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## AN OVERVIEW ON WHY ELECTRIC CARS ARE THE FUTURE OF TRANSPORTATION

Saqlain Ali

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AN OVERVIEW ON WHY ELECTRIC CARS ARE THE  
FUTURE OF TRANSPORTATION

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A Project  
Presented to the  
Faculty of  
California State University,  
San Bernardino

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In Partial Fulfillment  
of the Requirements for the  
Degree  
Master of Science  
in  
Information Systems and Technology

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by  
Saqlain Ali  
December 2021

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Approved by:  
Dr. Benjamin Becerra, Committee Chair  
Dr. Conrad Shayo, Committee Member  
Dr. Javad Varzandeh, Department Chair, Information and Decision  
Sciences

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## ABSTRACT

The motor vehicle industry has been the leading consumer of fossil fuel worldwide resulting in adverse effects on the environment. This study used secondary sources of information from previous research in scholarly journals, Google scholar as well as eBooks, case studies, science direct, research gate, and google books to investigate. The findings show that some of the major milestones achieved in the electric car development include: the reduction of charging time for effectiveness in use, the introduction of supercapacitors that ensures increased charge storage, and with greater effective electromotive force. Additionally, some governments in developed countries do offer subsidies to support electric car manufacturing companies and customers purchasing electric vehicles in order to meet their carbon dioxide pollution reduction obligations, reduce production costs, and make EVs more affordable. Additional findings include: the belief that Electric Vehicles have adverse effects on the environment compared to standard vehicles, that this is due to the fact that a lot of fossil fuels are consumed during the manufacturing of Electric vehicles. The conclusion is that more research and study should be done to provide insight into the manufacturing process of Electric Vehicles. There is not much data available to conclude a strong foothold regarding fossil fuel consumption when making Electric Vehicles. Areas for further study include: investigating the current state of more efficient energy storage technologies, longevity of storage batteries beyond current 5-7 years of life.

## ACKNOWLEDGEMENTS

I would like to wholeheartedly appreciate and acknowledge the support and help provided by Dr. Benjamin Becerra, Dr. Conrad Shayo, and all others who have provided extra encouragement throughout this research project over the past few months.

## DEDICATION

This project and my master's degree are dedicated to my father whose desire was to see me complete my degree from the United States. He passed away last year on August 1<sup>st</sup> because of complications due to COVID19. Would also like to acknowledge my family and friends for continuing to believe in me

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## CHAPTER ONE

### INTRODUCTION

Fossil fuel-dependent vehicles have faced criticism on the effects they have on the environment concerning global warming as well as other pollution conditions (Brand & Anable, 2019). To start with, oil and gas are nonrenewable sources of energy, and it is predicted that these two sources will be depleted within the next 100 years. This means existing reserves should be exploited conservatively to ensure meeting the current energy needs of the people as well as the future generations (Burch & Gilchrist, 2018). Also, this has generated a need to look for other sources of non-fossil energy.

With regards to the effects, they have on the environment, the petroleum industry has been the chief contributor to climate change and environmental pollution especially from the vehicular impact as well as for industrial purposes (Liu et al., 2020). Following environmental activists' perspective, most of them claim that doing away with fossil fuel completely is a better direction that humanity should take in the move to save our planet. The main question is, will it be done away with at the expense of the needs of the current generation? So far there hasn't been a better energy source that can rival fossil fuel due to inconvenience, concerns as well as the cost. However, with the passing of time and the constraints that are associated with its continual consumption, humans have been forced to find alternatives to slowly replace it. (Jack, 2019)

The introduction of electric cars has been a milestone in ensuring that this move is achieved, despite the challenges faced by the electric car manufacturers

such as the unfair competition as well as their primitivistic nature in the technological advancement since it's a new technology (Wilson et al., 2013) they have managed to thrive quite considerably and it can be projected that they'll soon replace gasoline cars and act as the frontier to the radical shift to greener energy sources.

### Problem Statement

Taking active measures to reduce environmental pollution which entails the reduction of greenhouse gas emissions has been considered as a solution towards the saving of our planet. The sectors that consume the most fossil fuel including the transportation, industrial, and the construction sectors have been forced to help combat environmental pollution conditions as well as the effects of climate change.

The motor vehicle industry has mitigated the problem with the introduction of electric cars with which the fossil fuel consumption is to be directed only to the heavy-duty machines rather than the small passenger cars. Despite the laxity in coming up with more sophisticated systems that are cost-effective for use, substantial efforts are visible and within the next three decades, electric cars will be affordable and cost-effective (Hensher, 2020).

Taking an extensive look into electric cars through research and sharing of ideas can be considered to be the cornerstone of this new revolution of going green and saving our planet. For example, Tesla Motors has championed the use of electric cars through sophisticated and modern techniques in ensuring that this becomes a living reality. When the whole of humanity focuses on reducing

their carbon footprints, a greener condition will be established, and the world will be a better place to be in. (Niemala et al., 2010)

## Apocalypse now

Count of annual billion-dollar disasters, United States

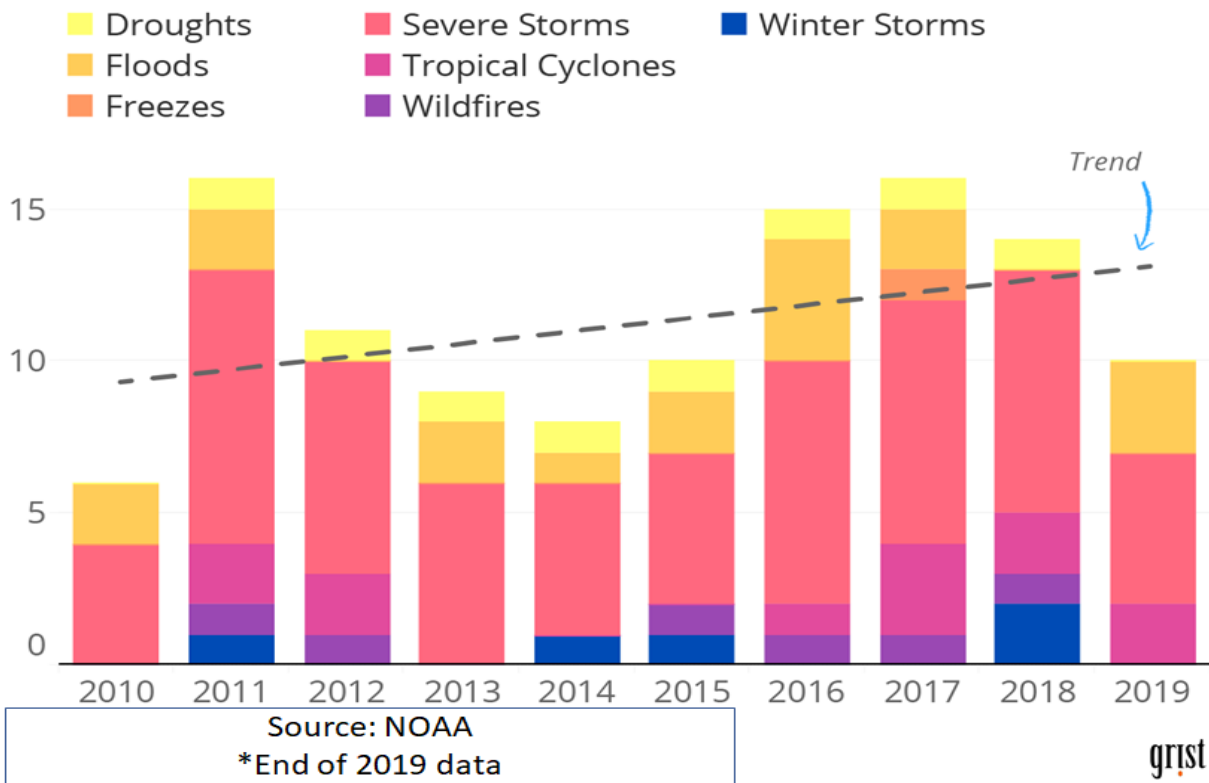


Figure 1. Billion Dollar Disasters in USA

### Inference

Researchers at JP Morgan believe that Electric Vehicles will be the future of the automotive industry and suggest that there are a lot of preparations by automakers to develop all Electric Vehicles by 2025. Materials, fuel cost, and auto manufacturers will look dramatically different in the next decade. members

of the European Council agreed to combat climate change by making all automobiles Electric by 2050. This move bolstered Battery Electric Vehicles to increase across Germany, U.K, France, Spain, and Italy. These 5 countries have more than 63% of Electric vehicles in the EU market increasing by 27% by the end of 2020.

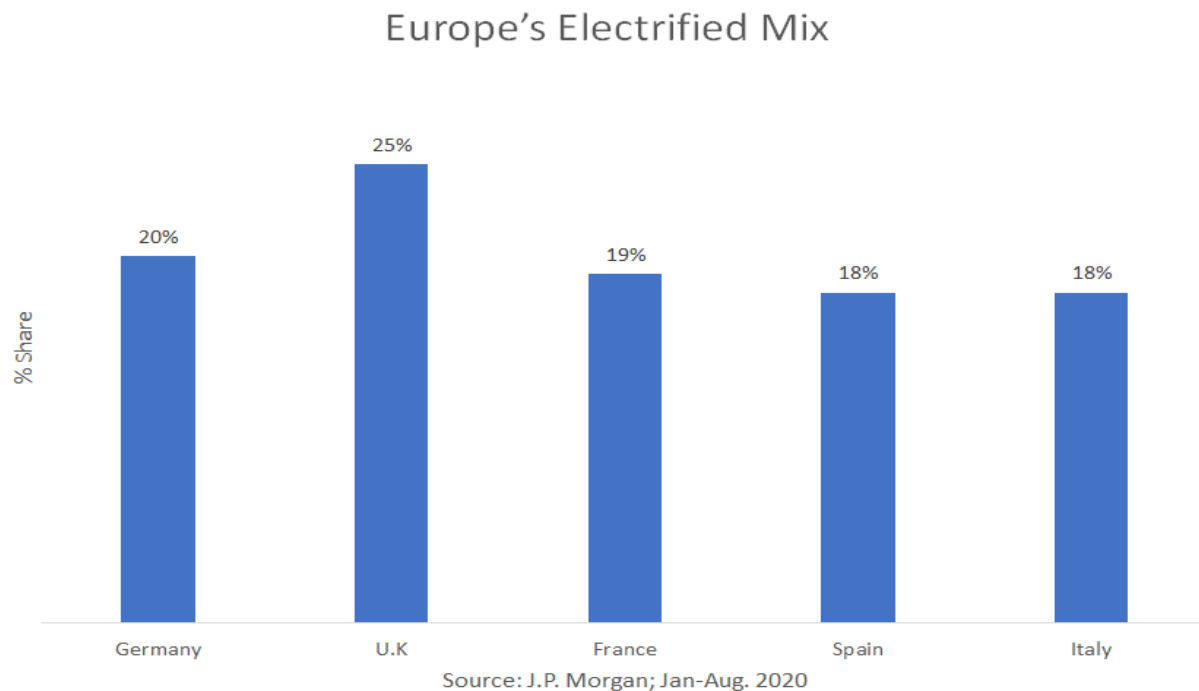


Figure 2. Electric Vehicle Market in Europe

Governments are trying to find a way to tackle the adverse effects of Internal-Combustion engines and automakers have stepped up and are prepared to phase out cars solely powered by fuel. More than 30% of all vehicle sales are estimated to be from Electric and Hybrids ("The Future is Electric," 2020). Countries are all working towards a plan to only Electric or Hybrid vehicles by 2050 and China is leading the way with a total of 1.3 million sales in 2020.

Researchers at JP Morgan estimate that it would increase upto 55% by 2025 (“Driving into 2025,” 2018). The primary reason for this is because of the rise of mini-EVs with smaller battery packs that are designed for small distances (62-93 miles). Prices for these vehicles start at \$6250 making them affordable and have helped boost the popularity of electric vehicles in China (“Driving into 2025,” 2018). A good start is when General Motors partnered with Nikola Motor Company to supply Hydrogen and battery-powered pickup trucks, Badger. Hydrogen Fuel cells can provide upto 1,000 Horsepower, 400+ miles of range and can charge to 100 miles in about 10 minutes. Main intention of the paper is to establish a strong foothold in the automobile world and explain that Electric Vehicles will be the future of vehicles in the next decade.

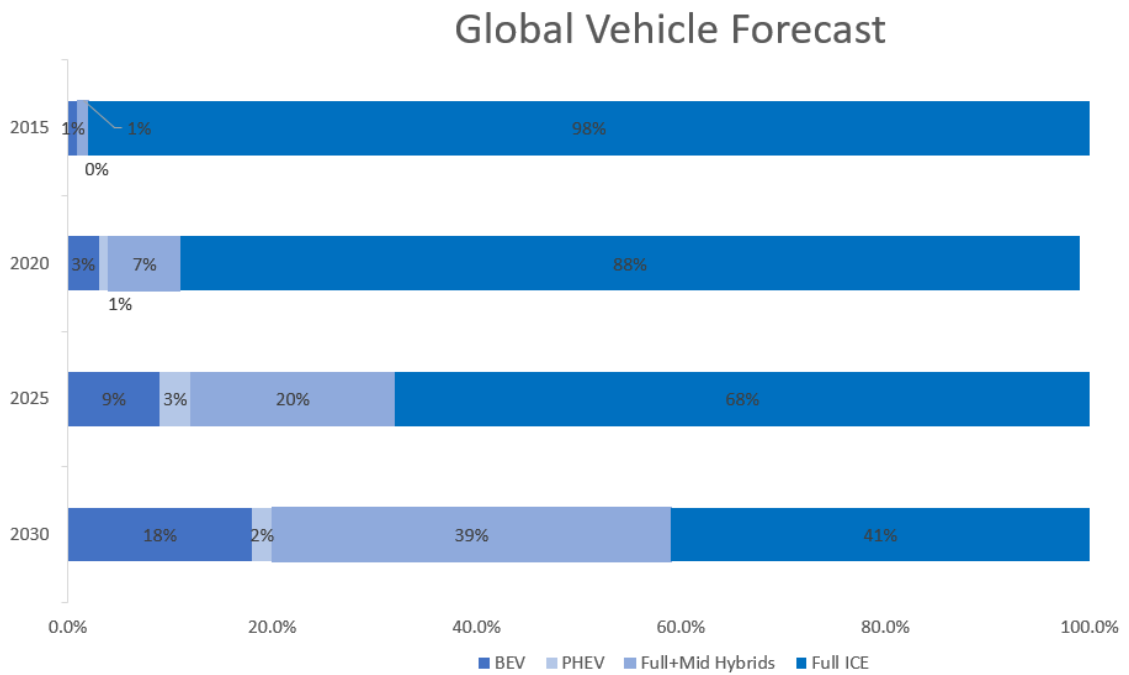


Figure 3. Global Vehicle Forecast



BEV (Battery Electric Vehicles) refers to cars powered solely by an electric battery. PHEV (Plug-in Hybrid Electric Vehicles) are similar to a Hybrid, but with a larger battery and electric motor. Mid/ Hybrid Electric Vehicles use an electric motor to assist gas-powered engines. Full ICE are cars that have an Internal-combustion engine and are the most common cars.

#### Research Questions

1. Can electric cars efficiently replace gasoline-dependent cars?
2. How could humans solve the charging time for electric cars?
3. Could electric cars be used in long-distance travel?
4. What are the milestones that humans have achieved in the introduction and use of electric cars?
5. What are the limitations that companies manufacturing electric cars are facing?
6. Are there better alternatives to the energy sector apart from electricity and fossil fuel?

## CHAPTER TWO

### LITERATURE REVIEW

This literature review focuses on the findings for which the adoption of electric cars could contribute to environmental conservation as well as the effectiveness to which they can operate without having a compromise on the state of the global economy as the efficiency in the transportation. Ensuring that our future generations can meet their needs is a collective responsibility that we are faced with as humans especially in the energy sector as well as for the environment at large. To be specific, the motor vehicle industry has been the chief contributor to environmental pollution and the effects of climate change(Bhandarkar, 2013).

In order to answer the research questions, this literature review and the paper is organized based on the following topics: (a) The possibility of Electric cars replacing gasoline dependent cars, the obstacles they face and how they are answered; (b) Solving charging time for Electric cars and how the issue of long distance travel is being addressed and solved; (c) The limitations and alternative sources of energy used in manufacturing Electric cars; and to show milestones that humans have achieved since the adoption of electric cars.

#### Possibility of Electric Cars Replacing Gasoline Dependent Cars and the Major Obstacles

Due to a variety of variables, electric automobiles have seen the most widespread acceptance of alternatively powered vehicles (Wilberforce et al., 2017). For starters, the cost of electricity is comparable to the cost of gasoline for

customers. Second, practically everyone who owns a car has access to a power source at home. It's simple to recharge. As documented in the 2006 documentary "Who Killed the Electric Car," electric automobiles failed when they first came to market, owing to high costs, a lack of familiarity, and reluctance from major automakers to produce them. However, a lot has changed since 2006. Electric cars are becoming more ubiquitous on American and European roadways, and their popularity is growing. But, can electric cars truly replace our gas-powered vehicles, or will they constantly trail behind their predecessors? The expense of replacing gas-powered cars with electric vehicles, or EVs, is the first major roadblock (Ortar and Righaug, 2019). Electric vehicles have always had higher upfront costs than gas automobiles. New technologies are lowering costs to make them more competitive, but the purchase price remains an important factor to consider. However, once you purchase the vehicle, the cost of ownership decreases. Tire rotation and replacement are still required, but oil changes and trips to the gas station are no longer required. In general, the expenses of maintenance and general operation are lower with an EV than with a gas automobile. In addition, the government has provided some tax breaks and credits to consumers who buy electric vehicles, which might help to reduce the cost even more.

The battery is another barrier that many individuals face when it comes to owning an electric vehicle. Despite Tesla Motors' (TSLA) efforts to enhance battery technology, most electric vehicles still have a limited range. The Nissan Leaf, for example (disclaimer: my father owns a Nissan Leaf), can only travel

around 100 to 200 miles on a full charge, and even less with the air conditioning or heat on. 2 These vehicles are useful for commuting, but they are not suitable for extended drives or road excursions. Even if you can find a charger at your midway point, if you want to make it back, you'll need to take the time to plug in (Raiper and Albrecht, 2020). Chargers are becoming more widely available, but the battery is still preventing electric vehicles from reaching their full potential. On a regular outlet, charging my father's Nissan Leaf from 0% to 100% takes all night. You can charge in seven hours with a home charging station, which can cost thousands of dollars to buy and install. New charger technology allows you to charge to 80% in 30 minutes, however these chargers are pricey and difficult to find.

If the average consumer saves \$10,000 on gasoline over the course of five years, which is a high estimate, the cost is more reasonable than gas-powered cars, and you may even save money in the long run. That is, if your electric vehicle has enough power to get you anywhere you want to go.

### Solving Charging Time for Electric Cars

Due to the large number of new electric vehicles that will be entering the market in the coming year, many people are wondering how we will be able to charge all of these automobiles. After all, there are around 15 electric vehicles for every one public charging station, so it is a reasonable topic to pose. Even in California, which has the most developed electric vehicle market, the 10:1 ratio is not significantly better (Ait-Ouahmed, 2018). These figures do not take into account the fact that about 95 percent of the currently available public chargers

are Level 2 chargers, which means it will take approximately 8-12 hours to fully charge a Tesla. When electric vehicles inevitably become commonplace, it will be a tremendous challenge to develop a public transportation system that functions in the manner in which people are accustomed. As a result, electric vehicles such as the Tesla Model 3 are bound to failure, as some have predicted.

### Possibility of Using Electric Cars in Long Distance Travel

Taking a road trip was not an option when electric vehicles first entered the market and were available to the general public. Long-distance driving was hampered by a number of significant obstacles, including the high cost of electric vehicles, a scarcity of charging stations across the country, and slow charging batteries. All three of these limits have now been overcome, making road trips with your electric vehicle virtually as simple as driving a gas-powered vehicle (Akerman et al., 2021).

The prospect for more charging stations, which is rising every year, addresses the worry of taking long distance trips with your EV. There are 21,362 charging stations with 61,679 charging outlets around the United States as of March 2019. Drivers should expect to see more charging stations available each year as more electric cars hit the road. Every week, more stations are added to the list, not just in major cities, but across the country, notably along state and interstate highways.

### Milestones Achieved in Electric Cars Development

The major milestones are depicted from the efficiency rooting from being super-fast. EVs are lightning fast. It's ridiculously quick, and it's only getting faster with new developments. Every electric vehicle, no matter how powerful its battery, will need to be charged at some time. The good news is that charging stations are springing up all over the country: there are already over 16,000, up from a few thousand just a few years ago and charging times are also decreasing (Kremer et al., 2014)

As EV batteries develop, owners will be able to drive their cars for longer periods of time between charges. This summer, someone established a Tesla range record by driving 670 miles on a single battery charge. This helps get rid of "range anxiety" .

### Limitations of Electric Cars

In the electric vehicle market, there are various constraints that limit growth and demand. There are causes that are currently causing concern, as well as elements that are expected to cause concern in the future (Andersen, 2013). This article discusses these concerns as well as proposed solutions. They include the following: battery capacity. Of course, no matter how long their range is, plug-in electric vehicles must be charged on a regular basis. Around 80% of electric vehicle charging takes place at home.

Electric vehicles consume a lot of energy. With electric vehicles accounting for less than 2% of all vehicles on the road in the United States, their impact on the electrical grid is now insignificant. However, as the number of

electric vehicles on the road grows, we should expect them to put a burden on infrastructure.

#### Alternatives to the Energy Sector Apart from Electricity and Fossil Fuel

The main alternatives to oil and gas energy include nuclear power, solar power, ethanol, and wind power. Fossil fuels still outnumber these alternatives in global and domestic energy markets, but there is significant public pressure to increase their use as corporations migrate toward sustainability, cleaner and greener business practices.

Fossil fuels, which primarily include coal, oil, propane, and natural gas, will account for 79 percent of total energy use in the United States by 2020.

Alternative energy sources have so far shown to be uneconomical alternatives to fossil fuels; they are inefficient and expensive (or, in the case of nuclear power, completely constrained in their ability to increase) compared to fossil fuels (Milano et al., 2016). As a result, the government now provides a number of incentives to those who choose cleaner renewable energy sources for their houses or cars. As more research and development is done in this field, supply and demand economics rules will eventually drive costs down to be competitive.

#### Consumerism On Car Demand

According to Hausman et al., (2001), a consumer dictated mode of production has been the cause of lag in the control of pollution effects which has, in turn, resulted in climate change getting out of hand. They depict a situation that the consumerism ideology that goods and services have to be as dictated by the consumers rather than the general picture of sustainability and health

considerations has been a leading cause of the detrimental effects humans are causing to the environment. As per the case of the motor vehicle industry, the efficiency in terms of ease of use, speed, and refilling has been the impacting factor concentrating almost all the players in the transport sector to depend on fossil fuel (Jawi et al., 2017). On the other hand, their use has resulted in environmental deterioration that includes the greenhouse gases such as methane, carbon monoxide, Sulphur (IV) oxide, and some heavy metals getting into contact with the environment. The growing health concerns such as the increased cancer cases have been associated with the effects of the heavy metals getting into contact with the human systems through inhalation as well as biomagnification. Resorting to electric cars has been speculated to not only help in solving this global disaster but as well, enhance the quality of life. (Soper, 2007)

### Going Green Movement

The future of investment in electric cars is luminous and it is high time for companies to do much research in the better ways of eliminating the use of petroleum derivatives as a source of energy. (Wilberforce et al., 2017). Moving towards a safe environment free from carbon-related emissions has been a global target for global economies worldwide. Most of the governments worldwide have offered to give subsidies to companies focused on the research of how electric cars can rival fossil fuel-dependent vehicles. As per the global carbon emission data, it has been established that states such as China and the US have been the leading emitters of greenhouse gases that lead to climate



change and other detrimental effects on the environment (Zhang et al., 2018). Ensuring that the environment can regain its initial safe state free from toxic compounds has been initiated by resolving the motor vehicle sector before other sectors such as the manufacturing sector can be focused upon (Ayaz, 2017). If the reduction or rather elimination of the oil and natural gas-dependent vehicles could be eliminated, the world could become more sustainable and self-sufficient for humans and other endangered species threatened by the imbalance being caused by the pollution effects.

### Market Demand for Electric Cars

A perennial question on who will buy the electric cars has been a hot topic that has posed many impediments to the continued research on how effectively they could infiltrate the competitive markets, as illustrated by Lieven et al., (2011). Since the introduction of electric cars in the market, they have not proved to be cost-effective for use especially as a result of their high demand for an intense car as well as the time taken for recharging them. Since fossil fuels are currently available in large quantities at affordable prices, competing fairly with electric cars has been a bigger challenge since people prefer what will be convenient for them and cost-effective. Using electric cars demands that only short distances are covered, and much time is spent on recharging them, which makes them unavailable especially for the middle class (Fridstrom and Ostli, 2021). This has therefore isolated them for use only by the rich tycoons who prefer to drive them as toys for prestige rather than for the need to move and transport goods. Since there is better improvement in them and a ray of light has

been shone on the possibility of them becoming cost-effective especially by the renowned revolutionary company, Tesla Motors, they could be depended upon in the future as fuel crisis continue to soar in the tough economic times.

### The Load Capacity of Electric Cars

Despite the continued need for the adoption of electric cars to help solve the environmental pollution effects of fossil fuels, the power generated by electric cars has not been sufficient for day-to-day transportation, (Belousov et al., 2015). Bringing the use of fossil fuel to an immediate halt will reduce environmental pollution immensely, however, it will cause a huge blow to the global economies in terms of production since almost all sectors depend on transportation for the economy to move. The existing electric cars have proved to be less effective in terms of the energy quotient. Before you can use them, you need to spend at least an hour recharging them in an optimal condition, with which, the duration might be even more, additionally, it takes a short while before the energy is depleted and it requires another recharging. Most of the investors in the transport sector have their backs on the use of electric cars especially taxis and personal cars. If it could be possible that they come cheaply, people could bear the duration of charge, however, they have proved to be the relatively most expensive cars that exist in the market. Therefore, even though it will take long before they can be adopted for use, adopting them will demand enabling conditions such as resource constraints as well as governmental enforcement.

## Stress to the HVAC Systems Through Electric Cars

As further illustrated by Lieven et al., (2011), the impact that electric cars will have on the economy will as well be a strain in other sectors such as the Heating, Ventilation, and Air conditioning HVAC facilities since there will be stress in their limited supply of electrical energy. In the current time, the electrical energy available through HEP systems, as well as biomass, has been constrained to the extent that people have resorted to supplementing it with fossil fuels. Considering economies such as Saudi Arabia where oil and natural gas is the main source of electricity have proved that the electric cars dependence on the grid system will be ineffective, therefore, their dependence on the direct gasoline could be superior to the recharging. On the lighter side of it, the high demand for more electrical energy could force global economies to be more inventive and formulate possibilities with which the HEP sources could be harnessed effectively to ensure that the growing demand is met. According to their script, Lieven et al., (2011) insist that there is a potential of producing surplus electricity that could be used in all the sectors if the great potential in rivers is fully utilized for the generation of power. Therefore, the possibility of electric vehicles causing stress to the existing resources could be minimized. Energy security can never be a big issue if the government puts much effort into ensuring that the available resources are fully exploited, especially HEP sources that could solve the great energy crisis that the world is facing today.

## Wind Energy for Electric Cars

An extensive work done by Bellekom et al., (2012) illustrates a case study of the Netherlands project on how to utilize their wind energy for electric cars. Environmental pollution through emissions has been aimed at ensuring that they can be reduced by handling the sectors of the economy that contribute much to these emissions. A case study in the Netherlands showed how they plan to adopt electric vehicles that will harness their abundant wind energy for recharging. The Netherlands has over the years depended on the importation of oil and natural gas from foreign countries, this has not only placed them in a compromising state in terms of national security but has as well forced them to stress on their available resources to strike a balance on their foreign exchange recovery. With the intended dependence on wind energy for the motor vehicle sector, there will be an immense impact on their economy as they will be more self-reliant and have a great sense of national security.

## Overcoming the Resistance of Electric Cars

According to Christensen et al., (2012), the enforcement of the use of electric cars as a case study in Denmark will face resistance especially by the investors in the oil and natural gas sector as well as the general population depending on the gasoline cars. Putting individuals and organizations out of business especially by depriving them of their only market will mean that there will be interference to their living standards. With the current democratic movement where the majority rules, resistance by a majority will mean continued use of fossil fuels unlike the stipulated better way of focusing on the more

sustainable and renewable source of energy. There are as well cartels that could potentially sabotage the moves made towards the adoption of greener energy sources for personal reasons. With the new law-making system in the Netherlands, it is possible that this law could be enforced, and this could make their economy change radically given that their carbon footprints are minimized, and they are more self-reliant.

Christensen et al., (2012) further argued that with the global research being done on how effective the electric cars could operate, they established a strong conviction that the shortcoming associated with the recharging and time taken by the vehicles to fully recharge could be resolved by total replacement, where instead of a vehicle waiting for recharge, a removable battery is dismembered from it and it is replaced by another one that is full of charge. Despite the weight and the lesser energy effectiveness that could be experienced by it, this could be an ultimate solution that could be more feasible for the future investment in electric cars. They speculated that Denmark could be the first country to have the total shift to the greener energy sources ahead of the US despite the superior technologies that have been put in place to enhance the research for the adoption of electric cars in the US.

#### Subsidy for the Electric Cars

According to Holtsmark et al., (2014), government involvement in ensuring that the citizens adopt the green energy sources should not be by the forceful implementation of the policies, but rather through tactical concepts such as the provision of subsidies to help support the sector. Ensuring that more tax is

enforced in the oil and natural gas sector can help promote the adoption of electric cars in that they would be readily available to the people more conveniently. Besides, ensuring that the companies moving towards the green energy sources are subsidized can as well help promote the culture of greener energy adoption. Electric cars have been projected to be the future of the transport sector as a result of the continued crisis in the energy sector. Coming up with a more sustainable economy where a government does not have to depend on foreign aid especially in the critical departments such as the energy sector ensures that national security is enhanced. The production of electric cars has faced insufficient research as well as skilled personnel to help in its improvement. Therefore, only a few private companies have over the past years focused on electric car manufacturing which has as well suffered constraints such as the lack of sufficient capital leading to their downfall. With the current government involvement in most of the developed economies, it is possible that much of the innovations within the sector could be brought to life and the move to ensure that the world is a better place to live in could be made a reality.

#### The Use of Supercapacitors for Power Storage

Horn et al., (2019) worked on the development of superior power storage mechanism literature and they showed a substantial light in the sector of adoption of electric cars. The problem associated with bringing electric cars to life has been pegged on the energy effectiveness to which they can operate. Coupled with long hours of charging time, people have over the years had a negative attitude towards the adoption of electric cars. The invention of

supercapacitors that are capable of retaining charge in large quantities and over a long period has shed much light on the move for making electric cars convenient for use. The shortcoming that was associated with the long hours of charging time could be reduced since these supercapacitors take a relatively shorter time to charge, unlike the conventional batteries that demand sufficient time to charge. It is possible that with the increasing research done in the sector, electric cars could reach a state of great convenience in use. The mechanism of operation of capacitors is that they store charge on their surfaces, these then produce an electromotive force which can then be harnessed for use. Within the automobile transportation sector, the existing modes of the battery have been less efficient and could not be easily implemented for commercial purposes, however, with the recent discovery of supercapacitors, more charge could be stored, and this can enhance the adoption of electric cars.

## CHAPTER THREE

### METHODOLOGY

This research is based on the secondary sources of information that include past research in scholarly journals, Google scholar as well as eBooks, and case studies within the publishing domain. Moreover, sciencedirect, research gate and google books contributed a lot in coming up with robust findings for the study and were accessed from Google search results. It as well entails a case study of the Tesla motors which will show a clear illustration of the various constraints and the leverages that they are having as a company. The keywords consisted of the following search terms: Environmental impact of electric cars, future transportation, fossil fuel emissions and their effects, Tesla Mergers and Geographic Expansion , consumerism on car demand, going green movement, and demand for electric cars. Content analysis models based on deductive reasoning were considered in establishing the general perspective of the

Table 1. List of Keywords and Articles used in the study



<b>Search Engine</b>	<b>Key Words</b>	<b># Of Hits</b>	<b># Of relevant Articles used</b>	<b>Articles Used in the Study Author (Year)</b>
<b>Google Scholar</b>	Environmental Impact of Electric Cars in European Countries	Total results returned were 240k	Scholarly	Scholarly
			Found a lot of articles but only 2 were relevant for this study	Helmers and Marx, 2012  Martins, F., Felgueiras, C., Smitkova, M. and Caetano, N., 2019
<b>ScienceDirect</b>	Demand for Electric Cars	Total results returned were 43,078	There were 2 articles that were interesting for this study	Beggs et al., 2001
<b>ScienceDirect</b>	The Norwegian support and subsidy policy	Total results returned were 9,346	1	Holtmark, B. and Skonhoft, A., 2014
<b>ScienceDirect</b>	Combining wind energy and electric cars	Total results returned were 11,963	Used 1 article for reference	Bellekom, S., Benders, R., Pelgröm, S. and Moll, H., 2012
<b>Google Scholar</b>	Tesla Motors Case Synopsis	Total results returned were 18,000	1	Liu, Y.E., Kang, Y., Wu, H., Chen, C. and Hon, E., 2014
<b>Google Scholar</b>	Electric Cars as an Issue for the Future	336k hits on Google, Google Scholar has 1 article	1	Venz, R., 2012
<b>Google Scholar</b>	Vehicular Pollution and their effect on Human Health	Google has 229k hits and Google Scholar has one relevant	1	Bhandarkar, S., 2013
<b>Google Scholar</b>	Electric cars carbon emission	Total results were 41,000	1	Wilson, L., 2013
<b>ScienceDirect /Semantic Scholar</b>	Supercapacitor as a new source of power	Total results varied depending on the database used	Found 1 article that answered this	Horn, M., MacLeod, J., Liu, M., Webb, J. and Motta, N., 2019

<b>ScienceDirect /Research Gate</b>	Who will buy electric cars?	More than 271k results for a generic term	Lots of articles, used the top one	Lieven, T., Mühlmeier, S., Henkel, S. and Waller, J.F., 2011
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research findings. Other visual sources such as YouTube illustrations were also considered to facilitate coming up with more reliable information that could assist startups as well as government parastatals (an organization having political authority and serving the government indirectly) in ensuring that the sector of electric car adoption is well catered for.

Articles used to research and write this paper were majorly inclined towards the authors that provided in depth information and their findings related to the automobile industry.

Table 2. List of Authors and their Findings

Author(s)	Summary of Findings
Meenakshisundaram & Shankar, 2018	Adoption of Electric Cars as a strategy to ensure that the world is a better place. Also, a study on a software provided and developed by “Better place” used in EVs
Pizano, 2018	Conducted a study and provided insights into why Electric Vehicles are not completely adopted in America
Oksanen, 2020	Conducted research to find the actions and factors that affect adoption of Electric vehicles
Venz, 2012	Major milestones achieved due to the introduction of supercapacitors was provided
Omuh et al., 2018	Provided information on various gases released and suggest use of alternative sources

Helmets et al., 2012	Conducted a study on the propulsion of Electric cars due to various renewable sources
Lassila et al., 2011	Researched on how to sustain economy when Electric Cars are adopted

## CHAPTER FOUR

### RESULTS

Following the effects of climate change and environmental pollution associated with fossil fuel consumption, the move by most of the world economies in the adoption of electric cars has been one of the strategies in ensuring that the world is a better place to live (Meenakshisundaram & Shankar, 2018). Global warming has been the leading cause of unprecedented flooding as well as the spread of desert conditions in some areas (Pizano, 2018). Moreover, the greenhouse gas effect of the emissions has disintegrated the ozone layer, hence there is a constant increase in the sun's intensity, and it can be projected that, soon, this will be unbearable.

Taking the actions to help create a balance such as planting trees has proved to be ineffective, therefore, ensuring that humans take responsibility for their mess to help save the planet is the way out (Oksanen, 2020). Taking the closest look at the motor vehicle industry, the highest emissions especially within the developed countries such as China and the US.

According to Venz (2012), Some of the major milestones that have been achieved in the electric car development department of the global economies include the reduction of charging time for effectiveness in use, the introduction of supercapacitors that ensures that more charge is stored and with greater effective electromotive force.

The various gases that could be prevented from entering the air include carbon iv oxide, carbon monoxide, gases of heavy metals like lead, and even gases of Sulphur derivative (Omuh et al., 2018). Ensuring that the adoption of alternative sources of energy that can ensure that these kinds of pollutions are reduced ensures that the environment is conserved and the rate of climate change that the world has been experiencing can be slowed down.

### Environmental Impact of the Use of Electric Cars

Generation of heat for propulsion of the battery dependent electric cars is generally a contributing factor that the electric cars will have, besides, a strain in the existing electricity sources could still force people to opt for fossil fuel to substitute the scarce green sources, (Helmerts et al., 2012). In the general perspective, energy sources such as the HEP, solar, biomass, and geothermal are normally renewable and it is possible that they can be available continually for future generations to come, they can be relied upon for the propulsion of cars. This not only solves the energy crisis that the world is facing today but also the environmental pollution caused by the consumption of fossil fuels. It is possible that striking a balance in environmental sustainability could be reached through the continuous dependence on electric cars and enforcing laws ensuring that people adhere to the going green movement.

### A Sustainable Economy with Electric Cars

According to Lassila et al., (2011), more exhaustive research is summarized on how a sustainable economy could be attained when electric cars are adopted for use. Most of the world economies depend on the importation of

fossil fuels from foreign economies since their availability is unevenly distributed. This has often raised alarms concerning the national security of most of the global economies. A particular emphasis on the US energy sector which has perennially been a matter of national security forced them to look into their available reserves to ensure that they can sustain their brimming population. Looking to the direction of electric cars has been speculated by the US economists that it could help solve the growing crisis in the energy sector by making their country self-sufficient. Electric cars will majorly depend on the available energy sources such as HEP, geothermal, and biomass. These have been seen to be renewable and once an equilibrium is attained, there will be no more dependence on the foreign states for energy supply. Improvement in the storage system of electric cars has rendered a positive direction and could be depended upon soon.

## Case Study

### Tesla Motors

According to Hoffman (2015), Tesla Motors is one of the pioneers in the innovation of electric motors. This case study illustrates the various strategies that they put in place to ensure that this becomes a reality in addition to the competitive advantages that they have in terms of the resources and availability of skilled personnel.

Tesla motors deals in the fabrication, manufacturing, assembling, and sale of electric cars majorly in the US, China, and internationally. Making it to the top despite the newness of their technology as well as the unfavorable market

conditions has been underpinned by their immutable strategies and leadership skills which have, in turn, enabled them to win a massive demand.

### Technology

Elon Musk who is the CEO at SpaceX is as well the CEO at Tesla Motors, with this, he has joined up the technical advances that are utilized in the rockets on electric cars. With this, they have managed to be in the development frontier which has, in turn, enhanced their electric cars immensely (Liu et al., 2014). Most of their target market views them as a copy cut of the SpaceX rockets and this has been a contributing factor towards their global dominance.

### Environmental Concerns

Following the continued environmental concerns related to the fossil fuel use and transport sector being the leading contributor to environmental pollution, most of the state governments have moved towards the support of the use of greener sources of energy that include solar, HEP power, biogas, and wind (Martins et al., 2019). Tesla being in the frontier of ensuring that going green is a reality through their advanced electric cars, they have managed to get government support through subsidies and political influence that has enabled them to reach the market more easily.

### Merger and Acquisition

Eliminating middlemen and ensuring that all the production is done under one roof has been among the leading contributors to the success of Tesla Motors. For instance, the acquisition of Hibar Systems, a private company specialized in the manufacture of batteries has greatly impacted the great

milestone of their charging system (Wiebe, 2019). Additionally, DeepScale, one of the AI start-ups was also acquired by Tesla Motors, this has ensured that their products can be of world-class quality. A sensitized production where every part has a specialized team handling is currently the futile business model that can be adopted in the competitive world.

### Investment in Research and Development

To keep the track of the consumerist economy, Tesla has majorly focused on performing intense research for continued improvement of their vehicles (Kastelan, 2020). Their budget allocated for research has been growing over the years putting them at a competitive advantage with other car manufacturing firms that depend on gasoline for propulsion. One of the major advances that they have put in place to help them win the interest of the public, is the use of social media in dissuading the masses from using gasoline cars for the move towards the reduction of carbon footprints. Events such as the global environmental days have provided a favorable podium for showcasing their products. Moreover, moving from merely basic technologies to advanced and more efficient designs is a product of their intense research for their cars since they are aimed at ensuring that all parts of the vehicle perform an important function.

### Geographic Expansion

Ensuring that they can penetrate all economies and be able to access the whole world as a market to their product has been another contributing strategy towards the success of Tesla Motors. Currently, they are setting their stores everywhere across the globe to ensure that the vast population can be able to



get access to electric cars. China is one of their leading markets where they have set a number of their stores, with the government of China getting involved in electric car sales and production, Tesla Motors has been enjoying the benefits of tax-free trade with which the import duty and tax tariffs have been lifted for them. This has additionally enabled them to get access to the market. The intense competition that they were facing from the gasoline dependent vehicles has greatly been reduced and there is a great chance of the company growing greatly.

## CHAPTER FIVE:

### DISCUSSION, CONCLUSION AND AREAS FOR FURTHER STUDY

Reducing the carbon footprints requires individualistic efforts where everyone all over the world takes care of their emissions and ensuring that they are not contributing to the adverse effects that the greenhouse gases are causing to the environment (De Melo et al., 2019). This can be generalized as a collective responsibility with which everyone is involved. Working on the measures to dissuade people from buying gasoline vehicles in addition to the enforcement of administrative bottlenecks within the governmental end can be a good way of ensuring that the shift is slow and sure.

Capitalism and opposition by the groups making a living within the sector could be solved by protecting their operations while blocking others from entering the market. Besides, the government can as well offer subsidies to help in solving the unfair capital distribution especially for the companies aligned with electric car production (Masiero et al., 2016). This could help reduce the production cost as well as encourage more investors to dive in and make it run.

Electric vehicles have been proven to be the future of the transportation sector and it is only a matter of time before this becomes effective (Honey et al., 2014). With the intense research, government involvement, and public awareness, the move towards the adoption of electric cars is futile.

There are a lot of key takeaways from the study on Tesla motors and the reason they have been successful. Including their research strategy and the use of discoveries and findings from other industries (rockets, space). This strategy

can be applied to some industries that could be beneficial including Autonomous Flying, Agriculture and Farming, Sports Analytics, Retail shopping, and Fashion. Artificial intelligence could be an integral part of surgeries (Ann Surg, 2019).

Many blue-chip companies are resorting to Electric vehicles. Chairman and Chief Executive Officer of General Motors, Mary Barra announced that he plans to completely phase out vehicles using internal combustion engines by 2035. Following which many automakers followed suit. Mercedes, BMW, Jaguar, Honda, Mazda, etc.

By 2030, there is expected to be a ban on the sale of diesel and gas automobiles in the United Kingdom.

However, there are a lot of gray areas when the world switches to fully electric.

About 150 years later, will the world still run-on Electric Cars? Shortage of Charging stations, High Electricity costs, Disappointing Battery Capacity...

Also, some scientists believe that Electric Cars are not necessarily clean as we think they are (David Biello, 2016)

### Conclusion

Electric vehicles offer great potential to recuperate efficiency within the transport system. This is majorly on roads, reducing traffic accidents, increasing productivity, and minimizing our environmental impact in the process. However, they have also seen resistance from different groups claiming that they are unsafe, pose a risk of being hacked, will threaten jobs, and increase environmental pollution from increased driving as a result of their convenience. In

order to gain massively from the advancing technology of the electric car's system and at the same time avoiding some of the many pitfalls, it is vital to effectively find out what negative impacts we stand to face in the future and what steps need to be taken now to avoid them as discussed in the paper. There exists a gap that still needs much intervention and is entirely based on the additional insights of how the policymaker's actions now will affect the future development and use of emerging technologies.

## REFERENCES

- 8 reasons why we need to phase out the fossil fuel industry (2019, September)  
<https://www.greenpeace.org/usa/8-reasons-why-we-need-to-phase-out-the-fossil-fuel-industry>
- Ayaz, H., 2017. Analysis of carbon emission accounting practices of leading carbon emitting European Union companies.
- Beggs, S., Cardell, S. and Hausman, J., 2001. Assessing the potential demand for electric cars. *Journal of econometrics*, 17(1), pp.1-19.
- Bellekom, S., Benders, R., Pelgröm, S. and Moll, H., 2012. Electric cars and wind energy: Two problems, one solution? A study to combine wind energy and electric cars in 2020 in The Netherlands. *Energy*, 45(1), pp.859-866.
- Bhandarkar, S., 2013. Vehicular pollution, their effect on human health and mitigation measures. *Veh. Eng*, 1(2), pp.33-40.
- Biello D., (2016, May 11). *Electric Cars Are Not Necessarily Clean*.  
<https://www.scientificamerican.com/article/electric-cars-are-not-necessarily-clean/>
- Brand, C. and Anable, J., 2019, June. 'Disruption' and 'continuity' in transport energy systems: the case of the ban on new conventional fossil fuel vehicles. In *European Council for an Energy Efficient*

*Economy (ECEEE) Summer Study 2019 Proceedings* (pp. 1117-1127). Leeds.

Burch, I. and Gilchrist, J., 2018. Survey of global activity to phase out internal combustion engine vehicles. *Center of Climate Protection: Santa Rosa, CA, USA*.

Christensen, T.B., Wells, P. and Cipcigan, L., 2012. Can innovative business models overcome resistance to electric vehicles? Better Place and battery electric cars in Denmark. *Energy Policy*, 48, pp.498-505.

de Melo, F.M., Silvestre, A. and Carvalho, M., 2019. Carbon footprints associated with electricity generation from biomass syngas and diesel. *Environmental Engineering & Management Journal (EEMJ)*, 18(7).

Fridstrøm, L. and Østli, V., 2021. Direct and cross price elasticities of demand for gasoline, diesel, hybrid and battery electric cars: the case of Norway. *European Transport Research Review*, 13(1), pp.1-24.

Grigor'ev, M.A., Naumovich, N.I. and Belousov, E.V., 2015. A traction electric drive for electric cars. *Russian Electrical Engineering*, 86(12), pp.731-734.

Helmers, E. and Marx, P., 2012. Electric cars: technical characteristics and environmental impacts. *Environmental Sciences Europe*, 24(1), pp.1-15.

- Hensher, D.A., 2020. Electric cars—they may in time increase car use without effective road pricing reform and risk lifecycle carbon emission increases.
- Hoffman, A.N., 2015. Tesla Motors, Inc. *Strategic Management and Business Policy*.
- Holtsmark, B. and Skonhoft, A., 2014. The Norwegian support and subsidy policy of electric cars. Should it be adopted by other countries? *Environmental science & policy*, 42, pp.160-168.
- Honey, E., Lee, H. and Suh, I.S., 2014. Future urban transportation technologies for sustainability with an emphasis on growing mega cities: A strategic proposal on introducing a new micro electric vehicle segment. *World Technopolis Review*, 3(3), pp.139-152.
- Horn, M., MacLeod, J., Liu, M., Webb, J. and Motta, N., 2019. Supercapacitors: A new source of power for electric cars?. *Economic Analysis and Policy*, 61, pp.93-103.
- J.P Morgan (2020, November 17). *Future is Electric*.  
<https://www.jpmorgan.com/insights/research/future-is-electric>
- J.P Morgan (2018, October 10). *Driving into 2025*.  
<https://www.jpmorgan.com/insights/research/electric-vehicles>
- Jawi, Z.M., Solah, M.S., Ariffin, A.H., Shabadin, A., Ali, A., Osman, M.R. and Wong, S.V., 2017. Automotive consumerism: A study of car user's practices & behaviour in Klang Valley, Malaysia.

- Kaštelan, A., 2020. *Sustainable and clean energy-the case of Tesla company* (Doctoral dissertation, University of Rijeka. Faculty of Economics and Business).
- Lassila, J., Haakana, J., Tikka, V. and Partanen, J., 2011. Methodology to analyze the economic effects of electric cars as energy storages. *IEEE Transactions on smart grid*, 3(1), pp.506-516.
- Lieven, T., Mühlmeier, S., Henkel, S. and Waller, J.F., 2011. Who will buy electric cars? An empirical study in Germany. *Transportation Research Part D: Transport and Environment*, 16(3), pp.236-243.
- Liu, Y., Lu, S., Yan, X., Gao, S., Cui, X. and Cui, Z., 2020. Life cycle assessment of petroleum refining process: A case study in China. *Journal of Cleaner Production*, 256, p.120422.
- Liu, Y.E., Kang, Y., Wu, H., Chen, C. and Hon, E., 2014. Tesla Motors Inc. Case Synopsis.
- Lombrana L., (2021, July 7). *Climate Change Linked to 5 Million Deaths a Year*. <https://www.bloomberg.com/news/articles/2021-07-07/climate-change-linked-to-5-million-deaths-a-year-new-study-shows#:~:text=Climate%20Change%20Linked%20to%205,Year%20C%20New%20Study%20Shows%20%2D%20Bloomberg>
- Martins, F., Felgueiras, C., Smitkova, M. and Caetano, N., 2019. Analysis of fossil fuel energy consumption and environmental impacts in European countries. *Energies*, 12(6), p.964.



- Meenakshisundaram, R. and Shankar, B., 2018. Business Model Innovation by Better Place: A Green Ecosystem for the Mass Adoption of Electric Cars 1, 2, 3. In *Case Studies in Social Entrepreneurship and Sustainability* (pp. 292-316). Routledge.
- Niemelä, J., Saarela, S.R., Söderman, T., Kopperoinen, L., Yli-Pelkonen, V., Väre, S. and Kotze, D.J., 2010. Using the ecosystem services approach for better planning and conservation of urban green spaces: a Finland case study. *Biodiversity and Conservation*, 19(11), pp.3225-3243.
- Oksanen, O., 2020. Drivers of adoption of electric cars: A comparison between Finland and Norway.
- Omuh, I.O., Ojelabi, R.A., Tunji-Olayeni, P.F., Afolabi, A.O., Amusan, L.M. and Okanlawon, B., 2018. Green building technology design and adoption: Occupants perspective. *International Journal of Mechanical Engineering and Technology (IJMET)*, 9(8), pp.1345-1352.
- Pizano, F., 2018, July. Adoption of Electric Cars in America. In [2018] *Congreso Internacional de Ciencias Humanas*.
- Sonnichsen N., (2021, February 5). *Oil demand share by sector*.  
<https://www.statista.com/statistics/307194/top-oil-consuming-sectors-worldwide/>
- Sonnichsen N., (2021, May 5). *U.S. Fossil Fuel consumption by sector*.

<https://www.statista.com/statistics/244429/us-fossil-fuel-energy-consumption-by-sector/>

Soper, K., 2007. Re-thinking the Good Life: The citizenship dimension of consumer disaffection with consumerism. *Journal of Consumer Culture*, 7(2), pp.205-229.

Surg A., (2019, July 1). *Artificial Intelligence in Surgery*.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5995666/>

Venz, R., 2012. Electric Cars as an Issue for the Future. *JOT-International Surface Technology*, 5(2), pp.44-45.

White A., (2021, June 26). *Here Are All the Promises Automakers Have Made about Electric Cars*.

<https://www.caranddriver.com/news/g35562831/ev-plans-automakers-timeline/>

Wiebe, J., 2019. *Driving Market Change: A Multi-Level Perspective on Institutional Disruption and Defense* (Doctoral dissertation, Queen's University (Canada)).

Wilberforce, T., El-Hassan, Z., Khatib, F.N., Al Makky, A., Baroutaji, A., Carton, J.G., and Olabi, A.G., 2017. Developments of electric cars and fuel cell hydrogen electric cars. *International Journal of Hydrogen Energy*, 42(40), pp.25695-25734.

Wilson, L., 2013. Shades of green: electric cars' carbon emissions around the globe.

Zhang, Y.J., Sun, Y.F. and Huang, J., 2018. Energy efficiency, carbon emission performance, and technology gaps: Evidence from CDM project investment. *Energy Policy*, 115, pp.119-130.