An Overview of Electric Vehicles Incorporating All Eco-Friendly and Future-Shaping Techniques

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Abstract: In recent years, there has been a discernible rise in the public's interest in electric vehicles, which has led to a positive growth in the market demand for automobiles of this type. All the vehicles are distinguished by the fact that their engines are fueled by electricity, which results in the transformation of the electrical energy into the mechanical power that drives the vehicle. It is usual practice to use the word "environmentally friendly" to describe this occurrence since it makes use of non-conventional, renewable forms of energy and has a negligible effect on the level of pollution in the area around it. Despite the recent surge in preferences, a recurrent problem has surfaced, which has led to a considerable number of users expressing dissatisfaction with the service. The primary issue is that there are not enough charging stations currently available. There is a significant amount of cause for concern over the difficult work that is required to simultaneously optimize time savings and cost reduction. In addition, the use of artificial intelligence and machine learning in the production of automobiles seems to represent a significant step forward in the development of technological innovation, and it may provide a more beneficial strategy for the preservation of the environment. The utilization of a variety of marketing methods, as well as artificial intelligence, machine learning, renewable energy sources, and other cutting-edge technologies, is investigated in this research pertaining to the subject of electric cars.

Keywords: Algorithms and Computational Theory, Artificial Intelligence, Electric Vehicles, Machine Learning, Renewable Energy Sources.

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1 Introduction

People have always had an aim throughout the development of technology. Recycling, environmentalism, savings, and renewable energy are sought after. According to us, automobiles are the main cause of environmental deterioration and global warming. Since the start of the 21st century, electric car research and development have intensified due to pollution and energy challenges. As technology advances, electric automobiles with cutting-edge equipment are being made. In 1884, Thomas Parker created the first electric car, which has a long history. In 1899, Ferdinand Porsche built an electric car in Germany [1]. Compared to steam and gasoline engines of the time, electric automobiles were quiet, easy to use, and non-threatening. In the 1920s, 28% of U.S. cars were powered; therefore, electric vehicle companies did well. This was before Henry Ford's Model T and mass production. Due to the high expense of electric vehicles and the rise of conventional automobiles, marketing and production stalled. Another reason was that the wrong strategy was established, and rapid expansion had negative effects [2]. Today, electric vehicles are more popular due to their developers' efforts.

The development of electric vehicles from the past to the present, by increasing its own equipment and gaining new features, came before the user and still continues to develop. If we manage to impress people with each of its features and compare it with the sales rates in the past, there will be an increase in the number of electric vehicles [3]. Although it is preferred for its environmentalist approach as well as for saving money

on fuel, the lack of charging stations is a major issue. Recently, electric vehicle companies have been working to solve this problem. They have proposed solutions to these problems by placing different numbers of charging stations in the designated areas. Although solutions for these continue to be developed, the solutions produced seem to be like this for now. When examining the solutions' contents, it is evident that artificial intelligence technologies are involved. According to all research, it is important not to fall behind these technologies in societies aiming at awareness and development. So users want the devices they buy, even the cars they drive, to be state-of-the-art. They are aware of the idea of making their work easier and of the reliability provided by these technologies. In addition to these, although there are elements that will pose a threat, this business should be the focus of manufacturers since users and drivers do not deal with these threats. Manufacturers who take these into account will grow even more as they gain the trust of users. Analyzing each step and rising can provide the right growth strategy. The feedback from users also aids in the development of a roadmap for future processes. In addition to the increase in sales, good advertisements and marketing strategies are important. As a result, although it has an environmentalist approach and is the focus of preference, poorly planned marketing and advertising will reduce the rate at which people choose electric vehicles. Accurately, the rising use of electric vehicles may be attributed to the development of equipment and marketing methods. Figure 1 shows the user charging his electric vehicle in the city center.

In fact, the technologies that contribute to the creation of electric vehicles are technologies that make our daily lives simpler and may be found in the equipment we employ. Unbeknownst to us, these technologies are constantly improving and are quickly becoming an extension of our own capabilities. The most well-known technologies are artificial intelligence, machine learning, and 5G. People have always been interested in it, as it may generate direct interest in electric vehicles and boost their desirability. These technologies, which strive to make people's lives simpler and increase their contentment, have a significant impact on social evolution. A civilization that wants to expand now has the tools to do so through innovation, made possible by modern technologies. To continually renew themselves, electric vehicles employ these technologies directly and provide a connection.

Figure 1. Electric Vehicle [4].

When the research on electric vehicles is analyzed, it is discovered that there are not many studies on the topic. As a result of the significance of artificial intelligence and machine learning, which are both utilized in the production of vehicles, a search was conducted to find references to these concepts in the relevant body of literature. However, it was discovered that there are few studies in this field that focus on these approaches. In addition to that, studies on different marketing tactics for electric vehicles are investigated. This research was conducted with the goal of bringing more attention to the studies that have been done on electric vehicles and filling this gap in the existing literature. In this study, a qualitative research approach was taken, and an investigation of the relevant literature was carried out. Moreover, the significance of artificial intelligence in electric vehicles, the use of machine learning in the production of electric vehicle batteries, the use of 5G technology in electric vehicle charging stations, cyber security, data science, the integration of renewable energy sources into electric vehicles, marketing strategies for electric vehicles, as well as the advantages and disadvantages of electric vehicles are discussed.

Poullikkas [5] examined the many technologies that are linked to electric vehicles and the charging processes that go along with them. His study covered a wide range of topics associated with electric cars, such as the fundamental categories and technical characteristics of these vehicles, the fuel economy and CO2 emissions, the charging methods for electric vehicles, and the concepts of grid-to-vehicle and vehicle-to-grid architectures. Kumar and Revankar [6] gave a summary presentation on the technology behind electric vehicles as well as the primary approach. In addition to this, the current state-of-the-art permanent magnet brushless DC motor drive for the use of electric vehicles was described in their study.

Sun et al. [2] presented a detailed analysis of the technological evolution of EVs as well as new

technologies for their potential applications in the future. The most important aspects of electric vehicles' battery technology, charging technology, electric motor and control systems, and charging infrastructure were outlined. Harper et al. [7] examined and assessed the existing methods for recycling and reusing lithium-ion batteries from electric vehicles and identified opportunities for further advancements. Das et al. [8] provided an in-depth analysis of the current state of the electric vehicle (EV) market, including its standards, charging infrastructure, and the effect that EV charging has on the grid. Sharma et al. [9] concentrated on batteries since they are the most important part of making electric cars friendlier to the environment, more cost-effective, and the primary factor that pushes the adoption of EVs in day-to-day life.

Sanguesa et al. [10] discussed the developments that have been made in electric vehicles in terms of trends in battery technology, charging techniques, and new research difficulties and open prospects. To be more precise, an examination of the current state of the electric vehicle market throughout the world and its potential for the future is carried out. Zhao et al. [11] examined the processes by which batteries generate heat and the effects of those mechanisms (such as thermal aging, thermal runaway, and fire accidents) on the powertrain systems in electric vehicles and hybrid electric vehicles.

Gärling and Thøgersen [12] developed a two-phase approach for the marketing of electric vehicles based on a discussion of the existing and predicted future characteristics of EVs as well as a study of studies on early adopters. Jensen et al. [13] discussed the difficulty of predicting market shares for new products and proposed a method that combines advanced choice models with a model of diffusion. Their approach considered the fact that new products frequently require some amount of time before gaining a significant portion of the market. Liao et al. [14] provided a thorough assessment of studies on consumer preferences for EV with the intention of better informing policy-makers and giving direction to additional study. Secinaro et al. [15] reviewed 254 research studies that were connected to customer behavior in the market for electric cars and carried out bibliometric and thematic analysis on those studies.

Chitra et al. [16] brought together the research that has been done in the electric vehicles and hybrid electric vehicles (EV/HEV) industry, as well as the leadership role of sophisticated optimization approaches using artificial intelligence (AI). This is accomplished by gathering the findings of a variety of research conducted in the electrical, electronics, computer, and mechanical fields pertaining to the EV/HEV system. Lee [17] analyzed the effects of artificial intelligence (AI) on the technological innovation of electric vehicles by utilizing a machine learning-based text mining model and the international patent classification (IPC) co-occurrence network analysis. The data for their study was comprised of patents that were submitted between the years 1980 and 2017.

Rhode et al. [18] suggested a method for estimating the power and mission energy of electric cars that does not require knowledge of vehicle-specific data, nor does it require a drive-train model to be built. The technique that they have developed makes use of a data-driven methodology that is wholly founded on data collected from accessible car sensors. Ahmed et al. [19] provided an overview of the recent developments in electric vehicles (EVs) and related infrastructure, the majority of which were the result of artificial intelligence (AI), which makes EVs a more appealing consumer alternative. Besides, a critical analysis and assessment of the use of artificial intelligence in the improvement of electric vehicles (EVs), the facilitation of electric vehicle charging stations, and the integration of EVs with smart grids are presented.

Song et al. [20] examined research and examples in which machine learning approaches from each category were utilized to develop energy management strategies for hybrid electric vehicle (HEV) systems. Paret et al. [21] did a brief review of the application of artificial intelligence to three different subtechnologies within a power electronics system in the context of electric vehicles. These subtechnologies were semiconductor devices, power electronics module design and prognostics, and thermal management design. Their review was conducted in the context of a power electronics system.

2 Materials and Methods

This study aims to examine the integration of electric cars with contemporary technology on a global scale. The annual increase in the prevalence of electric cars relative to conventional automobiles is evident. The details may be observed in Figure 12. The rise in the adoption of electric cars has been seen to occur not just in a singular location but also throughout several regions worldwide, spanning from 2012 to the present. The development of electric cars necessitates concurrent advancement with cutting-edge technology. As a result, this feature enhances its popularity in comparison to alternative solutions. Given the

heightened sensitivity of individuals, a product must demonstrate its environmental friendliness and cost-saving attributes to effectively penetrate the market. Continuous improvement in many aspects, such as manufacturing and sales, is crucial to achieving this. Hence, the production and integration of the aforementioned must be conducted in tandem with cutting-edge technology. The quantitative data was assessed using a statistical table in the research. The objective of this investigation was to ascertain the level of interest among individuals in electric vehicles and identify users' specific preferences and dislikes towards these vehicles. We conducted an extensive examination of contemporary industry papers, scholarly articles, and data sources to explore pertinent subjects, including the involvement of AI in electric cars, the influence of machine learning on batteries, the use of renewable energy sources, and the significance of 5G technology in charging infrastructure. In addition, we analyzed the client's marketing strategy by examining existing campaigns, customer perception, and market developments. Therefore, through the process of evaluating the benefits and drawbacks, a conclusion was reached on the measures that may be implemented to enhance communication with customers.

3 Examining the Electric Vehicles

This section delves into the examination of the interplay between electric cars and artificial intelligence, machine learning, and 5G technology.

3.1 Electric Vehicle Batteries

One of the most important components of electric vehicles is the battery. The battery is of vital importance for electric vehicles (EV) and is also a major factor in sales prices. The more powerful the battery, the higher the cost. Lithium batteries are the most used batteries for electric vehicles because they have very high power density and very high energy. Not only these, but also being light and fast charging is a big factor. Drivers look at the charging time as well as the comfort of the vehicle before purchasing it. Saving time is an important factor for everyone [22]. The cost of lithium-ion (Li-Ion) batteries for electric vehicles is shown in Figure 2.

All batteries used have a calculated lifespan. Accordingly, the performance of the vehicle may change. The main factors affecting battery degradation are charging cycles, power and depth of charge, and exposure to high temperatures. The characteristics of batteries in modern electric vehicles are shown in Table 1.

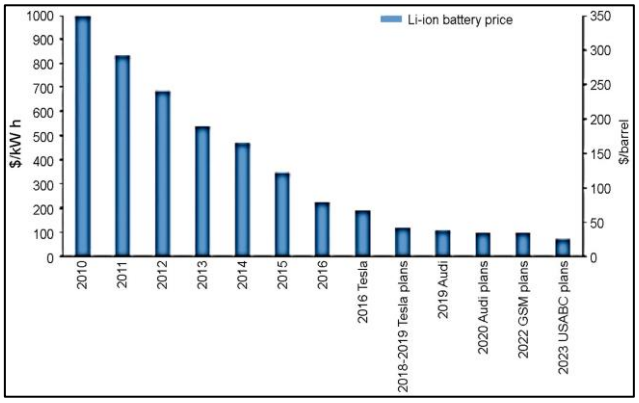


Figure 2. The cost of lithium-ion (Li-Ion) batteries for electric vehicles [23].

Table 1. Characteristics of batteries of modern electric vehicles [23].

Battery Parameters	**Tesla Model S**	**Nissan Leaf**	**BMV i3**
Battery capacity, kWh	85	24	22
Power reserve to full charge, km	426	175	160
Resource, years	7	5	5
Full charge cycle (220 V), h	8	8	8
Energy consumption, kWh/100 km	27.7	21	12

The charging time of the battery depends on the charge level of the electric vehicle when it arrives at the station and is proportional to the amount of energy transferred [22]. When drivers want to charge the battery, they want to go to the station with the shortest distance possible and visit a small number of stations in order to save time. In order not to shorten battery life, it is not recommended to charge the battery when it is fully discharged. Therefore, it is better to charge the battery more frequently rather than completely discharging it.

3.2 Using Artificial Intelligence in Electric Vehicles

Artificial intelligence, which has come to the fore with its admirable development day by day and by developing and expanding the areas in which it is used, has also taken part in studies that will draw attention to electric vehicles. Using artificial intelligence provides an important strategy, as the goals of the producers are to become popular by creating unique works. Unlike other vehicles, electric vehicles have many advantages,

so they are frequently observed on the highways. The role of artificial intelligence in its increase is quite large. Of course, as there are many fields of study in artificial intelligence, there are also studies on electric vehicles [10]. Artificial intelligence techniques play a significant role in the collection, processing, and interpretation of data and enable solutions and technologies that cannot be explained [24]. The correct processing of data from electric vehicles plays an important role in the development phase. Artificial intelligence applications can be used to increase the reliability of electric vehicles. Although there are different artificial intelligence application studies in different parts of the vehicle, one of the biggest problems with electric vehicles is undoubtedly the battery problem, and optimization processes are trying to be continued with artificial intelligence technologies. The use of AI technologies in the battery management of electric vehicles and range optimization to increase energy efficiency will also be the focus [25-27]. In Figure 3, the effect of artificial intelligence on all stages of electric vehicles and charging stations is shown.

The equations below are artificial intelligence algorithms for electric vehicles.

$$e_{ij} = [m \;\; 1] z_{ij} \tag{1}$$

$$z_{ij} = [\alpha_{ij} \;\; \beta_{ij}]^T \tag{2}$$

$$\alpha_{ij} = \sum_{(a,b) \in P_{ij}} \alpha_{ab}$$

$$\beta_{ij} = \sum_{(a,b) \in P_{ij}} \beta_{ab} v_{ab}^2 \tag{3}$$

$$t_{ij}^k = \sum_{(a,b) \in P_{ij}} \alpha_{ab} \frac{d_{ab}}{v_{ab}^k}$$

Energy calculation by artificial intelligence is realized with equations (1) and (2). Equation (3) is used to calculate the change in speed of the vehicle during each time period of the day. Calculating the energy is very important because it affects the speed of the vehicle. Where d_{ab} is the total distance between a and b. m is the truck load, set at 13500. e_{ij} is the energy between node i and j. v_{ab} is the average speed for road i to j. a and b are road links (or intersections). P_{ij} is the least energy path between i and j. α_{ij}, β_{ij} and z_{ij} are energy cost coefficients [28].

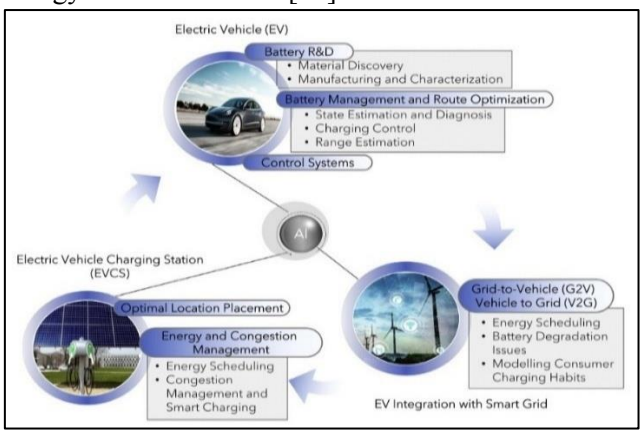


Figure 3. The Effect of Artificial Intelligence in Electric Vehicles [19].

3.3 Using Machine Learning in Electric Vehicle Battery Production

Batteries are often the power source, making electric cars a key component in the job of supplying energy storage [29]. To provide the desired energy to electric vehicles, the batteries are connected to each other to be combined into battery modules, and then the combined modules are connected to a battery pack. In fact, we anticipate that these connections will provide the desired performance for electric vehicles, but some performance deterioration may be detected during operation owing to the battery. Among these reasons, the vehicle cannot provide correct battery management or there are some errors due to the design and manufacture of the battery. Machine learning comes into play to ensure correct battery management. Batteries manufactured must be safe and efficient for proper management. This is where machine learning comes into play, improving consumer perception among electric vehicles and humans by following the battery schedule. At the same time, machine learning can be used as a solution when the vehicle is about to stay on the road. In fact, machine learning is less costly and time-saving than other approaches for battery material discovery and characterization [19]. Machine learning techniques can also train the chemical properties of the batteries used. This provides us with the desired efficiency in battery modules. Equation (4) is used to determine the capacities of batteries used in electric vehicles [30].

$$BSC(t) = \frac{K(t)}{K_m} \text{x\%100} \tag{4}$$

Battery State of Charge (BSC) is the percentage of the current capacity ($K(t)$) of the battery to the maximum capacity (Km) currently provided by the battery [30]. Nonetheless, there is a formula by which the Battery Energy Status may be calculated. However, the Battery Energy Status (BES) may be calculated using equation (5). BES gives us an idea of the way our electric vehicle can go, apart from the battery's life and performance, just like in the BSC. BSC gives us information in ampere-hours (Ah), and BES in Watt-hours (Wh).

$$BES(t) = BES(t-1) + \int_{t-1}^{t} \frac{P_{bat}(t)\eta_e}{E_{bat}} dt \, , t \geq 1 \qquad (5)$$

$BES(t)$ is the instantaneous BES value, $BSC(t-1)$ is the previously measured BES value (initial value for $t=1$), the nominal energy amount of the E_{bat} battery, η_e is the energy efficiency of the battery, and P_{bat} is the power value of the battery at the time t [30].

3.4 Using 5G in Electric Vehicles

Since everyone is accustomed to electric vehicles, it is no longer shocking that advancements that make consumers' lives simpler daily are no longer startling. Even while chatting with others, the term "digitalizing" is spoken with ease. Since millions of new pieces of data are created every day in the Internet age, it is crucial that these are given to the right parties swiftly and economically. In this case, 5G is also preparing to enter our lives. 5G technology, which is prepared for use in electric vehicles, plans to offer customers more connected and smarter vehicles [31]. 5G technology, on the other hand, is primarily intended for use in electric vehicle charging stations. Because the number of electric vehicles whose use is increasing to reduce carbon emissions increases, confusion may arise due to the large number of vehicles and the scarcity of charging stations for electric vehicles. As a solution to this, alternative solutions have been developed by using 5G technology and showing us where the nearest charging station is and how long we will wait to charge our vehicle at this station [31]. Figure 4 shows the effect of 5G technology in charging stations and it is seen that it is optimized and put into use day by day.

Figure 4. Charging Station with 5G Technology [32].

3.5 Sustainability Effect Formation in the Use of Electric Vehicles

Sustainability is the capacity to fulfill the requirements of the present world without jeopardizing the demands of future generations. Electric automobiles' sustainability pertains to their capacity to serve as a practical and eco-friendly substitute for conventional gasoline-powered automobiles [33]. The primary determinants of electric vehicles' sustainability are the specific sensors utilized. Each sensor is tailored for a distinct function, such as forward collision prevention, emergency braking, vehicle connectivity, and traffic sign identification. Electric cars are well-equipped and get significant attention. These sensors enhance driving comfort and safety by gathering data on both the vehicle's interior and exterior conditions. Figure 5 displays sensors installed in electric cars.

Electric vehicle sustainability may be categorized into three primary aspects. 1. life and prosperity; 2. a safe environment; 3. innovation and progress.

1. Electric cars enhance safety by reducing accidents, minimizing worldwide fatalities, ensuring passenger safety, and offering convenience to drivers, ultimately promoting life and prosperity. Electric cars also mitigate environmental health risks by enhancing the quality of life in metropolitan areas where air pollution is a significant concern.

2. Electric cars have a notable influence on the environment since they do not emit greenhouse gases that significantly contribute to climate change, thereby providing a safe environment. Electric cars are often more energy-efficient than gasoline-powered vehicles [33].

3. Electric car manufacturers always strive to innovate and develop their vehicles to enhance their efficiency. It excels at innovating and tackling obstacles, such as by enhancing models with extended battery life and enhanced safety features for driving. Vehicles are equipped with various sensors that aim to decrease travel time, alleviate traffic congestion, and

foster innovation and growth in the transportation industry. New technology and infrastructure, such as charging stations, can aid the expansion of the electric car industry and enhance the overall sustainability of the transportation system [33].

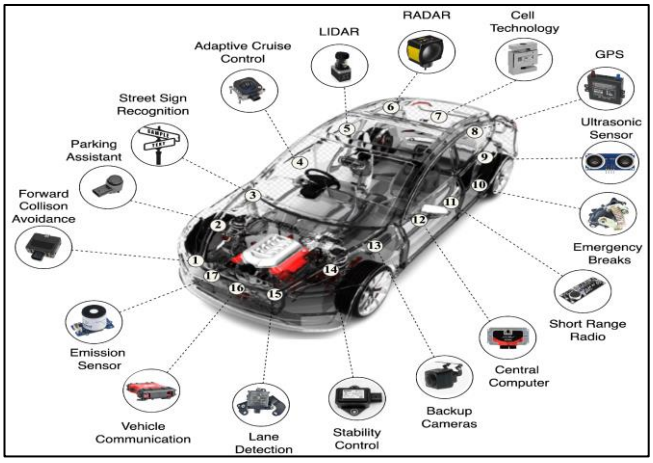


Figure 5. Illustration of sensors and safety features in electric vehicles [33].

4 Cyber Security and Attack on FPGA

In addition to the benefits brought forth by modern technology, there may be undesirable outcomes, such as cyberattacks on charging stations. The cyber security threat scenarios for electric vehicles are shown in Figure 6. It is to disable the circuit and make it vulnerable by changing the control parameters of the circuit that draws power from the station. The goal is to degrade system performance, degrade system reliability, or cause damage to circuit components [34]. In such cases, damage can often result as the battery of the electric vehicle is exposed to excessive voltage.

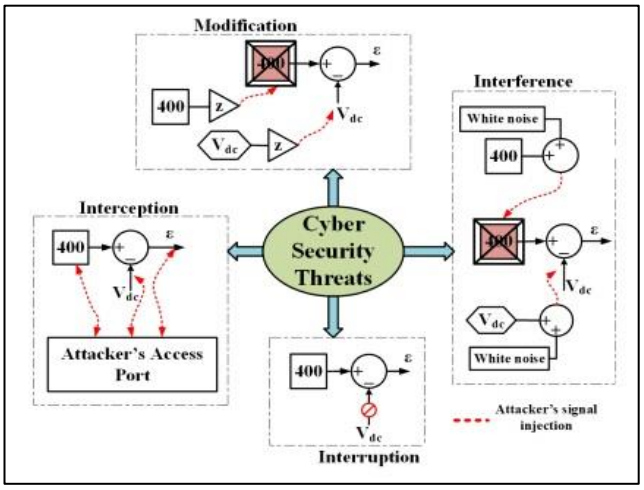


Figure 6. Cyber Security Threats [34].

Studies where everything is programmable, of course, have a great place in the creation of electric vehicles and charging stations. FPGAs (Field Programmable Gate Array) are digital integrated circuits consisting of logic blocks and intermediate components of logic blocks used in the creation of electric vehicles [35]. It is seen in attacks made on the FPGA. The logic of protection from these attacks is to use more than one control block inside the FPGA. It has FPGA-based security considerations, but the attacker may try to implement an attack circuit on a part of the FPGA to steal and modify the victim's control logic in the same FPGA via a side-channel communication link called an intra-FPGA attack [34]. Among the disadvantages of FPGA use is that the attacker can program a part of the FPGA remotely as he wishes since he has programming permission. In Figure 7, the internal attack scenario of the FPGA used in electric vehicles is shown.

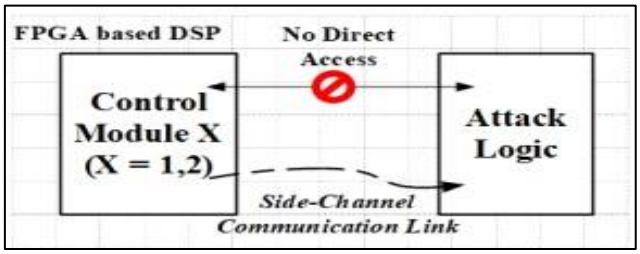


Figure 7. Intra FPGA Attack [34].

5 Data Science and Renewable Energy Sources in Electric Vehicles

Many sensors are employed throughout the manufacturing process of electric vehicles since technology advances. These sensors are in constant interaction with the devices in the vehicle and the transmitter and receiver devices in the charging station. A lot of data is generated from these interactions. In general, cloud services are used by using the Internet of Things and the Internet of Vehicles to parse, analyze, and use this data [36]. The stronger the in-vehicle and out-of-vehicle communications, the greater the power to connect to cloud services. All the data from the electric vehicle driver, the charging stations used, and the sensors used form complex data [37]. As an example of in-vehicle data, new vehicles produced by vehicle manufacturers are designed by incorporating this data and creating and recording numerous variables, such as how quickly the driver accelerates and decelerates, how long it takes to turn on the air conditioner and how long it stays on, or how long the charge lasts. By gathering and analyzing the collected big data, we can assure that the next generation of electric vehicles is manufactured with the required enhancements [38]. In Figure 8, the interaction between the charging stations and drivers, which are the components of the electric vehicle, is shown.

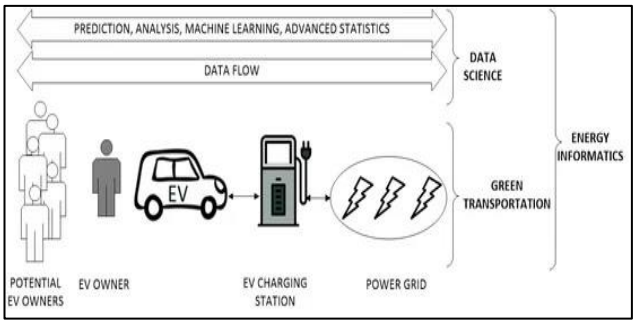


Figure 8. Interactions [39].

Integrating renewable energy sources into electric vehicles has improved the electric power grid and attracted consumers. These sources, notably wind and solar PV, will make the electrical grid greener. Renewable energy sources like wind speed and solar radiation can generate a lot or little electricity. Time-varying renewable energy sources are difficult to ship and have poor capabilities, especially for power system planning [40]. Many of these materials focus on the sophisticated and realistic power grid integration of wind energy conversion and PV solar systems. Fixed energy storage devices or controlled distribution loads can balance renewable energy generation in the network. When power generation is high or low, stationary energy storage systems absorb electricity. High investment costs for fixed energy storage. Electric vehicles will become essential in a few years as they gain notice.

Electric cars may absorb extra renewable energy power through charging schemes or supply power to the grid during low power generation to counter grid events. Electric vehicles will exert energy strain on grid regulations. Renewable energy and vehicle-to-grid electric cars will ensure energy security and reduce greenhouse gas emissions. To reduce greenhouse gas emissions and costs, a plan must maximize electric cars and renewable energy consumption. Therefore, EV-V2G cars and electric vehicles linked to renewable energy sources in smart grid mode cut daily vehicle expenses by 0.9% and emissions by 4.3%. According to these findings, electric cars and renewable energy sources are perfect partners [41].

Figure 9 shows the integration of wind and PV solar sources with EVs into the electricity grid. Electric vehicles are collected at a public or office charging station and can be used to suppress power surges from these renewable energy sources in vehicle-to-grid mode. In this way, we assume that all necessary communication and control schemes are available for vehicle-to-grid and charging scenarios. In Figure 9, T_i represents the power transformer in the electrical grid, where $i = 1,2,3,\ldots, n$ [42]. In addition, the effect of renewable energy sources on electric vehicles can be seen in Figure 9.

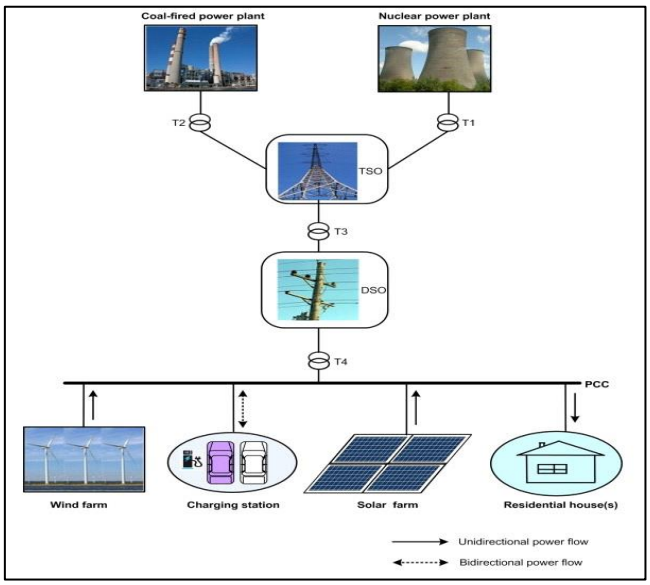
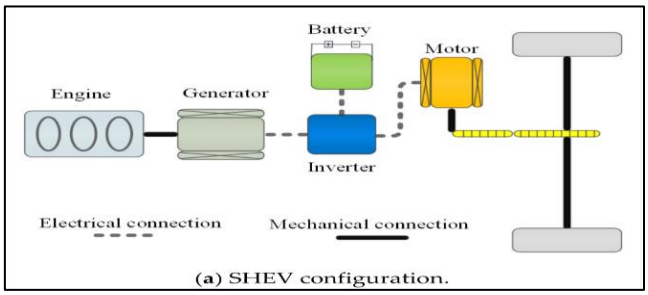


Figure 9. Renewable Energy Sources with Electric Vehicles [42].

6 Electric Vehicle Algorithms

When designing an electric vehicle, all possible conditions should be considered and precautions should be taken accordingly. This actually allows all aspects to be considered to revise the vehicle performance. Electric Vehicles can be divided into three categories according to their powertrain components, configurations and control strategies: series hybrid electric vehicle (SHEV), parallel hybrid electric vehicle (PHEV) and series parallel hybrid electric vehicle (SPHEV). Figure 10 shows different configuration types [43].



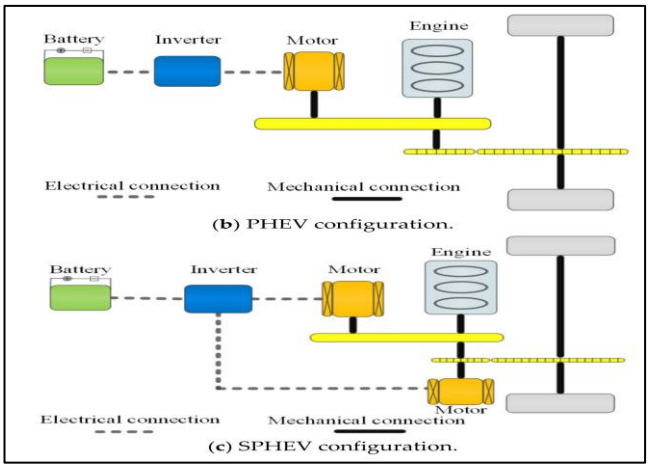


Figure 10. Classification of Electric Vehicles by components and configurations [43].

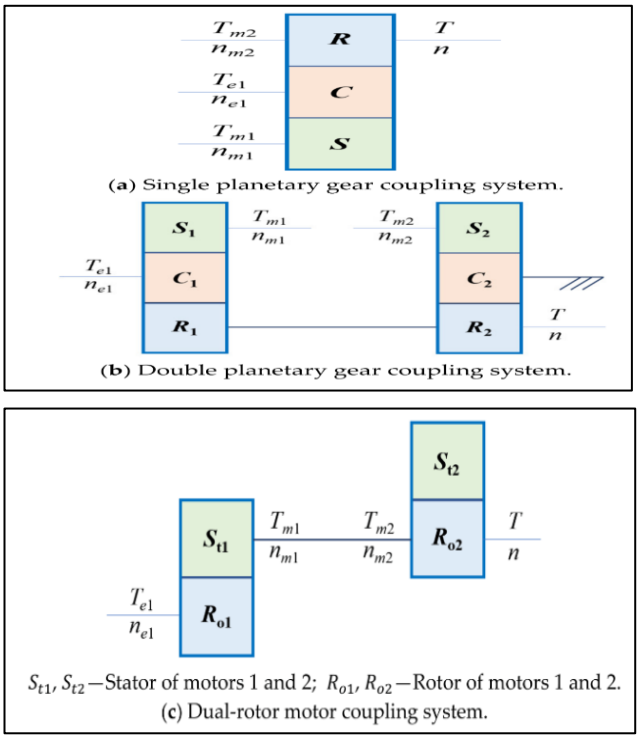


Figure 11. Schematic diagram of hybrid coupling system [43].

When in Figure 11a, a hybrid coupling system with a single planetary gear uses a generator and an electric motor. In Figure 11b, a generator and electric motor are linked by a double planetary gear system. The input-output connection is the same as in Figure 11a, but the coefficients change [43]. Figure 11c illustrates a double-rotor motor installation.

7 SWOT Analysis for Electric Vehicles

When examining the strengths, weaknesses, opportunities, and threats associated with the growing development and proliferation of electric vehicles, it becomes apparent that a comprehensive analysis is required. When considering the strengths of electric vehicles, the integration of artificial intelligence and machine learning has the potential to enhance their efficiency and intelligence, facilitating drivers' tasks. By evaluating the simulated motions of drivers while operating a car, this approach aids in enhancing the enjoyment and safety of their trip experience. The battery is a significant determinant of vehicular comfort. Machine learning has facilitated the enhancement of power and durability in the production of electric car batteries. The utilization of 5G technology facilitates rapid and safe transmission of data while also demonstrating an ecologically conscious approach through the incorporation of renewable energy sources.

Moreover, there are certain weaknesses or disadvantages. The integration of artificial intelligence (AI) and machine learning (ML) has grown widespread across several fields, enabling, and improving various facets of our everyday existence. Nevertheless, the use of these technologies gives rise to concerns regarding the complex nature and security of the algorithms utilized. Although the initial cost is significant, the integration of machine learning into battery production is anticipated to result in higher expenditures when compared to traditional batteries. On the other hand, the implementation of 5G technology can face constraints in some regions due to insufficient infrastructure. The possible susceptibility of the Field-Programmable Gate Array (FPGA) is a noteworthy concern as it facilitates the remote manipulation of the automobile, compromising the safety of the driver.

The opportunities of artificial intelligence in electric vehicles encompass a range of prospects, including the augmentation of driver assurance, the promotion of vehicular progress, and the enhancement of driving convenience. To broaden the user base of electric cars, the integration of machine learning methodologies in battery research and development has the potential to yield cost reductions. The implementation of 5G technology has promise for improving communication capacities and addressing infrastructural constraints, thereby alleviating common concerns in diverse locations. The attainment of this objective can be realized by ensuring the availability of adequate infrastructure. Providing the opportunity to install enhanced cybersecurity measures to minimize possible attacks on Field-Programmable Gate Arrays (FPGAs). The adoption of renewable energy sources has been found to contribute to increased environmental awareness and improved energy efficiency.

When considering the issue through the lens of threats, it becomes evident that the deployment of artificial

intelligence brings about a degree of unpredictability and possible risks, mostly arising from the complex nature of algorithms. The use of machine learning methodologies in battery production has the potential to introduce complexities and present obstacles to the market's inclusivity. The presence of inadequate infrastructure may lead to technical challenges with the adoption of 5G technology. In the event of a security breach aimed at an automobile's Field-Programmable Gate Array (FPGA), bad actors would be able to change how the car works, putting the safety of drivers and other people on the road at risk.

8 Marketing Strategies and Advantages-Disadvantages of Electric Vehicles

Although it is environmentally friendly, comfortable, and reliable, users make detailed research, prioritizing the price before purchasing. Although electric vehicles are currently attracting a great deal of attention around the world, there is no process until they are purchased due to improper marketing strategies. The customer may be restricted to only perusing [44]. Good marketing is vital to success. Even if the customer doesn't need it, making the customer feel like they need it is a sign that marketing strategies have been developed. If the company shrinks in the price-performance relationship, it indicates that this long-term marketing strategy is successful because it calculates well enough to compensate for the losses that will occur early in the long term [12]. Otherwise, if the calculations of this plan cannot be done well, the company may go to the brink of bankruptcy. Another issue affecting sales can actually be shown as the number of production volumes. Nobody will be willing to buy a product that is scarce in the market because of the defect, comfort, or reliability of the vehicle. To build effective marketing management, it would be prudent to employ technology. People even research a product on the internet and read the comments made by the people who bought that product before, and this plays an important role in forming the customer's ideas. When a customer who buys an electric car is satisfied, people unintentionally advertise the car online or by word of mouth. Since the first impression is very important, it can attract attention with the correct advertisements of the people who undertake the planning, marketing, and management strategies of the company. In addition, it is predicted that if the electric car is allowed to take a test drive by dealing with the customer one-on-one, it will instill a sense of testability and confidence in the customer. Before final purchases, the customer can be given the opportunity to try on his own social life by renting, so that the person will follow the buying path after experiencing that confidence and comfort. An excellent method is to focus on the consumer and convince them that they need this car. In line with all these strategies, electric vehicle sales rates by year and country are shown in Figure 12. According to the graph, there is an increase every year.

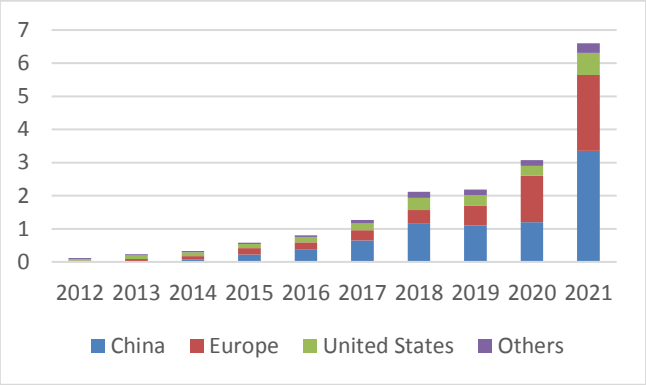


Figure 12. Global Electric Car Sales [45].

To begin with, while discussing the benefits of electric vehicles, the most obvious benefit that everyone is aware of is that they are ecologically beneficial. It runs cleaner than gasoline-powered vehicles, which makes it environmentally friendly. Drivers who want to save money always look for electric vehicles. It will help keep the budget under control as fuel prices continue to rise [46]. Therefore, another advantage is savings. The electric vehicle is much cleaner, and less fuel is required for the vehicle. This means fewer emissions and less dependence on fossil fuels. It reduces dependence on fossil fuels and aims to reduce its carbon footprint on the environment. Finally, it also provides comfort and safety to drivers due to the advanced technologies used.

People complain that electric vehicles are expensive. Electric vehicles are relatively more expensive than a regular fuel car [47]. In case of any malfunction in the vehicle, the driver who wants to repair it may have to pay higher maintenance costs. Because it will be extremely expensive to repair the parts of the vehicle developed with the latest technologies. It is considered unsuitable for speed lovers, but it is more suitable for urban driving than mountainous areas [48]. Even when all the advantages and disadvantages are considered, there has been a surge in the popularity of electric vehicles. These vehicles, which continue to attract the attention of drivers with each passing day, are slowly starting to take their place on the roads.

9 Results and Discussion

As a result, many aspects of electric vehicle production and sales have been investigated. Although there is a

plus to the latest technologies applied to these tools, marketing strategies also need to be structured correctly. Techniques such as artificial intelligence and machine learning are indispensable parts of both today and the future. It will be an advantage to develop these techniques further and integrate them into the electric vehicle produced each time. Observing the activities that the vehicle performs because of connecting it with renewable energy sources demonstrates a good association between environmental friendliness and cost savings. Electric vehicles are becoming increasingly popular to save money, improve comfort, and reduce environmental pollution. Obviously, it is impossible to overlook the technology employed to construct the car.

It has been observed that the feeling of comfort and confidence that is desired to be provided to drivers has increased with the development of technology. There are also contributions from users for each optimized tool, but in a way, it also provides reinforcement against external attacks. When the proper analysis and customer satisfaction are observed, an electric vehicle that is both innovative and environmentally friendly can be created. Even now, it is up to the manufacturers to remove the question marks from the minds of the electric vehicle's drivers, who are eagerly waiting to use it. Because a technology that is talked about and is the center of attention under properly structured strategies will be beneficial for both the environment and savings, this information should be accurately conveyed to the drivers. In a few years, it will become apparent that disregarding the flaws of our electric car and promoting it as such is not a feasible approach. But if it is continued by constantly optimizing, it will be beneficial to grow even more. Of course, the use of techniques such as artificial intelligence, machine learning, deep learning, and data science will provide a great advantage. Even when examining every piece of work completed with the use of these approaches, the future is already evidently bright.

Those that invest in electric vehicles do so with the expectation that their vehicles' batteries will be robust and long-lasting. The purpose of machine learning is to extend the life of the batteries in electric automobiles and to create workplaces that are safer and healthier for employees. This strategy turns into a useful tool when combined with various forms of artificial intelligence. It is hoped that 5G technology will make the jobs of its users easier by lowering the amount of uncertainty that exists at charging stations.

Liao et al. [14] reviewed consumer preferences for EVs to inform policymakers and guide future research. Their study of artificial intelligence and machine learning is less focused because it is not their main emphasis. Sun et al. [2] presented on electric car technology's battery, charging, electronic motor, charging infrastructure, and new technologies. They covered many important issues. They studied artificial intelligence and machine learning less. Rajper and Albrecht [49] studied driving and resisting factors for E4Ws, HEVs, and E2Ws in emerging nations. According to their literature review, E2Ws are more feasible for poorer nations because of their low purchase and running costs. They barely briefly address technology in their studies.

One of the most serious issues with electric vehicles, as we have already stated, is a lack of charging stations. Extending the wait time for those who wish to charge their cars in congested places might have harmful consequences. Simultaneously, due to a scarcity of adequate public charging stations for various types of EVs, more frequent charging stations will need to be constructed or other charging techniques will need to be investigated. In other words, because utilizing the same charging station for an electric car and an electric truck would be inefficient in terms of both time and power consumed by the vehicle, multiple charging techniques should be studied. The charging outlets in the parking spaces have adequate capacity to power an electric vehicle but not an electric truck. In such a case, it will be insufficient to completely charge these cars, which may lead them to remain on the road.

When the return-to-base model charging infrastructure is considered, this electric truck model may fully charge our electric automobiles at night or outside of working hours [50]. The most crucial thing is to set up charging stations that can accommodate all types of electric automobiles. Electric car makers must consider all types of electric vehicles and plan for their future work. This idea must be part of your strategy to flourish and grow. Because there are vehicles other than electric automobiles, such as electric trucks, electric motorbikes, electric bicycles, and electric scooters. This concept is only an example of how to charge an electric vehicle. Similar research should be conducted in this direction to overcome these issues by evaluating various electric cars.

There are already a variety of electric cars that are prevalent on the highways. How long does the electric car take to charge? and how long does the electric vehicle's charge last? are often the features that businesses must consider when purchasing electric vehicles. These should be given consideration. Because a vehicle is essential for a business. The electric car should not fail the company's personnel in an emergency and assure their safety. Otherwise, it will

not be favored. Some businesses desire business partnerships with other businesses to develop and expand. These parties may hail from beyond the city and, occasionally, even the nation. Companies that wish to meet them or transport them will utilize their own car. Based on comfort, safety, and long-term usage, they desire that the electric vehicle's battery does not run out of charge immediately. Since the use of electric cars has expanded, vehicle makers should pay particular attention to these characteristics. When assigning electric vehicles, it would be preferable if businesses, managers, and employees took these aspects into account.

The stability of electric vehicles (EVs) is a key aspect in ensuring safe maneuverability, effective battery weight distribution, and control of the center of mass, particularly under dynamic driving conditions. Recent studies have analyzed EV stability using metrics such as lateral acceleration, roll angle, and yaw rate [51-52]. In this study, a brief overview based on the bicycle model of vehicle dynamics is introduced, taking into account moment of inertia and road friction coefficients—elements commonly used in nonlinear stability control strategies. This modeling approach helps lay the groundwork for deeper understanding of stability-related behaviors in next-generation EVs. Furthermore, the study offers a unique perspective by combining eco-friendly design principles with artificial intelligence-driven control mechanisms—an intersection that remains relatively unexplored in the current literature [16, 19]. These integrations are intended to broaden the technological and conceptual scope of EV research. In future research, we anticipate that the production and optimization of charge will be enhanced. Because the durability of the charging capacity is crucial for businesses, managers, and external stakeholders, as well as for drivers.

10 Conclusion

This research explores the importance of AI in the context of electric vehicles (EVs), specifically focusing on its application in producing EV batteries and incorporating renewable energy sources. Additionally, the study examines the utilization of machine learning in battery production, the integration of 5G technology in EV charging stations, the significance of cyber security and data science in the EV industry, and the marketing strategies employed for promoting EVs. Furthermore, the research evaluates the merits and drawbacks associated with the adoption of EVs. The significance of our work is growing due to the rapid advancements in new technologies, since it encompasses several crucial subjects such as artificial intelligence, machine learning, and marketing. Our study is classified as multidisciplinary due to the incorporation of the field of marketing. Furthermore, a comprehensive study was undertaken to analyze the worldwide electric vehicle market, with a distinct focus on examining various marketing strategies employed in the industry. This research also examines the integration of renewable energy sources with electric vehicles, aiming to reduce the ecological footprint of these vehicles by harnessing electricity from such sources. The fast emergence of these vehicles can be attributed to their involvement in energy transformations and their cost-saving potential, making them a favorable option. By prioritizing the timeliness of these research endeavors, it establishes a solid foundation for the advancement of electric cars. This research not only contributes to the advancement of electric cars but also serves as a valuable resource for stakeholders and potential electric vehicle purchasers, offering guidance and information on these vehicles. The rapid global attention that electric vehicles have received indicates the existence of an interactive framework within the industry.

11 Ethics committee approval and conflict of interest statement

There is no need to obtain permission from the ethics committee for the article prepared. There is no conflict of interest with any person / institution in this article prepared.

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