precautions taken, rushing into a new method of 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.

Sources of Carbon Emissions

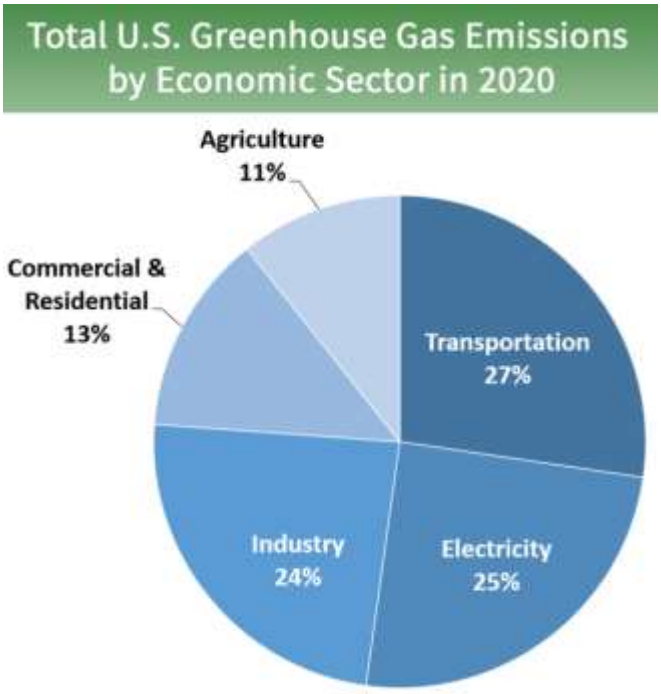
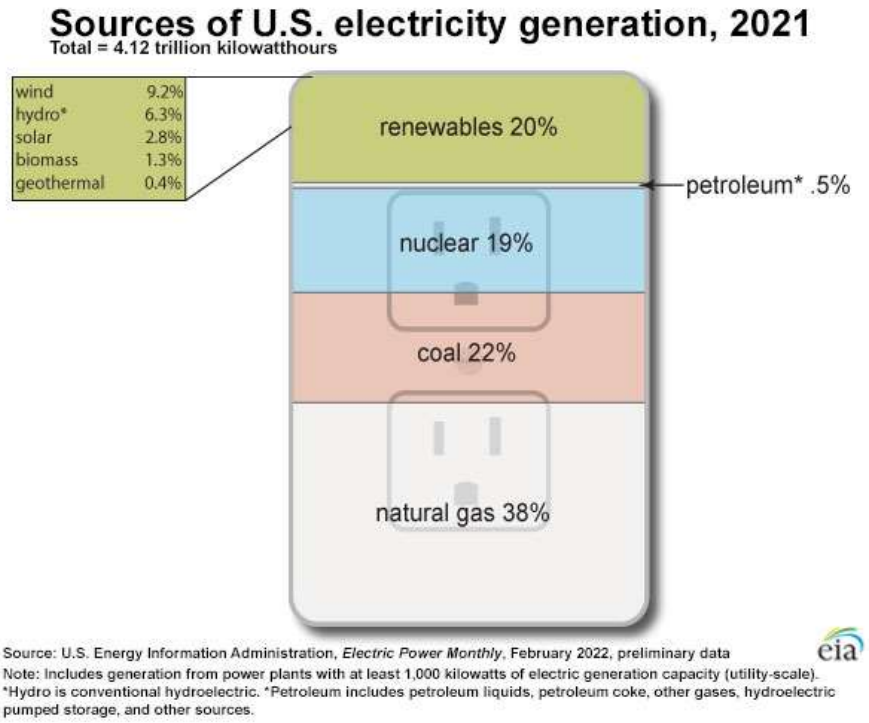


Figure 1. Environmental Protection Agency. (2020). *Sources of Green House Gas Emissions*.

As demonstrated by the Environmental Protection Agency's published results of carbon emissions in 2020, the electrification of the automotive industry could account for over half of the United States' emissions in the near future. The growing trend in electric vehicles could simply shift the transportation emissions into the electrical category. Change must happen at a

broader reaching level. The electrification of the automotive indsutry's increased demand for clean electricity has the potential to allow a cleaner and more efficient energy source to fulfill it.



Currently, the cleanest potential electricity source is the least utilized, and it is trending in the wrong direction. Sentiment and policy in the United States is strongly weighted toward energy sources classified as renewable. These energies include hydro, solar and wind. While these energy sources are widely regarded as clean alternatives, they generate more carbon emissions than nuclear, which is a zero-emission energy source. Solar and hydro actually produce four and six times as much carbon emissions as nuclear, respectively (Zhai). Clearly, the "cleaner" renewables need to be looked at in their entirety and not simply taken as being clean because they are renewable.

Despite not being not renewable because of how little waste is produced by nuclear, for all intents in purposes; it is. There is such a small amount of waste produced that it is essentially

negligible when compared to how much energy it produces. “All radioactive waste produced since 1960 could fit on a football field at a depth of 10 yards” (“Nuclear Waste”). With proper waste management, nuclear waste is a non-issue. Not only that but also nuclear waste is recyclable. After using uranium pellets for as long as five years, a substantial amount of potential energy remains. By extracting the used parts of the pellets and properly disposing of them, the remainder can be put back into reactors. However, the United States currently does not employ recycling nuclear waste because of its underutilization (“5 Fast Facts”).

Part III – Societal Impacts

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 increased to 20% (Skibell). 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 a worse environmental impact than in a traditional automotive industry. Again,

the issue comes down to the source of electricity, but there is no question that an increasing 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 emissions (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 consumer's 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.

Part IV – Conclusions

With electricity becoming increasingly more popular, to source its increasing demand, society must proactively change electricity sources sustainably and responsibly to cleaner options than certain renewables and burning coal. Nuclear energy is a vastly superior energy source because it emits zero greenhouse gases ("3 Reasons Why"). Also, its waste is manageable and recyclable, it can produce energy constantly, and it is space efficient. Despite the advantages of nuclear energy, it remains under funded and underutilized in the United States due to illogical public opinion. The simple word nuclear is surrounded in an off-base stigma. Society is quick to condemn it because of its relation to things like "war" and "fallout." While these issues are legitimate concerns, in the United States as an energy source, the negative stigma is unrepresentative. The following graph demonstrates human radiation exposure.

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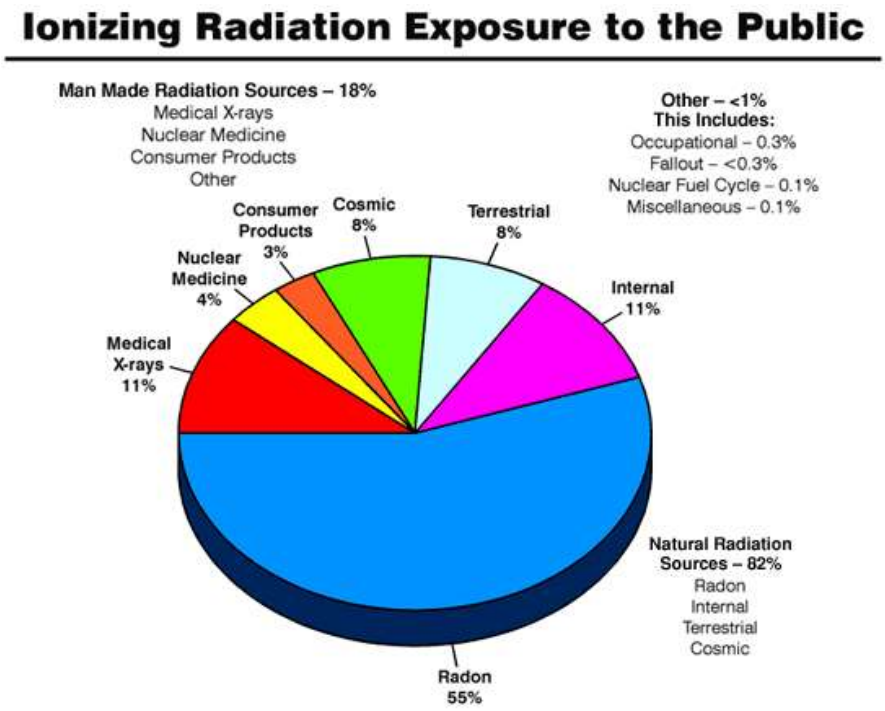

The above chart is taken from the National Council on Radiation Protection and Measurements (NCRP) Report No. 93, "Ionizing Radiation Exposure of the Population of the United States," 1987.

This chart shows that natural sources of radiation account for about 82% of all public exposure while man-made sources account for the remaining 18%.

As seen by the above chart, 82% of exposure is natural, and the remaining 18% comes from man-made sources that are notably unrelated to nuclear power. Nuclear fallout and fuel cycle account for 0.4% total. This fact demonstrates that society's concerns are off-base. Also, the type of reactor utilized in the United States does not produce fallout in case of extreme failure like reactors in Russia, specifically Chernobyl. For example, the meltdown in Three Mile Island in 1979 resulted in no deaths. Nuclear energy should gain increased research and development to meet increased societal demand for electricity because of the growing number of electric cars.

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