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Bachelor Thesis

Ethical and Environmental Issues in Electric Car Manufacturing

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Ethical and Environmental Issues in Electric Car Manufacturing

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Objectives of thesis

This thesis considers questions of ethics, environmental sustainability and social responsibility related to the manufacture and sale of electric cars. Electric cars are frequently presented as a more ethical and environmental alternative to traditional cars, especially because they contribute to reductions in carbon emissions. However, their dependence on rare earth minerals such as lithium and cobalt complicates this picture, raising broader issues about sustainability, environmental degradation and labour exploitation. The thesis will consider these issues in relation to debates in business and environmental ethics, and consider a framework for addressing them. It will investigate attitudes and understandings of these issues among consumers through quantitative research.

Methodology

Develop a literature review covering the core issues in the manufacture and sale of electric cars and the relevant concepts in environmental and business ethics, including corporate sustainability and responsibility. Undertake research into consumer awareness of these issues using quantitative (survey) methods.

The proposed extent of the thesis

40-50 pages

Keywords

Electric Vehicles, Sustainability, Business Ethics, Environmental Ethics, Exploitation

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CASTELVECCHI, Davide. (2021). Electric cars and batteries: how will the world produce enough? Nature 596: 336-339

DESJARDINS, Joseph. (2018). Business, nature, and environmental sustainability. In HEATH, Eugene, KALDIS, Byron and MARCOUX, Alexei (eds.) The Routledge Companion to Business Ethics. London: Routledge, pp. 376-392.

JONES, Sarah J. (2019). If electric cars are the answer, what was the question? British Medical Bulletin 129(1): 13–23

MORIARTY, Jeffrey. (2021). Business Ethics. In ZALTA, Edward N., (ed.) The Stanford Encyclopedia of Philosophy (Fall 2021 Edition). URL = <https://plato.stanford.edu/archives/fall2021/entries/ethics-business/>.

NUNES, Ashley, WOODLEY, Lucas, and ROSSETTI, Philip. (2021). Re-thinking procurement incentives for electric vehicles to achieve net-zero emissions. Nature Sustainability 5: 527–532.

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Declaration

I declare that I have worked on my bachelor thesis titled "Ethical and Environmental Issues in Electric Car Manufacturing " by myself and I have used only the sources mentioned at the end of the thesis. As the author of the bachelor thesis, I declare that the thesis does not break any copyrights.

In Prague on 15.03.2023 ______________________________

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Ethical and Environmental Issues in Electric Car Manufacturing

Abstract

This thesis aims to explore the ethical and environmental concerns inherent in the production of electric cars, which are often promoted as a superior alternative to traditional internal combustion engine (ICE)-equipped vehicles. Despite the touted benefits of electric cars, their production process is fraught with ethical and environmental challenges, and large corporations may attempt to conceal such issues from the public eye. Moreover, consumers frequently overlook the manufacturing process and its associated complexities, potentially enabling businesses to operate with insufficient ethical and environmental considerations. Consequently, organizations may exploit labor and harm the environment in pursuit of profit. To this end, the author investigates the specific ethical and environmental problems related to electric car production. Additionally, the study examines the social and economic implications of producing electric cars, including their impact on labor rights and working conditions during the manufacturing process. The thesis utilizes a systematic literature review of pertinent academic sources, alongside an analysis of industry reports and interviews. In the end, through a quantitative survey, the author tries to conclude the ethical and environmental issues in electric car manufacturing.

Keywords: Electric Vehicles, Sustainability, Business Ethics, Environmental Ethics, Exploitation

Etické a environmentální problémy ve výrobě elektromobilů

Abstrakt

Tato práce si klade za cíl prozkoumat etické a environmentální problémy spojené s výrobou elektromobilů, které jsou často propagovány jako alternativa k tradičním vozidlům vybavených opalovacím motorem (angl. ICE). Navzdory prosazovaným výhodám elektromobilů obsahuje jejich výrobní proces etické a environmentální výzvy a velké korporace se mohou pokusit o odstranění nebo zmírnění těchto problémů. Spotřebitelé navíc přehlížejí výrobní procesy a s nimi související spojitosti, což potenciálně vede podniky k počínání o nedostatečném rozvážení o etických a environmentálních důsledcích. V návaznosti na to mohou organizace zneužívat zaměstnaneckou práci a poškozovat životní prostředí ve snaze o zisk. Z těchto důvodů autor zkoumá specifické etické a environmentální problémy spojené s výrobou elektromobilů. Studie dále zkoumá sociální a ekonomické důsledky výroby elektromobilů, včetně jejich dopadu na pracovní práva a pracovní podmínky během procesu výroby. Práce využívá systematicky přehled literatury akademických zdrojů, spolu s analýzou průmyslových zpráv a rozhovorů. Nakonec se autor prostřednictvím kvantitativního průzkumu snaží shrnout etické a environmentální problémy ve výrobě elektromobilů.

Klíčová slova: Elektrická Vozidla, Udržitelnost, Podnikatelská Etika, Environmentální Etika, Vykořisťování

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List of abbreviations

EV	Electric Vehicle
BEV	Battery Electric Vehicle
HEV	Hybrid Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
FCEV	Fuel Cell Electric Vehicle
ZEV	Zero-Emission Vehicle
OSHA	The Occupational Safety and Health Administration
ICE	Internal Combustion Engine
ATL	Amperex Technology Ltd.
ISI	Systems and Innovation Research
AC	Alternating Current
DC	Direct Current
GM	General Motors
EU	European Union
CO2	Carbon Dioxide

1. Introduction

The author’s main piece of motivation for writing this bachelor thesis lies in his pure passion for cars, which he has shared for almost all his life. Being a passionate driver and a real follower of regular cars and prominent car manufacturers, the author recently found himself entangled in the situation when regular cars and owners of regular cars are being more and more pushed towards electric alternatives. Nevertheless, the author decided to take an insight into the matter and find out if there are any ethical issues related to the production of those cars and if those cars in general are good alternatives to regular cars in terms of the sustainability and negative effect to the environment.

The author, apart from taking an insight into the topic, is also interested in finding out if other people are fully aware of other potential risks and problems that might occur with the utilization and disposal of those cars, which were originally destined to become greener alternative for the sustainable future. Nevertheless, the author will try to find it out whether those electric alternatives are really vehicles of the future that has no ethnical issues related to the production of them and no environmental dangers related to the utilization.

In the conclusion, the author summarizes his findings and focuses on comparing them with the findings of other authors, who will be discussed in the theoretical part of the work. The author, above all, seeks to provide a series of recommendations to subject-matter experts, institutions and ordinary people actively using cars for their daily lives.

2. Objectives and Methodology

2.1 Objectives

This thesis considers questions of ethics, environmental sustainability and social responsibility related to the manufacture and sale of electric cars. Electric cars are frequently presented as a more ethical and environmental alternative to traditional cars, especially because they contribute to reductions in carbon emissions. However, their dependence on rare earth minerals such as lithium and cobalt complicate this picture, raising broader issues about sustainability, environmental degradation, and labor exploitation. The thesis will consider these issues in relation to debates in business and environmental ethics and consider a framework for addressing them. It will investigate attitudes and understandings of these issues among consumers through quantitative research.

2.2 Methodology

Develop a literature review covering the core issues in the manufacture and sale of electric cars and the relevant concepts in environmental and business ethics, including corporate sustainability and responsibility. Undertake research into consumer awareness of these issues using quantitative (survey) methods.

3. Literature Review

3.1 Cars, Engines and Processes

3.1.1 History and Invention of the Wheel

After around 3400 BCE, there is abundant evidence in the form of archaeological artifacts and inscriptions that wheeled vehicles were in use. There was a track found under a barrow mound. It was preserved in Flintbek, which is in northern Germany. It is believed that it could be created by wheels and used as early as 3600 BCE. Nevertheless, the reliability of this piece of evidence is under debate. Yet, about the year 3400 BCE is when the evidence first starts to mount up in a significant way (Anthony, 2007).

The historical period between 3400 and 3000 BCE is represented by a variety of wheeled vehicles in the form of three-dimensional depictions of wagons, as well as wooden wheels and wagon components that have survived from that time. It should be mentioned that the appearance of these four distinct pieces of evidence occurred everywhere throughout the ancient world between 3400 and 3000 BCE, which is around the same period as the domestication of wool sheep, and they unmistakably demonstrate when wheeled vehicles first became prevalent (Anthony, 2007).

The development of road networks and the taming of horses were critical factors in the widespread use of the wheel. In the beginning, people were taming horses for their meat. They supplied low-cost winter meat and could feed themselves during the steppe winter since they did not require many sources to provide compared to cattle and sheep. When horses were tamed and a lineage of placid males was created, someone rode a servile horse. This happened after horses were domesticated. Riding once managed herds of domesticated horses, sheep, and cattle. It made it possible for fewer people to manage larger packs, so the process was more efficient eventually. It was essential for a society in which domesticated animals served as the primary source of food and (Anthony, 2007).

3.1.2 Innovations and Invention of the First Motor Vehicle

Karl Benz brought huge value to modern car production. He received his patent for the Motorwagen, often known as the three-wheeled Motor Car, in the year of 1886. Since Benz was the first person to construct a vehicle that could be considered a truly the modern

Figure 1, The First Automobile

Source: Mercedes-Benz USA, 2023

automobile, he is typically given credit for inventing the vehicle. Other automobile-related technologies, such as a throttle system, water radiator, carburetor, and many others, were patented by Benz. Later, Benz established an automobile enterprise, which evolved into what is now known as the Daimler Group (Cox, 2022).

3.1.3 Numbers and Statistics

According to Eurostat, the most common form of transportation within the European Union is the car (Passenger mobility statistics, 2022). In Europe, the total number of automobiles in use in the year 2020 was roughly 405 million. This number includes cars, vans, trucks, and buses (Vehicles in use, Europe 2022, 2022). In comparison, United States accounts for almost 276 million vehicles (Number of motor vehicles registered in the United States from 1990 to 2020, 2022). Cars are the second most widely traded product in the world. Germany ($123 Billion), Japan ($83.1 Billion), the United States ($47.6 Billion), Mexico ($41.6 Billion), and South Korea ($36.9 Billion) were the top five exporters of automobiles in the year 2020. The United States ($144 Billion), Germany ($68.9 Billion), China ($42 Billion), France ($35.5 Billion), and the United Kingdom ($32.8 Billion) were the top five importers of automobiles in 2020 (Cars, n.d.).

3.1.4 How are Modern Cars Manufactured: The Process

A wide variety of unprocessed components must be assembled to construct an automobile from scratch. A lot of car manufacturing companies are on the lookout for materials that are not only inexpensive but also lightweight to satisfy the ever-increasing consumer demand for products that are more favorable to the environment. Design and engineering are the second part of car manufacturing. When designing a car, it is imperative to consider the preferences and prerequisites of the typical consumer. The design will go through many iterations before finally reaching its full potential. A car's interior and exterior design need to be appealing to prospective customers, and they must also incorporate innovative technology that renders a vehicle newsworthy and competitive concerning to other brands. It is planned to construct tiny models in two-dimensional and three-dimensional space to evaluate the car's design. Engineers will perform whatever type of testing has to be done, including those related to safety, fuel efficiency, and cost. After the design and engineering parameters have been approved, the manufacturing process can begin. Consequently, after the previous operations have met all the requirements, the company manufactures the car. Robotic machines stamp bodywork sheet metal. The car's side frames, doors, hoods, and roofs comprise these parts. As soon as the car's frame and individual components are complete, it will be put into production. As the vehicle progresses down the assembly line, it will be serviced by humans and robotics. Workers will affix car parts and may use robots in the process. Robots would perform welding, soldering, screwing, and gluing. Detailing takes place after the body of the car has been put together. This includes sanitizing, applying paint, and layering chemical formulas. The car's engine, transmission, axles, and exhaust are all now in place, and the tires are the last thing to be mounted. Testing and quality assurance are among the most important parts that will show if the vehicle is adequately made. It will now undergo a quality and safety check. The car is inspected for both internal and external problems. Multiple times the engine is started and shut down, the steering alignment is rectified, the brightness and reach of the headlights are examined, and so forth. For leaks, the car will be subjected to a pressure test. To ensure safety and accessibility, the programming and the electrics will be examined in detail. Cargo handling and airbag and seatbelt functionality will be discussed during final crash testing. The car can be sold if its design and manufacturing are sound. Finally, the vehicle is ready for its launch. Following the completion of market research, the development of an advertising strategy, and the determination of a reasonable retail price, the production of the car that dealerships and private dealers will sell will get underway (Step-by-Step Process of Manufacturing a Car, 2020).

3.1.5 European Emission Standards

Since 2009, stringent carbon dioxide (CO2) regulations have been imposed on new passenger vehicles in the European Union (EU). While these regulations have been strict, some car manufacturers were granted a more lenient CO2 emission allowance due to certain factors. Nonetheless, there appears to be a correlation between a manufacturer's average vehicle weight and the maximum allowable CO2 level for their vehicles to be sold in the market (Mock, 2019). "As the new target started applying in 2020, the average CO2 emissions from new passenger cars registered in Europe have decreased by 12% compared t the previous year and the share of electric cars tripled" (CO_2 emission performance standards for cars and vans, n.d.). The following table provides a concise overview of EU emission requirements. We can observe that from 1996 to 2005, in almost 10 years period, the amount of CO2 emissions halved.

Table 1, EU Emission Standards for Passenger Cars (Category M1*)

Stage	Date	CO	HC	HC+NOx	NOx	PM	PN
		g/km					*#/km*
Positive Ignition (Gasoline)							
Euro 1†	1992.07	2.72 (3.16)	-	0.97 (1.13)	-	-	-
Euro 2	1996.01	2.2	-	0.5	-	-	-
Euro 3	2000.01	2.30	0.20	-	0.15	-	-
Euro 4	2005.01	1.0	0.10	-	0.08	-	-
Euro 5	2009.09[b]	1.0	0.10[d]	-	0.06	0.005[e,f]	-
Euro 6	2014.09	1.0	0.10[d]	-	0.06	0.005[e,f]	6.0×10^{11} [e,g]
Compression Ignition (Diesel)							
Euro 1†	1992.07	2.72 (3.16)	-	0.97 (1.13)	-	0.14 (0.18)	-
Euro 2, IDI	1996.01	1.0	-	0.7	-	0.08	-
Euro 2, DI	1996.01[a]	1.0	-	0.9	-	0.10	-
Euro 3	2000.01	0.64	-	0.56	0.50	0.05	-
Euro 4	2005.01	0.50	-	0.30	0.25	0.025	-
Euro 5a	2009.09[b]	0.50	-	0.23	0.18	0.005[f]	-
Euro 5b	2011.09[c]	0.50	-	0.23	0.18	0.005[f]	6.0×10^{11}
Euro 6	2014.09	0.50	-	0.17	0.08	0.005[f]	6.0×10^{11}

* At the Euro 1..4 stages, passenger vehicles > 2,500 kg were type approved as Category N_1 vehicles
† Values in brackets are conformity of production (COP) limits
a. until 1999.09.30 (after that date DI engines must meet the IDI limits)
b. 2011.01 for all models
c. 2013.01 for all models
d. and NMHC = 0.068 g/km
e. applicable only to vehicles using DI engines
f. 0.0045 g/km using the PMP measurement procedure
g. 6.0×10^{12} 1/km within first three years from Euro 6 effective dates

Source: Dieselnet, 2022

3.1.6 The Nature of Electric Cars

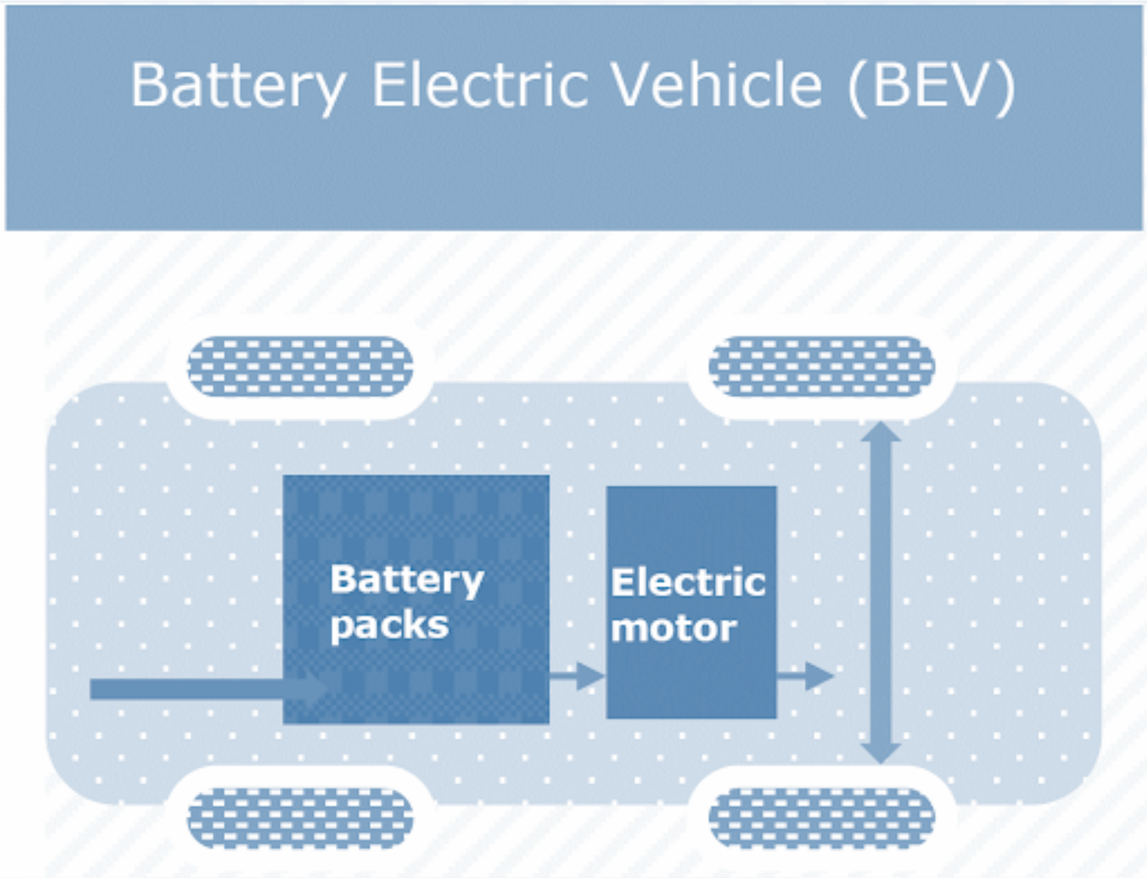
The manufacture of electric vehicles employs almost all the procedures described above; however, there is one significant difference between these techniques: the engine. Batteries powered by lithium-ion are typically utilized in electric cars rather than the more common internal combustion engines. Manufacturing these batteries, on the other hand, is a time-consuming process that is often far more challenging than manufacturing regular internal combustion engines, which companies have been making for decades.

Around the middle of the 19th century, electric vehicles became available for purchase, but the introduction of Henry Ford's Model T led to a significant decline in their level of popularity (Matulka, 2014). There were 6.5 million sales of electric vehicles globally in 2021. This figure reflects an increase of 109 percent over the year 2020 and covers fully electric as well as Plug-in Hybrid Vehicles (Clifford, 2022). As we can see, there is a rise in interest in electric vehicles when there is a scarcity of gas. The desire for alternative fuel cars was arguably limited by factors such as low cost of gasoline, its availability, and the ongoing development of improvements to the internal combustion engine, which lead to less fuel consumption.

3.1.7 Types of EVs and Principles of Their Work

It is crucial to understand the difference between EVs, so we would know how they use the batteries and their efficiency. EV is not just one simple car equipped with an electric battery; it has several types. For example, the first type is Battery Electric Vehicle (BEV): A vehicle completely powered by electricity. Compared to Hybrid and Plug-in Hybrid Vehicles, these have the better fuel economy. The second type is Hybrid Electric Vehicle, which is divided into Hybrid Electric Vehicle (HEV) and Plug-in Hybrid Electric Vehicle (PHEV). The powertrain of the first type, a hybrid electric vehicle, often known as an HEV, is comprised of both an internal combustion engine (typically one that runs on gasoline) and a motor driven by batteries. When the battery is depleted, the gasoline engine propels the vehicle and charges it. Unfortunately, these automobiles do not offer the same level of fuel economy as fully electric or Plug-in Hybrid Vehicles. The second one takes advantage of the first type (HEV) because of its nature. A Plug-In Hybrid Electric Vehicle, often known as a PHEV, combines the benefits of two different types of vehicles into one: an internal combustion engine and a battery that can be charged by plugging into the socket. It allows the car’s battery to be charged with electricity, without interacting with the engine. Regarding energy efficiency, PHEVs rank higher than HEVs but lower than BEVs. The final one is Fuel Cell Electric Car (FCEV). It turns chemical energy into electrical energy so that the vehicle may generate power. An example is a fuel cell electric vehicle (FCEV) fueled by hydrogen (Types of Electric Vehicles, n.d.).

Figure 2, System Architecture of Battery Electric Vehicle (BEV)

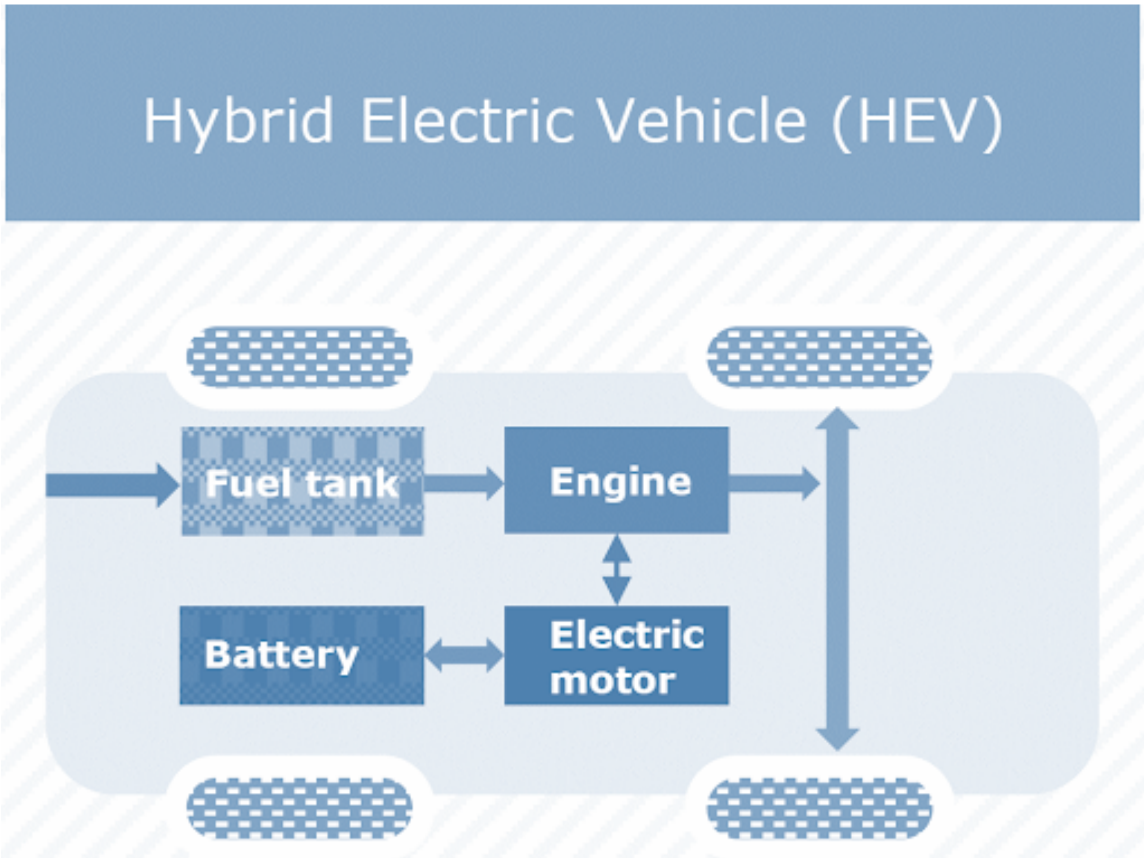


Source: E-Amrit, 2023

Battery Electric Vehicles (also known as BEVs) are sometimes called All-Electric Vehicles (also abbreviated as AEVs). Batteries are the sole power source for electric vehicles based on battery electric vehicles (BEVs), which obtain their power from an electric engine. Getting the enormous battery pack housed within the car back up to its total capacity is feasible. This battery pack holds the necessary power for the vehicle to function on the road. The motors of an electric vehicle receive their power from the charged electric batteries contained within the vehicle's battery. The converted direct current (DC) power powers the electric motor from the battery, which is AC. Every time the accelerator button is pressed, the controller receives a signal. Altering the frequency of the alternating current (AC) that flows from the inverter to the motor enables the controller to adjust the vehicle's speed without physically interacting with it. As a result, a gear connects the engine to the wheels, which ultimately makes the wheels rotate. The engine functions as an alternator when the brakes of an electric car are applied, or the vehicle is slowing down. The process is depicted in Figure 2 (Types of Electric Vehicles, n.d.).

A hybrid electric vehicle may also be referred to as a series hybrid or even a parallel hybrid. These are only two of the many names for hybrids. Hybrid electric vehicles (HEVs) have a combination of an internal combustion engine (ICE) and an electric motor, and in this

Figure 3, System Architecture of Hybrid Electric Vehicle (HEV)



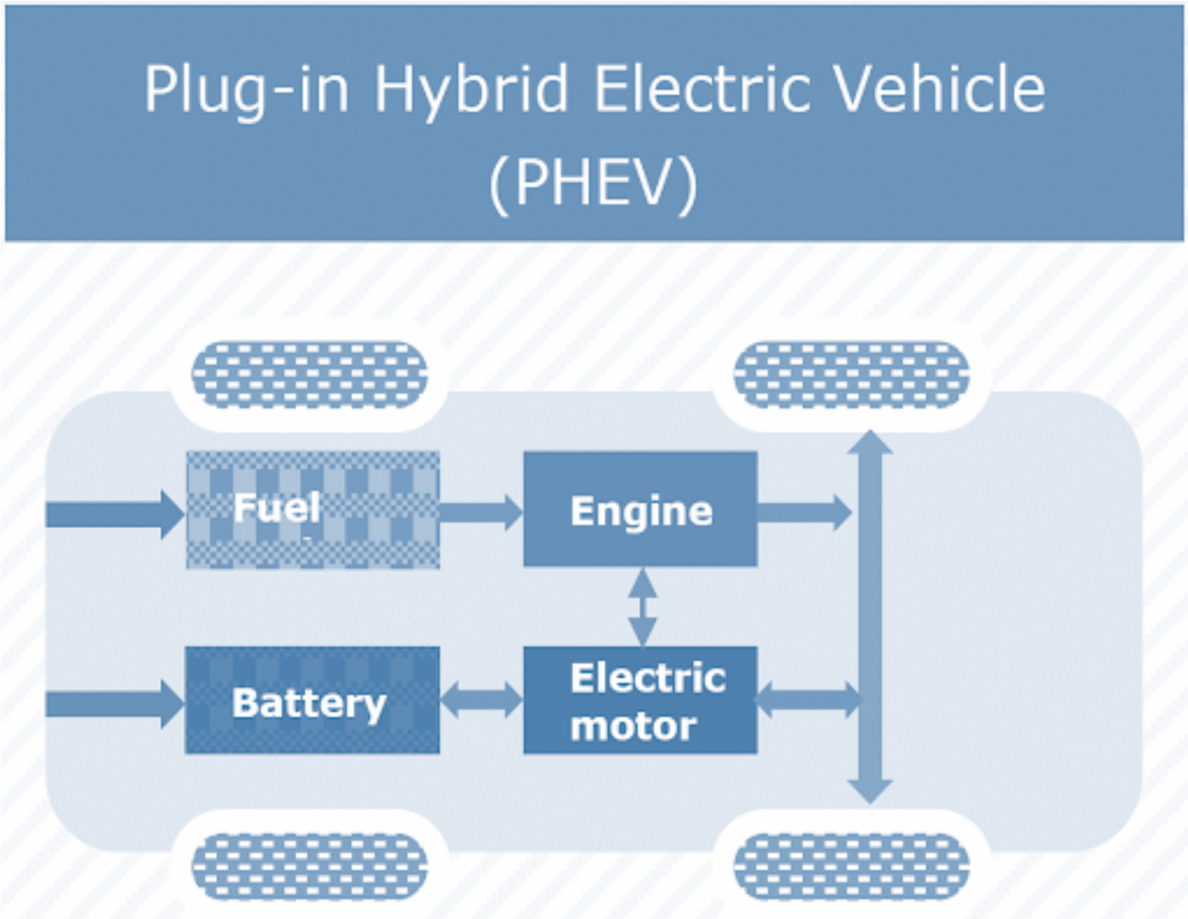
Source: E-Amrit, 2023

system, gasoline supplies the power to the engine, while the ability for the motor is provided by the batteries. In addition to being driven by the internal combustion engine of the vehicle, the gearbox of this vehicle is additionally powered by an electric motor and as a result it is making the car to go. In the same manner as a typical car, the fuel tank supplies the engine with the energy it requires to run. The power coming from the batteries is provided by an electric motor. The internal combustion engine and an electric motor have the potential to turn the gearbox in combination with one another. The process is depicted in Figure 3 (Types of Electric Vehicles, n.d.).

In certain contexts, Plug-in Hybrid Electric Vehicles (PHEVs) may also be referred to as series hybrids. In addition to the motor that was there before, there is also an engine that has already been placed there. Either regular fuel, such as gasoline, or another type of fuel, such as biodiesel, may be used in the engine of the vehicle.

Moreover, it can source the energy from its battery pack. The point is that the battery in this type of vehicles can be externally charged. When starting-up a PHEV, they function in an

Figure 4, System Architecture of Plug-in Hybrid Electric Vehicle (PHEV)

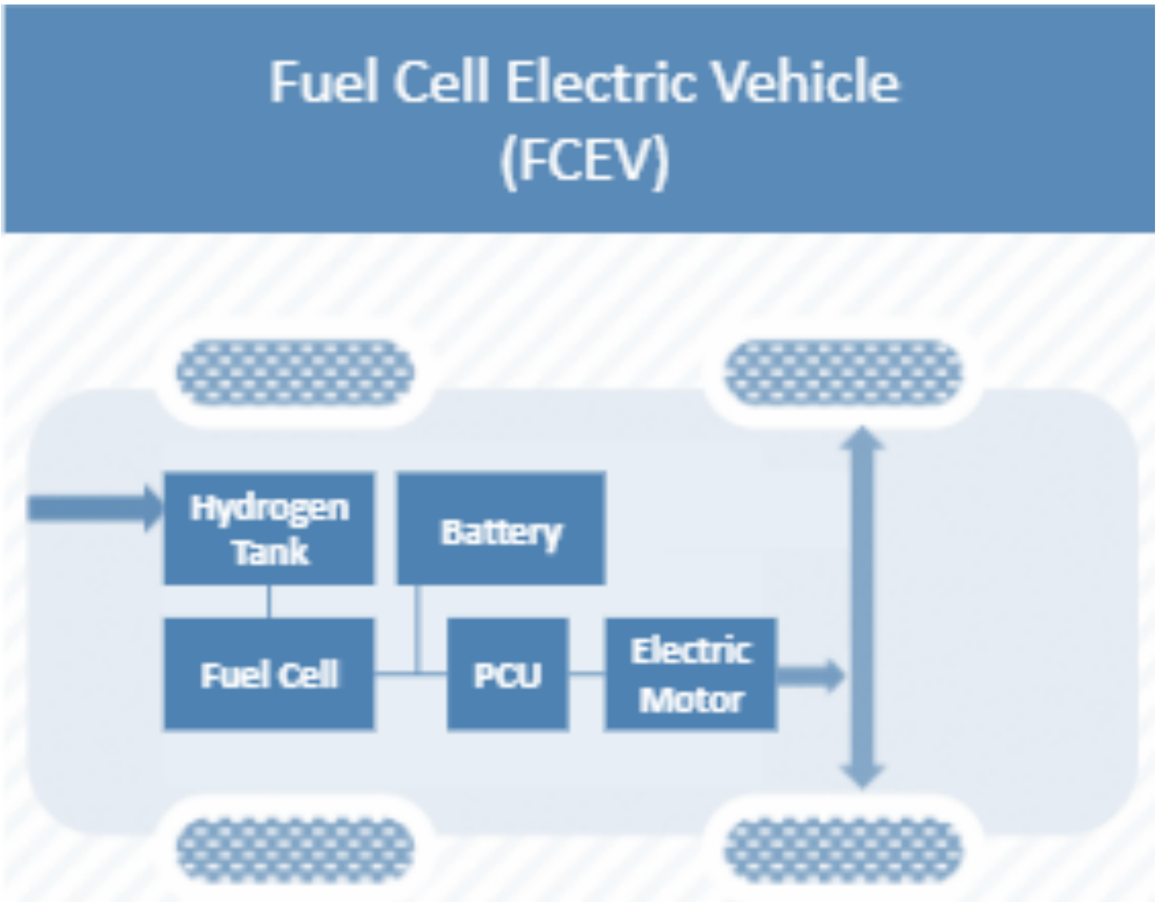


Source: E-Amrit, 2023

all-electric mode and continue to make use of electricity all the way up until the point where their battery is dead. The vehicle reverts to working as a conventional hybrid, which does not require the usage of an additional plug-in source right after the battery has been used up entirely. Regenerative braking or usage of an external power source can charge the batteries of Plug-in Hybrid Electric Vehicles, often known as PHEVs. The electric motor changes into a generator when the brake pedal is pressed and then stores the energy that it draws from the system in the battery. Smaller engines can be utilized and lead to an improvement in the vehicle's fuel efficiency without resulting in a drop in the performance of the vehicle, since the power of engine adds up to the electric motor's power. The process is depicted in Figure 4 (Types of Electric Vehicles, n.d.).

The abbreviation ZEV, which stands for Zero-Emission Vehicles, is another name for fuel cell electric vehicles (FCEVs). To supply the car with power, they make use of a method that is commonly referred to as "fuel cell technology" and that is the type of system when the chemical energy that is stored in the fuel is immediately harnessed to power the generators that produce electricity. The fuel cell electric vehicle (FCEV) is capable of self-generation of the electricity needed to power the vehicle. The process is depicted in figure 5 (Types of Electric Vehicles, n.d.).

Figure 5, System Architecture of Fuel Cell Electric Vehicle (FCEV)



Source: E-Amrit, 2023

3.1.8 Batteries

What is the most common thing between all types of electric cars? The answer is the battery. The battery is one of the most critical components of the electric vehicle. It is basically what makes the electric car an electric car. When it comes to batteries that are used in electric vehicles, lithium-ion cells are the best choice in terms of mobility while also being extremely long-lasting. In 1991, the lithium-ion battery was introduced to the public for the first time (Muslimin, Nawawi, Suprapto, & Dewi, 2022). Many changes were taking place in the battery business as a direct result of the high specific energy of these batteries (120-250 Wh/kg) and the high energy density of these batteries (about 600 Wh/L). According to Bruno Scrosati and Jürgen Garche, we must significantly increase our reliance on renewable energy sources because of the critical need for immediate energy renewal. Replacement of internal combustion engine (ICE) powered vehicles with ideally zero-emission vehicles, such as electric vehicles (EVs) or controlled emission vehicles, such as full hybrid electric vehicles (HEVs) and plug-in electric vehicles (PHEVs), may be the only solution to the CO2 problem and the resulting air pollution in large urban areas (Scrosati & Garche, 2010). As a direct consequence of this trend, lithium-ion batteries are now found in a growing number of electric cars. The cycle life of lithium-ion batteries is astonishingly long, and in addition to this, the batteries' total energy capacity and efficiency are high. All these benefits need to speak for themselves (Muslimin, Nawawi, Suprapto, & Dewi, 2022).

"Despite the developments in cell chemistry, the proportion of lithium by weight in each cell of around 72 g/kg is not likely to reduce noticeably during this period, according to estimates by the Fraunhofer Institute for Systems and Innovation Research (ISI). However, the proportion of cobalt could fall significantly from 200 g/kg of cell weight to around 60 g/kg. Therefore, the demand for primary raw materials for vehicle battery production by 2030 should amount to between 250,000 and 450,000 t of lithium, between 250,000 and 420,000 t of cobalt and between 1.3 and 2.4 million t of nickel" (Backhaus, 2021).

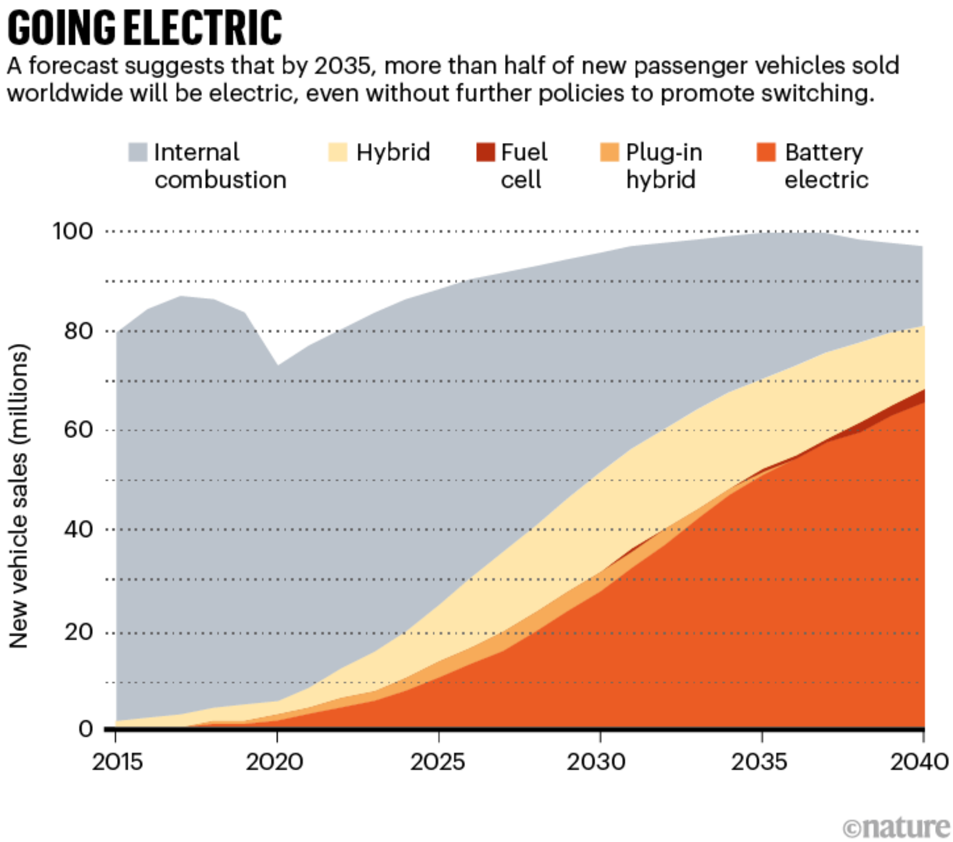
3.1.9 What is the plan and what are the challenges?

In 2020, there were an estimated amount of 10 million vehicles on the roads, which is 3 million cars more when compared to 2019. China has the highest number of EVs on its route, with over 5 million vehicles, making it the absolute leader. The USA has the second highest EV amount with 1.77 million cars, followed by Germany with 570,000 electric vehicles. In the year 2020, the number of electric cars that were newly registered reached a record level of 3.18 million. After 2030, they may account for between 25 and 75 percent of newly registered vehicles. Because of this, the annual demand for the power supplied by batteries is expected to be between 1 and 6 TWh (Backhaus, 2021).

To keep up with the rising demand for electric vehicles, manufacturers will have to source more rare and exotic materials to utilize in their vehicles' batteries. Graphite, cobalt, lithium, manganese, and nickel will be the major minerals needed to create lithium-ion batteries, which are predicted to become the standard solution for electric vehicles within the next decade (Backhaus, 2021).

Within the next ten years, governments in some countries, mainly those in western Europe, have stated their intent to make it illegal to sell new automobiles fueled by an internal combustion engine. From 2035 onward, the European Union plans to de facto prohibit the sale of brand-new gasoline and diesel automobiles, including hybrids. The year 2030 will mark the beginning of the prohibition on cars powered only by internal combustion, while 2035 will mark the beginning of the ban on hybrid vehicles. The restrictions on gas in Norway and South Korea won't take effect until 2025. Moreover, Belgium and Austria won't impose theirs until 2026 and 2027, respectively. In the United States, Washington has set the year 2027 as its objective, while California and New York have set their bans for 2030 as their aim. It is not expected that by the year 2040 or 2050, other states in the United States will prohibit the sale of internal combustion engine vehicles (Charlton, 2022).

Figure 6, Global Forecast of Vehicle Sales



Source: Nature, 2021

Even if there are no additional laws that are passed to encourage people to make the changeover, a prediction estimates that by the year 2035, more than half of all new passenger vehicles that are sold throughout the world will be electric (Castelvecchi, 2021).

3.2 Electric Car Manufacturing: Ethical Issues

3.2.1 Business Ethics

It is not uncommon for people who are experts in specific fields to be referred to as "professionals" in their industries. As a direct consequence of this fact, individuals are obligated to behave following the standards that are stipulated by professional organizations. There is a significant increase in the number of companies that have ethics and compliance departments. These departments oversee the creation and implementation of all-encompassing codes of conduct. The study of professional practices, specifically the content, formation, enforcement, and implementation of codes of conduct intended to control the behaviors of those participating in business activity, is one definition of commercial ethics. Another definition of commercial ethics is the study of professional practices. Business ethics are useful tactics that strive to repair society's ethical issues or inadequacies that firms or civic leaders have overlooked. These worries or deficiencies might arise from the fact that business ethics have been ignored. These issues have been disregarded because the ethics of business have not been given sufficient importance. Currently, there is a lot of debate taking on regarding the role that corporations need to play within the context of larger parts of society. It is possible for managers to make use of norms as a tool to accomplish social outcomes and to strike a balance between the conflicting interests of a range of stakeholders. The preexisting norms and concerns of society must operate as a regulatory framework for the acts of management (Moriarty, 2021).

Prior to dealing with ethical issues that may occur in your firm, you must have a full awareness of the many ways in which they can appear. When you have a good grasp of how to spot and discourage these issues, it is simpler to focus on your organization's development and success rather than its maintenance. An important issue is a health and safety in the workplace. The following is a list of the top ten regulations that were most often cited by OSHA inspectors during recent federal OSHA inspections. This list was compiled in response to recent inspections that were carried out by OSHA. The Occupational Safety and Health Administration (OSHA) is responsible for publishing a list of regulations that are often cited. This allows firms to take precautions to identify and eliminate recognized dangers before OSHA inspectors arrive on the scene:

1. Fall Protection, construction
2. Respiratory Protection, general industry
3. Ladders, construction
4. Hazard Communication, general industry
5. Scaffolding, construction
6. Fall Protection Training, construction
7. Control of Hazardous Energy (lockout/tagout), general industry
8. Eye and Face Protection, construction
9. Powered Industrial Trucks, general industry

10. Machinery and Machine Guarding, general industry (Top 10 Most Frequently Cited Standards, 2021).

The compliance with these top 10 criteria is linked to a much larger number of preventable occupational illnesses, injuries, and deaths than the compliance with any other group of standards (Top 10 Most Frequently Cited Standards, 2021).

If you place a high value on your reputation, you will do all in your ability to steer clear of engaging in the behavior and understand the importance of keeping in mind the standards for health and safety in the workplace that were recently reviewed. Businesses face an overwhelming number of other ethical issues, including but not limited to discrimination, harassment, unethical accounting, abuse of leadership authority, nepotism and favoritism, privacy, and corporate espionage. It is a widespread practice in the world of business for companies to operate as if ethical considerations do not occur, even though this behavior is unethical. Frequent gag orders are among the additional procedures that are used to ensure that employees do not speak out about anything that is going on (Holton, 2020).

3.2.2 Unethical Behavior in Vehicle Manufacturing Companies

Having discussed business ethics, it should be mentioned that some companies violate ethical rules. As it was mentioned before, experts want to be called “professionals” in the field of their interest. Therefore, we can assume, that big companies should also behave and take responsibility for everything they do. Sometimes greediness prevails over humanity and can make people forget about morals and ethics.

Figure 7, BTR Logo

Source: BTR China, 2023

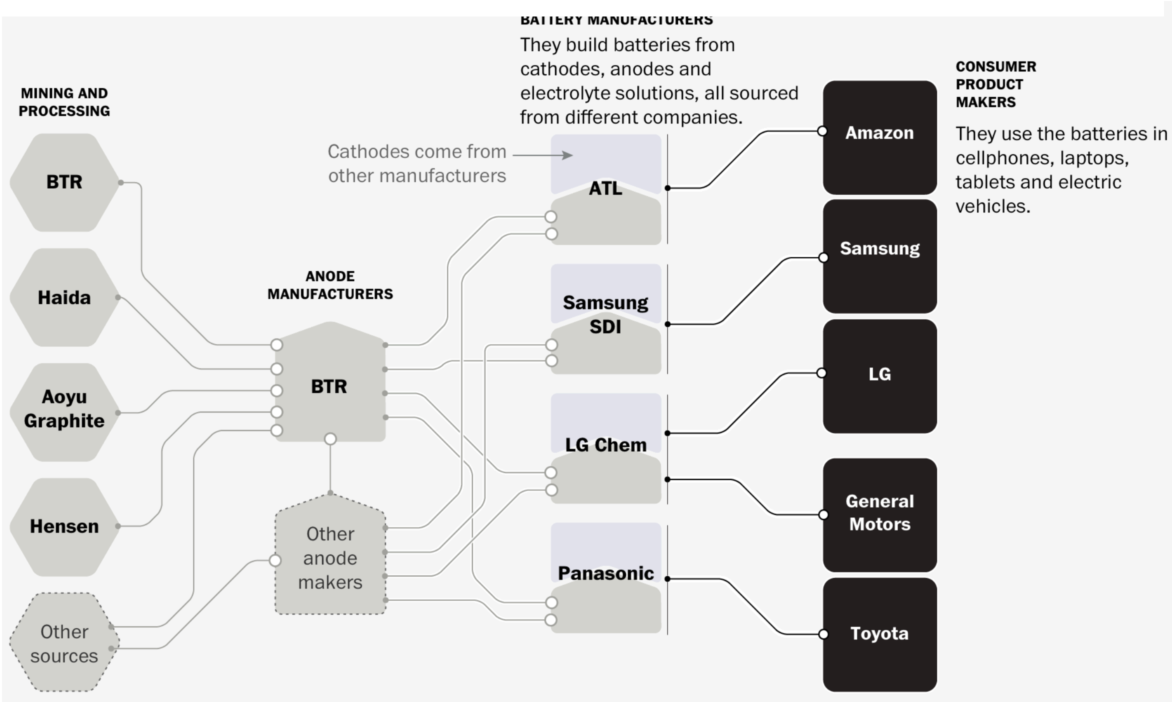
“At five towns in two provinces of China, Washington Post journalists heard the same story from villagers living near graphite companies: sparkling night air, damaged crops, homes and belongings covered in soot, polluted drinking water — and government officials inclined to look the other way to benefit a major employer” (Whoriskey, 2016).

Samsung SDI, LG Chem, and Panasonic, three of the world’s leading makers of lithium-ion batteries, get most China’s graphite exports. To name just a few examples, these businesses manufacture batteries for use in anything from portable electronic gadgets like smartphones and laptops to vehicles as huge as electric automobiles. Samsung, LG, General Motors (GM), and Toyota are just a few of the corporations that rely significantly on these battery makers to supply their goods with reliable batteries. The need for high-performance batteries is on the rise due to the increasing popularity of electric vehicles and renewable energy storage systems. Because of this, competition has been fierce among battery makers to find stable supplies of graphite and other essential elements (Whoriskey, 2016).

One good example is Toyota. When Toyota’s spokesman did not provide any answer about their graphite supplies and said that Toyota does not make direct purchases. He also stated “we make efforts to minimize the impact of our procurement activities on local communities… We will ask our suppliers to take actions to avoid using certain materials if there is a concern about the source” (Whoriskey, 2016).

Besides this, Toyota had made a statement regarding its lithium sources as well, which was quite like the one about graphite. “Toyota said in a statement that it does not buy lithium directly but tries to minimize the suppliers’ impact on local communities, “and we will ask our suppliers to take actions to avoid using certain materials if there is a concern about the source" (Frankel & Whoriskey, 2016).

Figure 8, Tracing Your Battery's Graphite



Source: Washington Post, 2016

Additionally, batteries from Samsung SDI and LG Chem are used in Apple devices. However, Apple spokesperson Fred Sainz noted that the business no longer uses mined graphite in its current products and instead uses synthetic graphite and the firm refused to comment on when it switched to using just synthetic graphite. (Whoriskey, 2016). The supply chain of the lithium-ion battery industry is depicted in figure 8.

Despite being asked multiple times, many businesses have been evasive about where they get their graphite from. As an example, Panasonic is the maker of the batteries that are used in electric vehicles produced by Tesla, which is perhaps the best-known electric vehicle company indeed, Tesla claims their batteries never contained graphite from the BTR, yet the corporation still won't say where they get their graphite from as well as BTR which denied the allegations in this matter (Whoriskey, 2016).

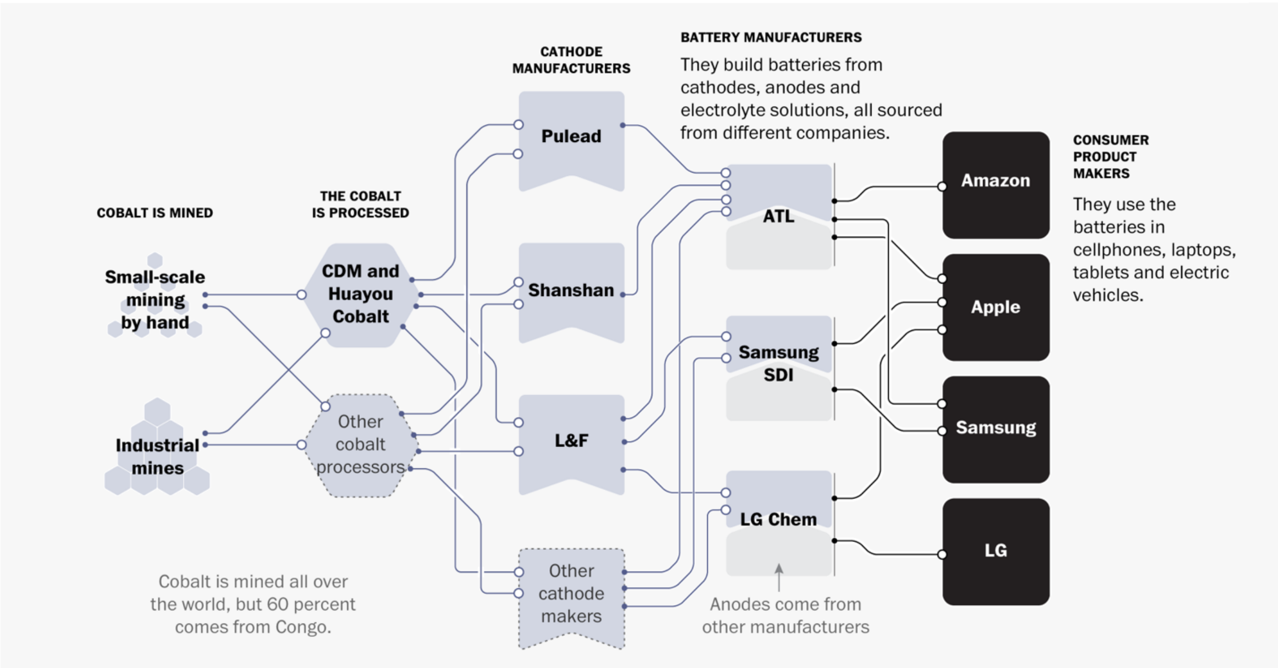
"Most Tesla models use batteries from Panasonic, which buys cobalt from Southeast Asia and Congo. Replacement batteries for Tesla are manufactured by LG Chem. Tesla told

The Post it knows LG Chem's Tesla batteries do not contain Congolese cobalt, but it did not say how it knows this" (Frankel, 2016).

"These companies — which also buy refined minerals from other companies — make the cobalt-rich battery cathodes that play a critical role in lithium-ion batteries. These cathodes are sold to battery makers, including companies such as Amperex Technology Ltd. (ATL), Samsung SDI and LG Chem" (Frankel, 2016). Later in the paragraph about ethical issues the author will be talking about "artisanal" miners and the way they are mining cobalt, and it will grasp more clarity regarding this issue. In figure 10 we can observe the sourcing system of each company.

The scariest thing is that people who live in the areas that are most directly affected by pollution are the ones who know the most about the factors that contribute to it; despite this, they are often unwilling to protest openly, particularly in China (Whoriskey, 2016).

Figure 9, Tracing Your Battery's Cobalt



Source: Washington Post, 2016

3.2.3 Promotion of EVs

People working for Greenpeace believe, that EVs are the future. If we prioritize the use of renewable energy for public transportation and rapidly eliminate diesel and gasoline automobiles (Reid, 2019). This is a big part of ethical issues in EV production.

If we look at the pictures in figures 11 and 12, we can see the huge difference from Figure 10. In figure 10, we can see two female activists wearing clean jackets and peacefully protesting, while in figure 11 there is a person who works at the Jin Yang

Figure 10, Activists From Germany, Poland, Belgium, and Greenpeace Luxembourg Peacefully Demonstrated Outside a Meeting of EU Transport Ministers in Luxembourg

Source: Greenpeace, 2019

graphite factory in China, who is also fully covered with the mineral and in figure 12 there is a man that is pushing a bicycle laden with charcoal used for cooking and heating. This is what activists should remember when protesting.

People sometimes forget about the prices that must be paid for prevention of climate change. When seeing smoke from diesel vehicle pipes, the first thing they should understand is that the reason could be the engine malfunction and not thinking that the engine works that way and extremely pollutes the environment as a default. Still, not seeing exhaust pipes at all seems to be “greener”, since there are no emissions and no smoke, but we should bear in mind the consequences of batteries that electric cars have and how bad is their influence

Figure 11, A Worker at the Jin Yang Graphite Factory in Mashan

Source: Washington Post, 2016

in the long term. At this point, people should rather consider responsible use of vehicles, which will be spoken about later.

Activists in Europe fight for clean air. Greenpeace activists believe, that one of the most effective ways to improve air quality can be achieved with the help of governments. They believe that the law gives governments the authority to oblige automobile manufacturers to

Figure 12, A Man Pushes a Bicycle Laden with Charcoal, which is used for Cooking and Heating, Past Musompo, a Mineral Market Outside Kolwezi

Source: Washington Post, 2016

meet a certain target to produce electric vehicles (EVs) or to forbid the further distribution of gasoline-powered and diesel-powered vehicles in the foreseeable future (Reid, 2019).

3.2.4 Child Labor

In common usage, “child labor” refers to activities that are detrimental to a kid’s physical and mental growth as well as their ability to enjoy their childhood in peace and with respect for their own potential and worth (Worst Forms of Child Labour Convention, 1999). The Fair Labor Standards Act of 1938 established minimum ages in the United States as follows: 14 for nonmanufacturing work outside of school hours; 16 for school-day jobs in interstate commerce; and 18 for positions considered hazardous (Britannica, 2022). Still, the concept of child labor lacks a single, agreed-upon definition. Its definition differs from country to country, legal system to legal system, and industry to industry. When there is no globally agreed-upon minimum age for child labor, it is more difficult to assess the situation (Momen, 2020). Developing countries have this issue in a more serious way. Millions of children, some even 7 years old, work in places such as quarries, mines, factories, farms, and service companies. Middle East is accountable for 10 percent of children in the workforce, while Latin America and some areas of Asia have from 2 to 10 percent children of in their overall workforce. Their employment or the conditions under which labor is conducted are governed by very few laws if any at all. The widespread poverty among families and the dearth of educational opportunities makes it impossible to effectively implement restrictive regulations (Britannica, 2022).

3.2.5 Labor Exploitation, Cobalt, and Congo

The copper belt of the Democratic Republic of the Congo, which is situated in the southeastern portions of the nation, is the location of more than 60 percent of the world's cobalt mines. The rest of production comes from industrial mines, the most majority of which are owned and operated by international firms, mainly those located in China (Melville, 2020). According to representatives of the DRC government, these so-called "artisanal" miners are responsible for the production of 20 percent of the cobalt that is sold from the country and presumably the number could be even higher. It is known that the price of cobalt produced by "artisanal" mines is relatively smaller when compared to industrial mines and the reason behind it could be the salaries that are paid. Moreover, the demand is increasing rapidly, and resourcing locations are spreading in the country (Dummett, 2017). The "artisanal" miners in Congo, who are already living in abject poverty and don't have access to modern mining equipment like pneumatic drills or diesel draglines, are subjected to the harshest working circumstances. This army is a major player in the cobalt trade. Even while industrial mines account for most of the Congo's cobalt output, "artisanal" miners are nonetheless responsible for a disproportionate share of the country's total production (Frankel, 2016).

"Working with a Congolese NGO, Afrewatch, Amnesty International found children as young as seven in the mining areas. None of the adult or child miners we saw wore facemasks that could prevent them from inhaling cobalt dust, which could lead to potentially fatal lung disease. Mines collapse frequently, burying people underground" (Dummett, 2017).

"The world's soaring demand for cobalt is at times met by workers, including children, who labor in harsh and dangerous conditions. An estimated 100,000 cobalt miners in Congo use hand tools to dig hundreds of feet underground with little oversight and few safety measures, according to workers, government officials and evidence found by The Washington Post during visits to remote mines" (Frankel, The Cobalt Pipeline, 2016).

Figure 13, A Boy carries a Bag used to transport Cobalt-Laden Dirt and Rock at the Musompo Market

Source: Washington Post, 2016

In an interview, the provincial governor of Kolwezi, Richard Muyej, who holds the highest government position in the city, stated that “It is true, there are children in these mines.” In addition, he also admitted that there were issues with mortality and pollution caused by mining. (Frankel, 2016). Muyej also stated “We are challenged by the paradox of having so many resource riches, but the population is very poor” (Frankel, 2016).

The issue of child labor is one that is acknowledged by both government authorities and workers, yet it is nonetheless frowned upon. In contravention of Congo’s mining legislation, children are used in a variety of cobalt-related industries, including not just the mines themselves but also the supply and distribution networks (Frankel, 2016).

Women and girls, who are traditionally discouraged from mining, frequently accept the toughest occupations, such as digging in the rain or heat, transporting, sorting, or hauling water for less money or prestige than their male coworkers, often while also still having to provide children and adhere to home rules. Women and girls, as young as 12 years old, are often forced to work as prostitutes and sex workers to support the mining towns, or they are trapped in harsh, polygamous marriages. Furthermore, they face the persistent dangers of theft, assault, and abuse in mining camps (Sovacool, 2021).

Children who were employed in the mines were interviewed by the researchers. The children shared their stories of hardship, highlighting the difficult conditions they were expected to work in. They said they worked in the mines for up to 12 hours a day, carrying heavy objects, and were only paid between $1 and $2 daily. It's important to note that there were kids who worked 10–12 hours on weekends and vacations despite also attending school full-time. Several of the kids had to labor there throughout the school year because they weren't attending classes. Paul, who is 14 years old, started his job when he was just 12 years old, and he has been working in the shadows ever since. His statement to the scientists was that he would regularly "spend 24 hours down in the tunnels. I arrived in the morning and would leave the following morning" (2016).

By purchasing many Congolese mines, China has effectively dominated the global cobalt trading market, since most of the purchasing houses that purchase cobalt from child slaves in the Congo and then sell it to large organizations and consumer electronic businesses are owned by Chinese corporations (Melville, 2020). As it was mentioned before, "artisanal" miners have no equipment and do not officially work for any company. Their global supply chain starts in a small marketplace called Musompo, located in Kolwezi. Close to seventy of these stores, that are known as "comptoirs", line the road leading to the border. Maison Saha, Depot Grand Tony, and Depot Sarah are just a few of the shop names sprayed onto the walls. The current price of cobalt and copper may be found inscribed on a chalkboard outside of each store. Metorex is the name of a machine that is used to identify mineral content and looks like a radar gun. Most miners think that they cannot trust such equipment. According to the statements of one of the miners, the material that they mine is first sold to the Chinese, and then it is sold to CDM (Frankel, 2016).

According to Washington Post, it is not legal for foreigners to own a comptoir. This is one of the parts of racial discrimination as well. Also, Metorex was run entirely by a team of Asian employees. The Post saw men loading a truck while dressed in CDM logo jumpsuits. Monopoly in this business is clearly observed. The truck was tracked to its destination, which was the CDM facility with armed guards at the gate (Frankel, 2016).

3.3 Electric Car Manufacturing: Environmental Issues

3.3.1 Lithium, Water and Scarcity

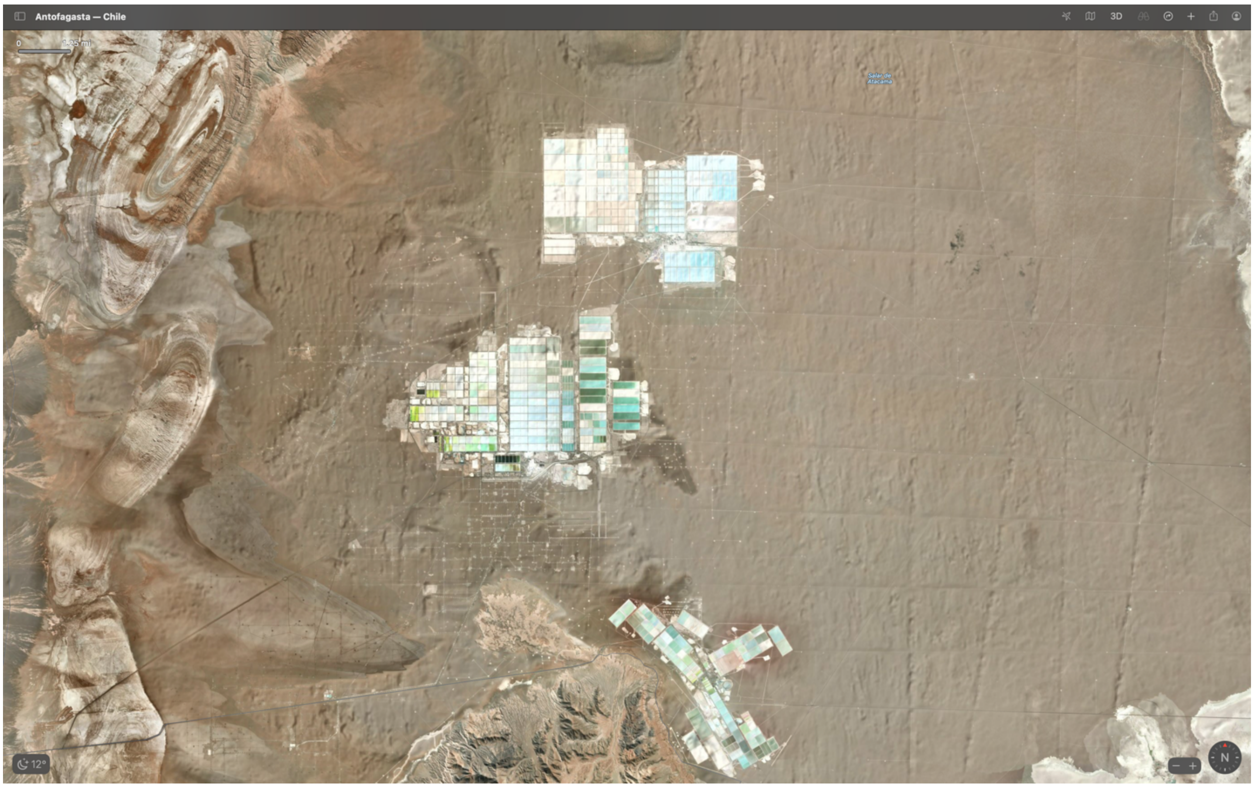
The production of 1 ton of lithium requires the use of around 500,000 gallons of water (Brooks, 2021). When converting 500,000 gallons to liters, it makes 1,892,705.892 liters. A 70 kWh Tesla Model S battery pack, which weights approximately 453 kilograms, contains around 63 kilograms of lithium (Lambert, 2016). By dividing 1 ton by 63 kilograms, we get approximately 16, which means that 1 ton of lithium is enough to produce 16 of 70 kWh Tesla Model S battery packs and it is enough for roughly 16 cars. To put this in perspective, the production of 1 gallon of gasoline requires anywhere between 0.60-0.71 gallons of water (Sun, Elgowainy, Wang, Han, & Henderson, 2018). This indicates that approximately 770,000 gallons of gasoline may be produced using around 500,000 gallons of water. According to Unicef, about 4 billion people, or about two-thirds of the global population, face acute water scarcity for at least one month each year and by 2030, severe water shortages might force the migration of as many as 700 million people (Water scarcity: Addressing the growing lack of available water to meet children's needs, n.d.). The mining industry is responsible for using nearly 65 percent of the water supply in Salar de Atacama, Chile. Since this region experiences a dry environment, there is a water shortage. Eventually, it affected the expansion of drought-stricken farms. There is a high demand for food in communities living there since farmers are facing problems with watering their crops and feeding their animals. This is all due to water shortage caused by Lithium mining (Ahmad, 2020). Two cases filed in federal court attempted to prevent the proposal, and Max Wilbert who had been living in a tent on the site of the proposed mine was reported as stating, "Blowing up a mountain isn't green, no matter how marketing spin people put on it" (Penn & Lipton, 2021). The process of recovering lithium brine is a relatively uncomplicated yet protracted undertaking. Essentially, water that is imbued with a high concentration of saline is extracted and transferred to a sequence of ponds that promote evaporation. This water is allowed to dissipate gradually over several months, leading to the precipitation of various salt species, thereby resulting in the formation of brine that is enriched in lithium content (Lithium Extraction and Refining Technology, n.d.).

“Water covers more than 70 % of Earth’s surface. It was in water that life on Earth started, so it is not surprising that all living things on our blue planet need water. Water is in fact many things: it is a vital need, a home, a local and global resource, a transport corridor and a climate regulator. And, over the last two centuries, it has become the end of the journey for many pollutants released to nature and a newly discovered mine rich in minerals to be exploited. To continue enjoying the benefits of clean water and healthy oceans and rivers, we need to fundamentally change the way we use and treat water” (Bruyninckx, 2018).

Given the information as well as what we know about the amount of water consumed during the manufacturing of electric vehicles, can we believe that this is an appropriate method to make use of the resource that is essential to the continuation of our modern lifestyle? It is not a surprise that to function properly, every human being requires water. A person can get from point A to point B within a city without the use of an automobile, but without water, he would not be able to live. It is common knowledge that there are locations that cannot be reached by a human being without the use of a vehicle or another form of transportation, but we can reduce the number of unnecessary movements by cars, making driving a more responsible action. The responsible use of vehicles will be discussed later. Nevertheless, if there was no water, there would be no life. It is necessary to have water to irrigate fields with fruits and vegetables, feeds household animals, and ensure the survival of other species of animals that live in the wild.

“Of all the electricity in the world, about 20% is generated by hydropower. Hydropower generating prevents a lot of pollution. Hydropower generating is clean and does not leave any waste. Because of the electricity generated by hydropower, the amount of oil and coal needed to produce enough electricity is reduced. It prevents the need to burn about 22 billion gallons of oil or 120 million tons of coal each year” (Hossain, 2015). Water, as we can see, plays a significant part in the development of our civilization. If there was no more water left on the planet, mankind would perish. This is not just the case due to natural factors, but also due to the life-supporting industries that are critical to the functioning of our society.

Figure 14, An Aerial View of The Biggest Lithium Deposit in Salar de Atacama, Chile



Source: Google Maps

3.3.2 Toxic Waste and Recycling

"Bloomberg NEF projects that plug-in vehicle sales will rise from 6.6 million in 2021 to 20.6 million in 2025. Plug-in vehicles are predicted to make up 23% of new passenger vehicle sales globally in 2025, up from just under 10% in 2021. Three-quarters of those will be fully electric" (Lewis, 2022). According to the most recent estimations, the average lifespan of an electric vehicle battery is anywhere between 10 and 20 years before it must be changed (Van Barlingen & Biggins, 2022). We can assume that when all the batteries of electric vehicles lose their capacity, there will be a mountain of electric batteries. Eventually, we will need to figure out what to do with all of that to prevent toxic leakage or even explosions caused by damaged batteries. "The lack of knowledge about the manufacture and composition of batteries is an obstacle to the efficiency of recycling processes and can even lead to technical accidents" (Danino-Perraud, 2020).

“The batteries, if damaged, can get wet and explode or catch fire, and if they do the vapors can be extremely hazardous. Traditional lead-acid batteries can be and often are recycled, but that is not the case with the lithium-ion versions” (Courter, 2021). A lot of things can change in a period of 10 years: people can come up with other ways of recycling or even reusing those batteries. The fact of having huge toxic waste in 10- or 20 years challenges the eco-friendliness of any EV.

“Based on the number of electric cars sold in 2017, researchers in the United Kingdom calculated that 250,000 metric tons, or half a million cubic meters, of unprocessed battery pack waste will result when these vehicles reach the end of their lives in about 15 to 20 years — enough to fill 67 Olympic swimming pools” (Hunt, 2019).

All lithium-ion battery cells undergo a gradual deterioration process after numerous cycles of charges and eventually discharges, which results in cathode material damage and diminishes the battery’s capacity. As electric vehicles become more prevalent, millions of their batteries will eventually reach this state. When discarded in landfills, these batteries can release toxic substances or even catch fire, posing a significant environmental risk. Although some US companies offer battery recycling programs, their capacity falls short of the number of lithium-ion batteries that require recycling from various sources, including computers, mobile phones, and other electronic devices. Only 15% of retired lithium-ion batteries were able to get from landfills by some US recycling entities, highlighting the need for more efficient and effective recycling methods. One significant obstacle to battery recycling profitability is the complex composition of lithium-ion batteries, which makes disassembly and mineral extraction costly and difficult. It has been estimated that recycling lithium costs up to five times more than mining pure lithium from brine. Moreover, existing recycling methods like pyrometallurgy apply melting down the batteries and the plastic separators are burned off, which leads to the release of harmful gases and the loss of valuable minerals completely. The increase in electric vehicle sales will soon result in a surge of discarded batteries, presenting an additional challenge for recycling programs. According to analysts, by 2028, over a million metric tons of used batteries will require processing. Ultimately, the success of battery recycling hinges on the prices of the processes involved. Despite the emergence of advanced technologies, recyclers may find it challenging to compete with the cost of mining pure minerals. Nonetheless, the demand for eco-friendly and sustainable practices emphasizes the need for the development of efficient, practical, and cost-effective recycling methods (Chrobak, 2022).

Electric cars are often hailed as an environmentally friendly alternative to their traditional gasoline-powered counterparts due to their lower emissions output. However, the production of electric cars is not without its ecological impact. This impact can be attributed in large part to the mining of rare earth metals, such as lithium and cobalt, which are integral to the production of electric car batteries. The environmental impact of both traditional and electric cars is an ethical concern, but they differ in the nature and magnitude of their impact. Traditional cars emit greenhouse gases and pollutants, leading to air and water pollution. Although the latest engines have significantly reduced these emissions, they are still present, but much lower than the old engines. In contrast, electric cars produce waste in the form of batteries, which contain toxic materials and are challenging to recycle, causing severe harm to the environment. Furthermore, the extraction of rare earth metals used in electric vehicle batteries is plagued by ethical issues, such as child labor and exploitation in some parts of the world.

3.3.3 Responsible Driving and Oil Importance

Whenever people drive their cars, they should question the importance of crude oil for the industry. If people would use their vehicles responsibly and reasonably, regardless of if they are electric cars or ICE-equipped cars, they would significantly reduce the number of emissions and the proper use of petroleum for other industries would be aligned. When it comes to cars, oil is very important to mention as a fuel and important part of humanity. Also, it may seem that ethical and environmental issues of electric cars may suggest keeping on driving regular cars that use gasoline, but oil is rather needed to keep our civilization functioning and water is needed to keep us alive. Regular ICE vehicle question is not anymore only a question of environment, but it has a bigger meaning and complexity now. People sometimes require a personal car to commute for important occasions or to travel, but most people use their cars on daily basis to commute between destinations that they could easily reach with public transport, which is also a great alternative to reduce pollution. Crude oil is used in a wide variety of products. But, because of its indispensable function in a wide variety of facets of our lives, oil is a vital ingredient in the development of contemporary civilization. It is crucial for developing nations to have access to energy that can be purchased at a reasonable price since this may assist enhance the life quality and empower residents. The transportation industry relies heavily on petroleum as a source of energy. Petroleum is the primary source to produce over two-thirds of all fuels used in transportation (NS Energy, 2017). We mustn't overlook the role that logistics played in the production of all the goods that are currently available in retail stores. Nevertheless, logistics necessitates the use of a wide variety of transportation modes, all of which must be powered by oil. Thus, it is safe to presume that international trade is strongly reliant on the availability of petroleum. Although though most of its applications are in the transportation industry, petroleum is also utilized in the creation of electrical power. Even though coal is the most common source of electricity generation, several nations continue to rely heavily on oil for power generation. This makes up a sizeable portion of the electricity sector in many countries. Lubricants, which are made from petroleum, are used to minimize the amount of friction that occurs in a wide variety of machinery across nearly all industries as well as in all sorts of vehicles, including industrial machines. In addition to this, they find uses in the kitchen, in human bio applications, in ultrasonography tests, and medical examinations. It is essential that we do not overlook the importance of petroleum byproducts. Crude oil and petrolatum are two examples of these. They are put into effect during the production of external medicinal lotions and other therapeutic products. One of the human causes is that agriculture relies heavily on petroleum, and this is a significant contributor. In addition to being a source of nitrogen for agricultural fertilizers, ammonia is also manufactured from petroleum. We shouldn't forget that most insecticides are derived from petroleum. In addition, the machinery used for agricultural chores uses petroleum, and all these items are transported via the use of logistics, which may involve trucks, aircraft, or ships to deliver them. The chemical industry is probably the most evident user of petroleum products since many of the by-products of this industry are utilized as raw materials in other operations. In a previous section, it was indicated that the manufacturing of fertilizers and pesticides also involves the use of petroleum, particularly chemical varieties. In addition, synthetic fibers, pesticides, perfumes, and paints are included in this category. Other important by-products of the petroleum industry that are used in households as well include plastic, detergents, naphtha, grease, Vaseline, wax, and butadiene, the latter of which is also utilized in the automotive sector (NS Energy, 2017). It is essential to understand the significance of petroleum and to cut back on personal use as much as possible to save this resource for activities that are important to the global community.

4. Practical Part

4.1 Concept

The purpose of the author's analytical section is to get an overall understanding of whether the public is aware of the dangers and problems associated with the manufacturing of electric cars. These dangers and problems are related not only to the production of the cars themselves but also to their use and further processing. To do this, the author devises a questionnaire, the responses to which are largely focused on the phenomena that have been described. The author has given much thought to the findings of the questionnaire, which he or she sent to both persons who regularly drive and those who do not own or operate a vehicle of their own. Consequently, the author's analysis is founded on this consideration. Following that, the author compares those outcomes with each other to see how they stack up.

4.2 Limitations

For the limitations of the research, it is surely enough possible to conclude that the approach selected by the author cannot anyhow be categorized as a representative one because the author had originally selected a broad population that consists of not just thousands of people but of millions and even billions. Henceforth, the author suggests that his analysis is illustrative, and it can help to draw general ideas and thoughts about the way how people tend to perceive the phenomenon of electric cars and ethical along with environmental issues related to it.

Another limitation is related to the demographics and the geography of responses – the author mainly contacted his acquaintances, so the geography of the research is limited to just a series of countries, as well as the research is rather limited to just particular target groups, consisting mainly of Russian and English speakers. For this purpose, the author does not focus on testing any hypothesis as his sample is already not a representative one, so the author focuses on interpreting the results and connecting them to the theoretical framework that had already been discussed before.

4.3 Participants

The main criteria for being a participant of the author's questionnaire is being above 18. The questionnaire is shared among participants of the interview via What's App, Facebook and Telegram and the author primarily incorporates his acquaintances or friends of his acquaintances. In addition to that, it is also wise to say that the author's questionnaire consists of 13 questions, and the main platform for putting all those questions was Google Forms. Questions used in the questionnaire are presented below:

1. What is your gender?
   a) Male
   b) Female
   c) Prefer not to say
2. Where are you from?
   a) Armenia
   b) Azerbaijan
   c) Czech Republic
   d) Georgia
   e) Germany
   f) France
   g) Israel
   h) Italy
   i) Russia
   j) USA
   k) Other
3. To which age category do you belong?
   a) 18-25
   b) 25-41
   c) >41
4. Do you have a driver's license?
   a) Yes
   b) No
5. Do you currently drive a car?
   a) I used to, but currently I am not driving

b) Yes

c) No

6. Have you ever owned an electric car?

a) Yes

b) No

7. Do you consider electric cars as a sustainable means of transportation?

a) Yes

b) No

8. Do you believe that electric cars are fully green?

a) Yes

b) No

9. Do you believe that electric cars are the best alternative to regular cars?

a) Yes

b) No

10. What are the main issues related to electric cars according to your perception?

a) Production Issues

b) Ethical Issues

c) Marketing Issues

d) Environmental Issues

11. Would you support the complete shift from regular cars to electric ones?

a) Yes

b) No

12. What is your favorite car manufacturer?

a) BMW

b) Toyota

c) Mercedes

d) Tesla

e) Ford

f) Audi

g) Other

13. Do you know what materials are batteries for electric cars are made of?

a) Yes

b) No

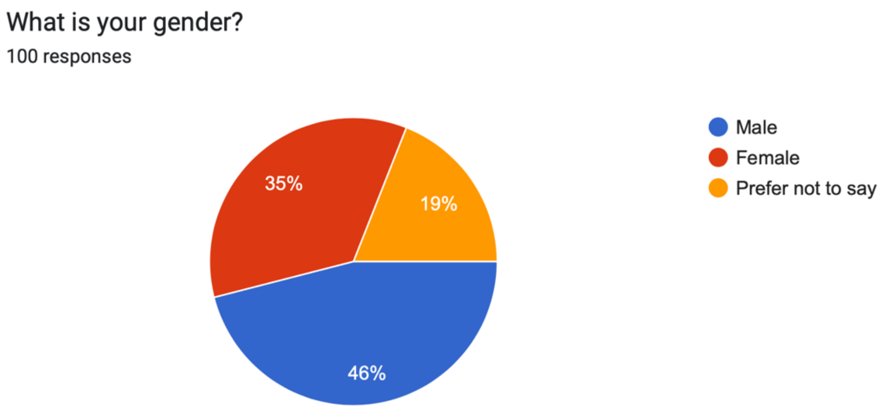
4.4 Evaluation

The procedure involved in gathering the pertinent data required to fulfill the aim of this thesis, which is to delineate the ethical and environmental predicaments inherent in the manufacturing of electric cars, and subsequently elucidate the level of cognizance amongst consumers, entailed the construction of a questionnaire that probed into the issues. This questionnaire was formulated with a set of inquiries that were designed to stratify the participants according to their age, gender, and other relevant details, which was intended to provide a comprehensive insight into the perspectives of the participants on the subject matter through their responses. It is noteworthy to mention that the author anticipated that the respondents' knowledge regarding the subject matter would be very narrow, but to the contrary, the findings revealed that most of the participants had a reasonable level of familiarity with some of the issues. It is acknowledged, however, that the degree of knowledge amongst the participants varied and was likely limited. To provide more insight, the questionnaire will be discussed in detail in the ensuing part of this thesis. In essence, the author was considerably intrigued by the process, as it proved to be an enlightening opportunity to gauge the level of support for the topic of the thesis. The results of the questionnaire will be analyzed in the next part of this work and condensed to arrive at a conclusive summary in the end.

5. Results and Discussion

5.1 The Participant Classification in this Study

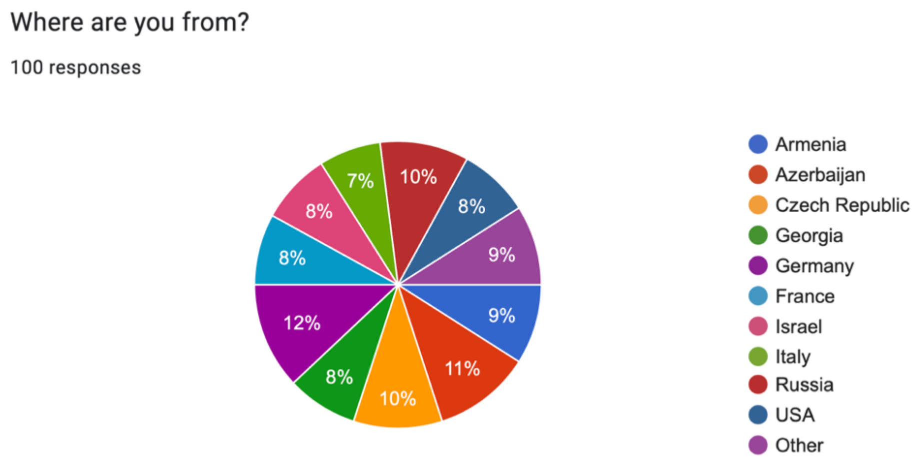
Figure 15, Gender Diagram



Source: own research

A person's gender can influence their attitudes and behaviors towards technology and environmental issues, including electric cars, and therefore, including gender as a variable in a survey on electric cars and awareness can help to identify potential gender-based differences in attitudes, behaviors, and knowledge about electric cars. For instance, this may help to understand whether men or women are more environmentally conscious and concerned about the impacts of climate change which may influence their attitudes towards them. We can observe in figure 15 that the most respondents are men, making up almost a half (46%), the second place are women with 35% of all respondents. The lowest number of people (19%) preferred not to specify their gender.

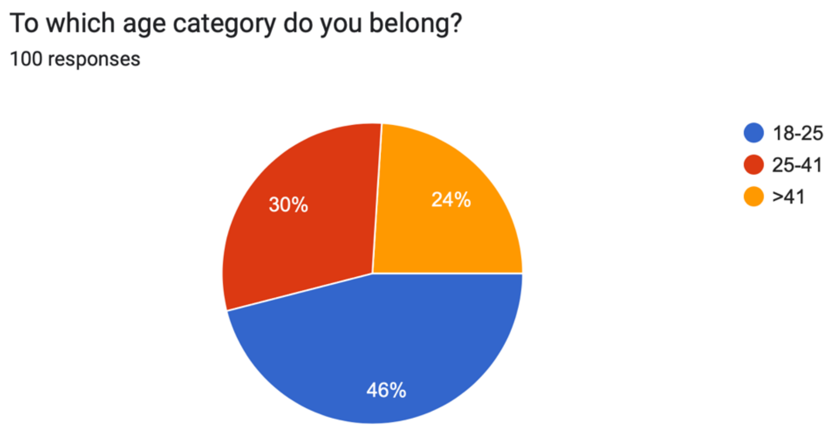
Figure 16, Country Diagram



Source: own research

Incorporating country of origin as a variable in a survey on opinions and awareness about electric cars can yield valuable insights into how diverse cultural, economic, and political contexts shape attitudes and behaviors toward sustainable transportation. By considering respondents' countries of origin, researchers can explore potential cross-cultural differences and uncover nuances in the relationship between these attitudes and behaviors. A country's development, infrastructure, and policies regarding electric cars can have a significant impact on the availability, affordability, and perception of these vehicles among the population. For instance, some countries have implemented robust incentives and infrastructure to promote electric car adoption, resulting in higher rates of ownership and awareness. In contrast, other countries may lack these resources and have a more challenging environment for electric car adoption. Additionally, cultural factors such as values, beliefs, and norms can shape attitudes and behaviors toward electric cars. In some post-Soviet countries, car ownership is often viewed as a symbol of status and prestige, which may result in less enthusiasm for electric cars if they are perceived as less desirable or prestigious than traditional gas-powered vehicles. Figure 16 shows that the most respondents were from Germany, making up 12%, followed by Azerbaijan which makes up 11% of respondents and 10% for both Czech Republic and Russia. The survey includes a very diverse combination of countries that have different cultures and perceptions. In some countries, there may be a stronger sense of community and social responsibility, which may motivate people to embrace electric cars as a means of supporting the environment and the public good.

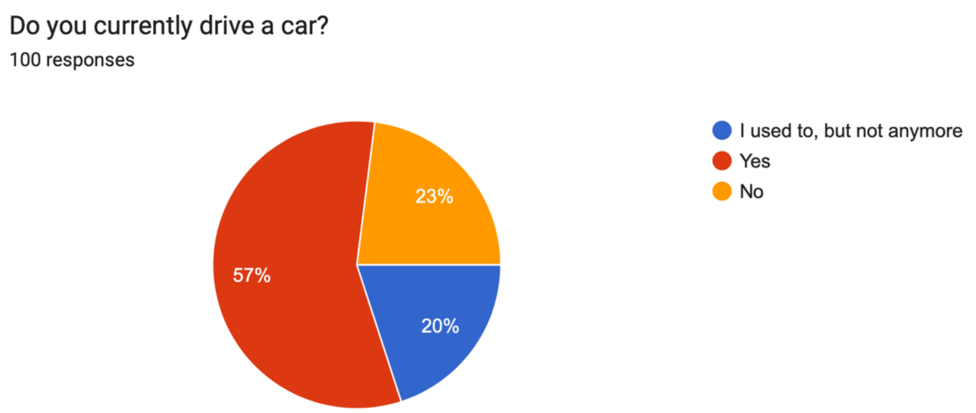
Figure 17, Age Diagram



Source: own research

To conduct this research, the author elected to partition participants into three distinct age groups, spanning from 18 to 25, 25 to 41, and 41 and above. The justification for these groupings stems from the significance of individual viewpoints, personalities, and outlooks, which can vary greatly depending on one's life experiences. As is commonly presumed, older generations tend to prefer traditional internal combustion engine vehicles, whereas younger generations tend to be more receptive to electric vehicles. However, it is the cohort of individuals aged 25 to 41 that proves to be the most intriguing, as they are both young and mature enough to form an impartial unbiased opinion and assessment, which is particularly

Figure 18, Currently Driving a Car Diagram

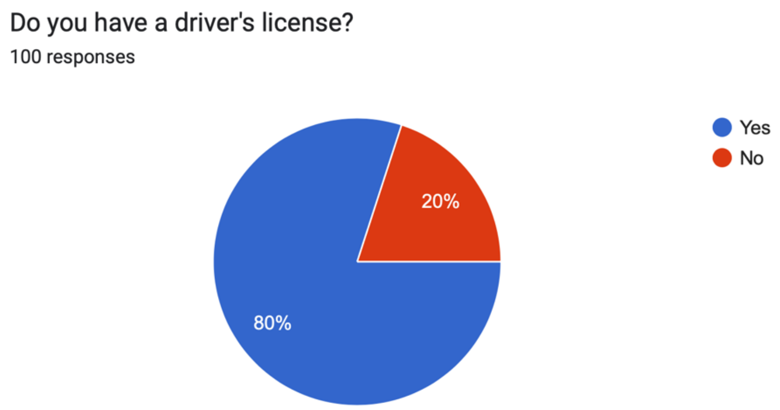


Source: own research

fascinating to observe. We can observe in figure 17 that out of 100 participants 46% were in the 18-25 age group, almost a quarter (24%) were older than 41 years old, and the rest that is making up 30% are people in the age range from 25 to 41.

When conducting a survey, it is helpful to divide respondents into two groups, one based on whether they currently own or use a car and the other on whether they have ever owned or used a car. Both groups can provide valuable insights and help define the obstacles that may prevent the adoption of new technologies. Figure 18 depicts that more than a half of respondents (57%) currently drive a car, while 20% used to, but not anymore and 23% do not drive a car. People who are already car owners or drivers have firsthand knowledge of the benefits and drawbacks associated with vehicle ownership and operation; as a result, their perspectives on the positives and negatives of electric vehicles are likely to be more well-informed than those of other people. They are also more likely to be knowledgeable about the infrastructure, range, and cost implications of owning an electric car because they have already made similar decisions when purchasing or using a traditional car. This is because they have already made similar decisions. Alternately, individuals who do not currently own or use a car may have different attitudes and perceptions about electric cars than those who do. They might be less familiar with the practical considerations and benefits of car ownership in general, and they might not have the opportunity to consider electric cars as a viable option. This could be because they haven't owned a car before. It would be possible to discern the opinions, attitudes, and knowledge of these distinct cohorts if survey participants were separated into these two groups before the survey was administered. This would help uncover potential gaps or challenges in the process of promoting the adoption of electric cars. For instance, they may discover that individuals who own or use a car are more concerned about the driving range and infrastructure of electric cars, whereas individuals who do not own or use a car may be more concerned about the initial cost and accessibility of these vehicles. This could be the case if they find that individuals who do not own or use a car are more likely to be concerned about these aspects.

Figure 19, Holding a Driver's License



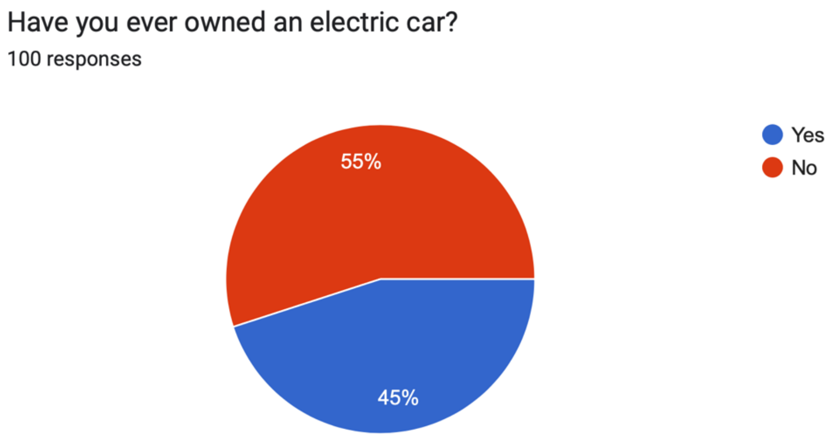
Source: own research

People who hold a driving license have undergone training and possess the skills required to operate a vehicle, and they may have more knowledge about car ownership in general. They are also more likely to have had previous experience with different types of vehicles, including traditional ICE cars, and may be more familiar with the infrastructure and maintenance requirements of cars. In contrast, individuals who do not possess a driving license may have less knowledge and experience with cars and may have different perceptions and attitudes towards vehicle ownership and alternative modes of transportation. Moreover, they may have a different set of concerns and considerations regarding the use of electric cars, such as the availability of public transportation or the feasibility of car-sharing or carpooling programs. Figure 19 shows that 80% of respondents have driver's license.

Upon closer review when the results are split by gender, it appears that 39 out of the 46 male participants have a driver's license, while only 25 out of the 35 female participants possess the same. However, it is important to note that this finding may be subject to several confounding variables such as cultural and societal norms, as well as individual preferences for modes of transportation. Furthermore, a small proportion of individuals declined to specify their gender. Analysis of this subset suggests that 16 out of the 19 individuals possess a driver's license, while the remaining 3 do not. This suggests that gender may not be a significant factor in determining the likelihood of obtaining a driver's license. It is important to acknowledge that the present findings are based on small sample size and may not be representative of the wider population. Nonetheless, these data provide preliminary insights into licensing rates among the surveyed individuals and the potential impact of gender on licensing rates.

As shown in figure 20, approximately half (45%) of respondents have owned an electric car and it can be attributed to a multitude of factors. Firstly, electric cars are a novel technology, and the novelty and exclusivity may render the ownership of an electric vehicle a privilege, out of reach for many individuals. Also, the availability of charging infrastructure may also affect the decision to purchase an electric car, particularly in areas where the infrastructure is not fully developed, making it difficult or impossible for electric

Figure 20. Electric Car Ownership Diagram



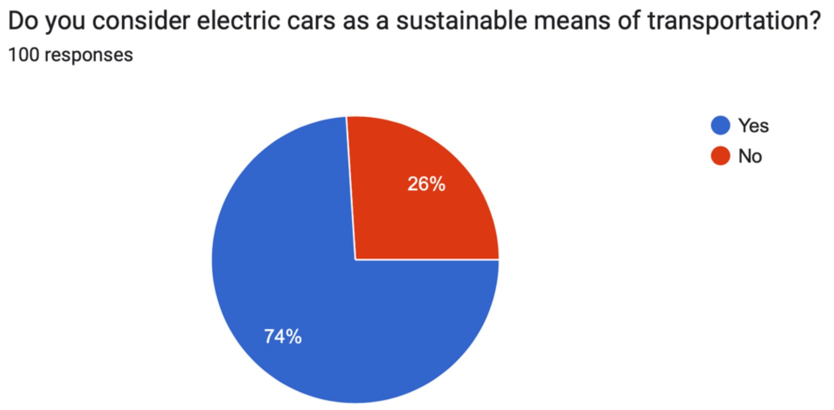
Source: own research

car owners to recharge their vehicles. A lack of knowledge or misconceptions about electric cars may be another hurdle to the widespread adoption of electric vehicles. Finally, some individuals may simply prefer gasoline-powered vehicles, based on their driving habits or lifestyle choices, which can influence their purchasing decision.

5.2 The Participants Opinions and Views on Electric Cars

The divergent views on the sustainability of electric cars are shown in figure 21, with 74% of respondents answering in the affirmative and the remaining 26% in the negative, may stem from a variety of factors. Firstly, the perception of electric cars as an

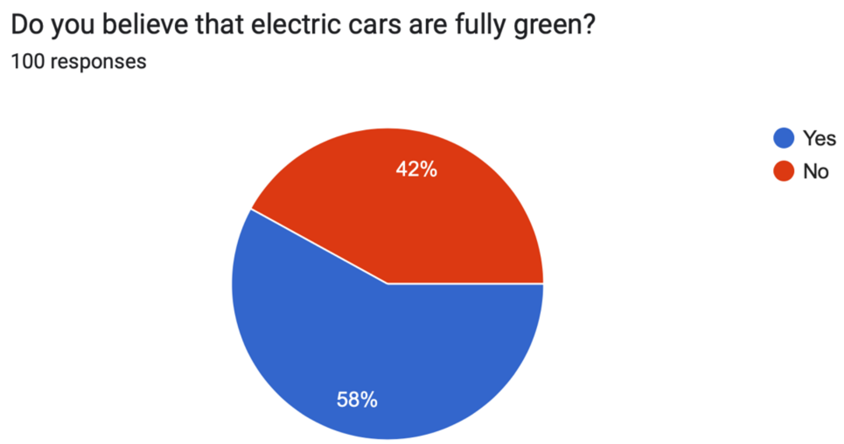
Figure 21, Sustainability of Electric Cars as a means of Transportation Diagram



Source: own research

environmentally friendly option may be a major driver for the positive response, especially among individuals who prioritize environmental awareness and seek to minimize their carbon footprint. Secondly, the perception of electric cars as cutting-edge and innovative technology could contribute to their portrayal as a more sustainable alternative to traditional

Figure 22, Electric Cars being Fully Green Diagram

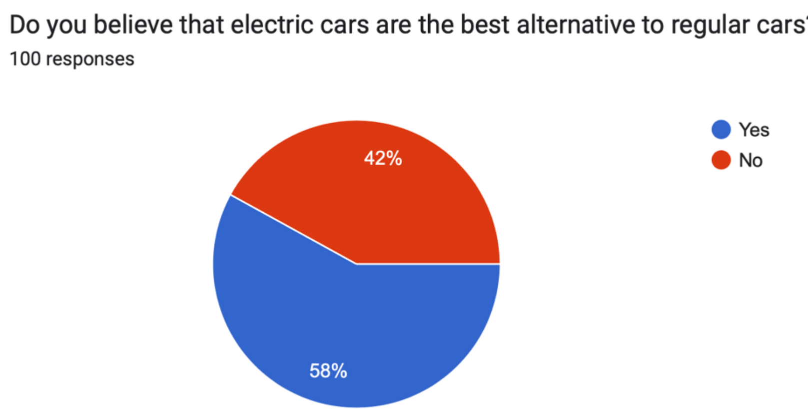


Source: own research

gasoline-powered vehicles. Thirdly, limited awareness or misconceptions about the environmental impact of electric cars may be responsible for the negative response, with some individuals either unfamiliar with the technology or holding unfounded beliefs about its carbon footprint, which we will also figure out later. Fourthly, the financial considerations of purchasing electric cars may influence some individuals to view gasoline-powered vehicles as more sustainable for them.

Figure 22 shows that 58% of respondents consider electric cars fully green. It is a common misconception held by certain individuals that electric vehicles are inherently ecologically sound, as suggested "fully green" in a survey, which implies that they are devoid of any adverse environmental effects. One significant reason is that the battery that electric cars are equipped with does not emit any greenhouse gas emissions while driving, which cannot be said about regular ICE-equipped cars. Therefore, many people view electric cars as an environmentally friendly alternative. Another contributing factor is the growing awareness of climate change and the need for sustainable technologies, which has led to an increased interest in electric cars, which are marketed as fully green. Some individuals can view electric cars as a more sustainable option due to their use of renewable energy sources such as solar and wind power for charging. However, it is important to acknowledge that the production of electric cars and their batteries still rely on non-renewable resources, such as lithium and cobalt that were spoken about previously.

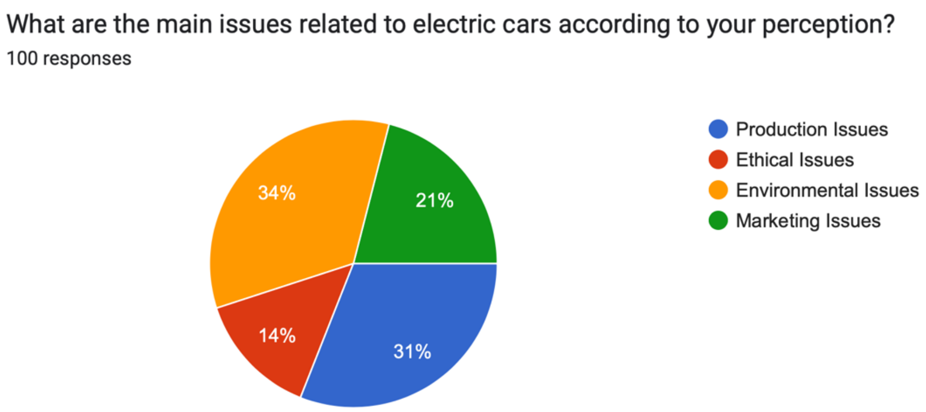
Figure 23, Electric Cars being the best Alternative to Regular Cars



Source: own research

Figure 23 illustrates that the proportion of participants who regard electric cars as the optimal substitute for conventional cars is almost identical to the percentage of respondents who view electric cars as fully environmentally friendly. However, it is essential to acknowledge that the two views are not necessarily mutually exclusive, and other factors may also influence individuals' preferences for electric cars.

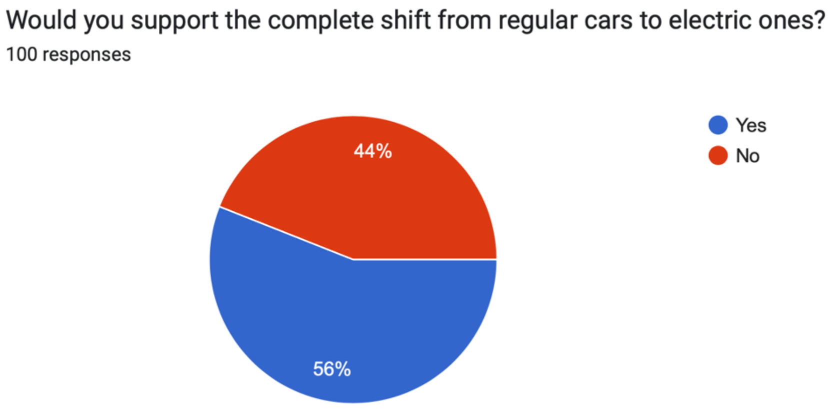
Figure 24, Perception of the Main Issues Related to Electric Cars



Source: own research

The survey results in figure 24 from a sample of 100 people regarding their perceptions of electric cars indicate that "Environmental Issues" are the primary concern, with 34% of the respondents selecting this option. This could imply that consumers are placing greater emphasis on sustainability. The survey also reveals that "Production Issues" are the second most frequently cited concern, with 31% of participants selecting this option. This suggests that there may be reservations among people either on material availability or toxic waste during production. Additionally, the survey showed that 21% of respondents selected "Marketing Issues" and 14% selected "Ethical Issues." These results suggest that while these issues are still important to some people, they are deemed to be of lesser importance than environmental and production concerns. Overall, the survey findings underscore the significance of awareness about ethical issues factors in electric car production, highlighting the need to address ethical concerns to increase consciousness. When examining the data on a country-by-country basis, some notable trends emerge. In Armenia, for instance, respondents seem to have the least awareness of ethical issues related to electric car production. None of the 9 respondents selected the "ethical issues" option, while 6 chose "environmental issues," and 2 chose "marketing issues." This finding suggests that there is a significant gap in public understanding of considerations associated with electric car production in Armenia, as only 1 person voted for "production issues". In Azerbaijan, out of 11 respondents, 4 selected "environmental issues," 3 selected "ethical issues," and 2 selected both "marketing issues" and "production issues." This finding highlights that respondents in Azerbaijan appear to be equally concerned about both marketing and production issues. Similarly, respondents in the Czech Republic also identified environmental concerns as the most significant, with 5 people selecting it as their top choice. However, respondents also seem to have a strong awareness of marketing issues, with 3 respondents selecting this option. Interestingly, nobody selected the "ethical issues" option, just like in Armenia, suggesting that this may not be a significant concern regarding electric cars among the Czech people. In France, respondents were almost evenly split between environmental, marketing, and production issues, with 3 people selecting "environmental issues," 2 selecting "marketing issues," and 2 selecting "production issues." Only 1 respondent selected "ethical issues." In Georgia, respondents showed significant concern for production issues, with 3 people selecting this option. Environmental and ethical concerns were also evident, with 2 people selecting each option, while only 1 respondent chose "marketing issues." In Germany, respondents had the most diverse range of concerns. While environmental concerns were identified by 3 respondents, an equal number of individuals selected ethical and marketing issues as their top choices. Production issues were also a significant concern, with 5 respondents selecting this option. Israeli respondents identified both environmental and ethical concerns as their top choices, with 3 people selecting each option. One respondent selected "marketing issues," and 2 respondents selected "production issues." In Italy, respondents seem to be primarily concerned with production issues, with 4 people selecting this option. Environmental, ethical, and marketing concerns were less prominent, with only 1 person selecting each option. In Russia, environmental concerns emerged as the most significant, with 6 respondents selecting this option. Only 1 respondent identified ethical and marketing issues, while 2 individuals selected "production issues." In the United States, marketing issues emerged as a significant concern, with 4 respondents selecting this option. Environmental and ethical concerns were also identified, with 1 person selecting each option. Two respondents identified "production issues" as their concern. Finally, respondents from other countries identified production issues as the most significant concern, with 6 people selecting this option. Two respondents selected "marketing issues," while only 1 person selected "environmental issues." Notably, nobody selected the "ethical issues" option in this category.

Figure 25, Support of Complete Shift Diagram

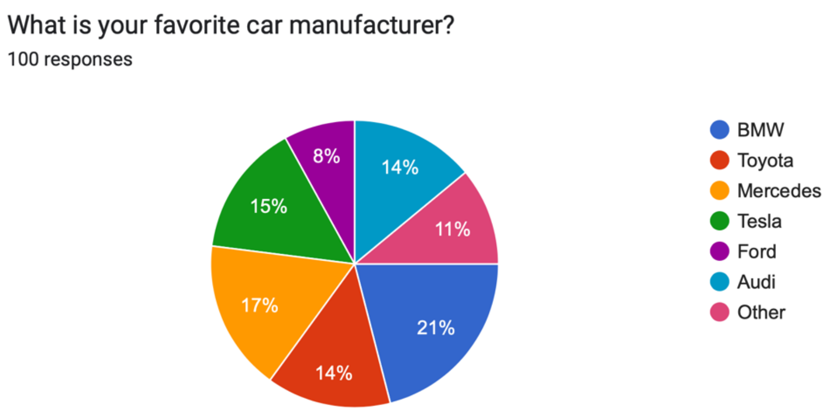


Source: own research

Figure 25 demonstrates that most respondents, 56%, would be in favor of making an entire transition away from traditional cars and toward electric cars. This finding suggests that there is some level of receptivity to the idea of transitioning to electric cars among the population that was surveyed. Having said that, it is essential to keep in mind that the overall population may not be represented accurately by this sample. It is also important to note that the 44% of respondents who answered "No" to the question may have different reasons for their lack of support for the transition to electric cars, and it is important to note that this lack of support may be for a variety of reasons. There are a few potential aspects that could be subjective rather than objective. The utilization of varying degrees of agreement in surveys may yield insightful information on the degree of intensity of respondents' attitudes and opinions. Nevertheless, the author has chosen to abstain from implementing this practice due to the possible drawbacks and difficulties it poses in data interpretation. One of the main concerns is that participants may hold diverse interpretations of the meaning of each level of agreement, resulting in incongruent responses and challenges in comparative analysis. Moreover, the inclusion of an excessive number of response options may result in a burdensome and protracted survey for respondents, causing reduced response rates and the potential for prejudiced outcomes. There is a possibility that some of the respondents who indicated their support for the transition may still be lacking in some knowledge.

When split into ages and preferences to a complete shift from regular cars to electric ones, the younger generation is more prone to vote for a complete shift. 25 participants in the "18-25" age range, 15 voted for complete shift and 10 preferred no shift. As for the older generation in the "25-41" age group, 12 favored complete shift, while 7 preferred no shift at all. Surprisingly, the preference for complete shift and no shift were evenly split among the 24 participants in the "41+" age range with 12 participants favoring each option.

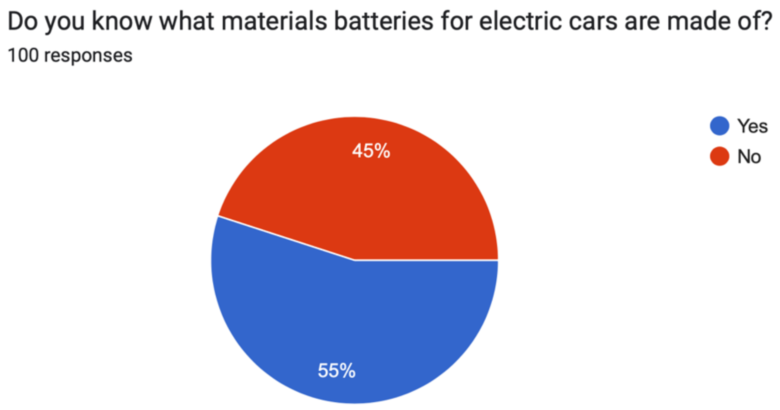
Figure 26, Favorite Car Manufacturer Diagram



Source: own research

The survey results in figure 26 indicate that BMW is the preferred car manufacturer for 21% of the participants, followed by Mercedes at 17%, and Toyota and Tesla at 14% and 15%, respectively. Audi and Ford are also popular choices with 14% and 8% of the respondents, respectively. The remaining 11% of the respondents selected "Other" as their favorite car manufacturer. From this data, it can be inferred that respondents have varied preferences when it comes to car manufacturers, and there is no clear consensus on a single favorite manufacturer. Additionally, it is interesting to note that two of the most popular car manufacturers, BMW, and Mercedes, are known for producing luxury vehicles, while Tesla, the only manufacturer dedicated exclusively to electric vehicles, ranks third in popularity. However, it is important to say that the survey results do not necessarily indicate a preference for electric cars specifically. While Tesla is known for producing electric vehicles, the other preferred car manufacturers on the list produce a range of vehicles, including both electric and gas-powered cars.

Figure 27, Materials Used in Battery Production Awareness Diagram



Source: own research

Figure 27 shows that 55% of the 100 respondents are aware of the materials used in batteries for electric cars. This suggests that more than half of the surveyed population has some level of awareness regarding the components utilized in the production of electric vehicle batteries. However, it is crucial to bear in mind that the remaining 45% of participants did not manifest any proficiency concerning the materials employed in electric car batteries. This lack of knowledge could be attributed to diverse factors, such as a lack of interest or exposure to information about electric vehicles and their constituent parts. Furthermore, it is important to consider the potential limitations of the survey results. It is challenging to establish the depth or accuracy of the knowledge held by those who responded positively to the question. For example, some respondents may possess a general knowledge of the materials used in electric vehicle batteries, while others may have a broader understanding.

6. Conclusion

In conclusion, the electric car industry continues to confront ethical and environmental challenges that remain unresolved despite ongoing efforts to address them. The author has endeavored to tackle these challenges and assess the level of public awareness, recognizing that consumer consciousness can significantly impact industry practices. However, a comprehensive understanding of the complex ethical and environmental issues that plague electric car manufacturing remains largely elusive among the public. As such, individuals must assume greater responsibility for their actions and their impact on society and the environment, particularly in the context of vehicle production and consumption. By fostering heightened awareness and consciousness of ethical and environmental concerns, consumers can exert a decisive influence on the industry practices that exploit public ignorance and fuel the proliferation of unethical and unsustainable production practices. Consumers can therefore play a pivotal role in driving a shift towards more sustainable and equitable production and consumption of electric cars. Furthermore, the transition from Internal Combustion Engine (ICE) equipped engines to other engine types, which may not necessarily be electric cars, appears likely in the future. This transition could be motivated by both ethical and environmental considerations, as well as the significant role of petroleum in other industries and vital aspects of human life. In essence, promoting greater consumer awareness and responsibility towards ethical and environmentally conscious vehicle production and consumption can facilitate the transition towards a sustainable and equitable future, unlocking the economic, environmental, and societal benefits of ethical and sustainable practices in the electric car industry.

7. Bibliography

Ahmad, S. (2020, January 15). *The Lithium Triangle: Where Chile, Argentina, and Bolivia Meet*. Retrieved from Harvard International Review: https://hir.harvard.edu/lithium-triangle/

Anthony, D. W. (2007). *The horse, the wheel, and language: How bronze-age riders from the Eurasian steppes shaped the modern world.* New Jersey: Princeton University Press. xii 553pp. ISBN: 978-0-691-5887-0.

Backhaus, R. (2021, August 27). Battery Raw Materials - Where from and Where to? *ATZ Worldwide*, 8-13. Retrieved from National Library of Medicine: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8390110/. DOI: https://doi.org/10.1007/s38311-021-0715-5.

Britannica, T. E. (2022, August 15). *Child Labour*. Retrieved from Encyclopedia Britannica: https://www.britannica.com/topic/child-labour

Brooks, E. (2021, December 31). *Lithium Extraction Environmental Impact*. Retrieved from Ecojungle: https://ecojungle.net/post/lithium-extraction-environmental-impact/

Bruyninckx, H. (2018, August 30). *Clean water is life, health, food, leisure, energy….* Retrieved from European Environment Agency: https://www.eea.europa.eu/signals/signals-2018-content-list/articles/clean-water-is-life-health

Cars. (n.d.). Retrieved from The Observatory of Economic Complexity: https://oec.world/en/profile/hs/cars?cumulativeMarketShareSelected=value

Castelvecchi, D. (2021, August 17). Electric cars and batteries: how will the world produce enough? *Nature*, 336-339. DOI: https://doi.org/10.1038/d41586-021-02222-1.

Charlton, A. (2022, June 6). *Which car companies are going electric and when? Everything we know so far*. Retrieved from Tom's Guide: https://www.tomsguide.com/news/which-car-companies-are-going-electric-and-when-everything-we-know-so-far

Chrobak, U. (2022, September 21). *What will it take to recycle millions of worn-out EV batteries?* Retrieved from Knowable Magazine: https://knowablemagazine.org/article/technology/2022/what-will-it-take-to-recycle-ev-batteries

Clifford, C. (2022, February 14). *Electric vehicles dominated Super Bowl ads, but are still only 9% of passenger car sales*. Retrieved from CNBC: https://www.cnbc.com/2022/02/14/evs-dominated-super-bowl-ads-but-only-9percent-of-passenger-car-sales.html

CO_2 emission performance standards for cars and vans. (n.d.). Retrieved from European Comission: https://ec.europa.eu/clima/eu-action/transport-emissions/road-transport-reducing-co2-emissions-vehicles/co2-emission-performance-standards-cars-and-vans_en

Courter, B. (2021, July 19). *Electric Vehicle Batteries Can Explode After an Accident.* Retrieved from Government Technology: https://www.govtech.com/fs/electric-vehicle-batteries-can-explode-after-an-accident

Cox, L. (2022, March 25). *Who Invented the Car?* Retrieved from livescience.com: https://www.livescience.com/37538-who-invented-the-car.html

Danino-Perraud, R. (2020, March). *The Recycling of Lithium-Ion Batteries: A Strategic Pillar for the European Battery Alliance.* Études de l'Ifri, Ifri. ISBN: 979-10-373-0135-2.

Dummett, M. (2017, September 28). *The Dark Side of Electric Cars: Exploitative Labor Practices*. Retrieved from Time: https://time.com/4939738/electric-cars-human-rights-congo/

Frankel, T. C. (2016, September 30). *The Cobalt Pipeline*. Retrieved from Washington Post: https://www.washingtonpost.com/graphics/business/batteries/congo-cobalt-mining-for-lithium-ion-battery/?tid=batteriesseriesnav

Frankel, T. C., & Whoriskey, P. (2016, December 19). *Washington Post*. Retrieved from Tossed Aside in the "White Gold" Rush: https://www.washingtonpost.com/graphics/business/batteries/tossed-aside-in-the-lithium-rush/

Holton, L. (2020, July 9). *8 Ethical Issues Businesses Face Today*. Retrieved from myVA360: https://myva360.com/blog/8-ethical-issues-business-face-today

Hossain, M. (2015). Water: the most precious resource of our life. *Global Journal of Advanced Research*, 1436-1445. ISSN: 2394-5788.

Hunt, K. (2019, November 6). *The rapid rise of electric vehicles could lead to a mountain of battery waste* . Retrieved from CNN Business:

https://edition.cnn.com/2019/11/06/business/electric-vehicles-battery-waste-scn/index.html

(2016). *"This Is What We Die for" Human Rights Abuses in the Democratic Republic of the Congo Power the Global Trade in Cobalt.* https://www.amnesty.org/en/wp-content/uploads/2021/05/AFR6231832016ENGLISH.pdf

Lambert, F. (2016, November 1). *Breakdown of raw materials in Tesla's batteries and possible bottlenecks*. Retrieved from Electrek: https://electrek.co/2016/11/01/breakdown-raw-materials-tesla-batteries-possible-bottleneck/

Lewis, M. (2022, May 31). *This is where electric vehicle adoption is headed between 2022 and 2025*. Retrieved from Electrek: https://electrek.co/2022/05/31/this-is-where-electric-vehicle-adoption-is-headed-between-now-and-2025/

Lithium Extraction and Refining Technology. (n.d.). Retrieved from STT Storage and Transfer Technologies: https://www.sttsystems.com/industries/lithium-extraction/

Matulka, R. (2014, September 15). *Energy*. Retrieved from The History of the Electric Car: https://www.energy.gov/articles/history-electric-car

Melville, J. (2020, June 19). *From Stone to Phone MODERN DAY COBALT SLAVERY IN CONGO*. Retrieved from Byline Times: https://bylinetimes.com/2020/06/19/from-stone-to-phone-modern-day-cobalt-slavery-in-congo/

Mock, P. (2019, January 3). *CO2 EMISSION STANDARDS FOR PASSENGER CARS AND LIGHT-COMMERCIAL VEHICLES IN THE EUROPEAN UNION*. Retrieved from The International Council on Clean Transportation: https://theicct.org/sites/default/files/publications/ICCTupdate_EU-95gram_jan2014.pdf

Momen, M.N. (2021). Child Labor: History, Process, and Consequences. In: Leal Filho, W., Azul, A.M., Brandli, L., Lange Salvia, A., Özuyar, P.G., Wall, T. (eds) No Poverty. Encyclopedia of the UN Sustainable Development Goals. Springer, Cham. https://doi.org/10.1007/978-3-319-95714-2_30

Moriarty, J. (2021, September 16). *Business Ethics*. Retrieved from Stanford Encyclopedia of Philosophy: https://plato.stanford.edu/entries/ethics-business/#EndsSharPrimStakBala

Muslimin, S., Nawawi, Z., Suprapto, B. Y., & Dewi, T. (2022). Comparison of Batteries Used in Electrical Vehicles (A Review). *5th FIRST T1 T2 2021 International*

Conference (FIRST-T1-T2 2021) (pp. 421-425). Atlantis Press International B.V. DOI: https://doi.org/10.2991/ahe.k.220205.074.

NS Energy. (2017, November 25). Retrieved from Major Uses of Petroleum: https://www.nsenergybusiness.com/news/newsmajor-uses-of-petroleum-5986242/

Number of motor vehicles registered in the United States from 1990 to 2020. (2022, January 12). Retrieved from Statista: https://www.statista.com/statistics/183505/number-of-vehicles-in-the-united-states-since-1990/

Passenger mobility statistics. (2022, December). Retrieved from Eurostat: https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Passenger_mobility_statistics

Penn, I., & Lipton, E. (2021, May 6). *The Lithium Gold Rush: Inside the Race to Power Electric Vehicles*. Retrieved from The New York Times: https://www.nytimes.com/2021/05/06/business/lithium-mining-race.html

Reid, L. (2019, June 7). *Making the leap to electric*. Retrieved from Greenpeace: https://www.greenpeace.org/international/story/22231/making-the-leap-to-electric/

Scrosati, B., & Garche, J. (2010). Lithium Batteries: Status, Prospects and Future. *Journal of Power Sources*, 2419-2430.

Sovacool, B. K. (2021, March). When subterranean slavery supports sustainability transitions? power, patriarchy, and child labor in artisanal Congolese cobalt mining. *The Extractive Industries and Society*, 271-293. Retrieved from Science Direct: https://www.sciencedirect.com/science/article/pii/S2214790X20303154

Step-by-Step Process of Manufacturing a Car. (2020, September 1). Retrieved from NRTC Automation: https://nrtcautomation.com/blog/step-by-step-process-of-manufacturing-a-car

Sun, P., Elgowainy, A., Wang, M., Han, J., & Henderson, R. J. (2018). Estimation of U.S. refinery water consumption and allocation to refinery products. *Fuel*, 542-557.

Top 10 Most Frequently Cited Standards. (2021, September 30). Retrieved from Occupational Safety and Health Administration: https://www.osha.gov/top10citedstandards

Types of Electric Vehicles. (n.d.). Retrieved from E-Amrit: https://e-amrit.niti.gov.in/types-of-electric-vehicles#ongoingsec

Van Barlingen, W., & Biggins, C. (2022, August 1). *How long do electric car batteries last?* Retrieved from EVBox: https://blog.evbox.com/uk-en/ev-battery-longevity

(2022, January). *Vehicles in use, Europe 2022.* ACEA. Retrieved from ACEA.

Water scarcity: Addressing the growing lack of available water to meet children's needs. (n.d.). Retrieved from Unicef: https://www.unicef.org/wash/water-scarcity

Whoriskey, P. (2016, October 2). *In Your Phone, In Their Air*. Retrieved from The Washington Post: https://www.washingtonpost.com/graphics/business/batteries/graphite-mining-pollution-in-china/

Worst Forms of Child Labour Convention. (1999, June 1). Retrieved from International Labour Organization: https://www.ilo.org/dyn/normlex/en/f?p=NORMLEXPUB:12100:0::NO::P12100_ILO_CODE:C182