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A Detailed Analysis of Electric Vehicle Technology Advancements and Future Prospects

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Abstract: The development of electric vehicles has surged in several nations in an effort to lessen reliance on oil and environmental damage[1]. A solution to the energy crisis and environmental problems is the adoption of EVs, particularly battery electric vehicles. This study offers a thorough analysis of the technical advancement of EVs and new technologies for use in the future. EV charging infrastructure, electric motors, batteries, charging technology, and electric motor control are all briefly discussed. As an additional contribution, this study also emphasises the technological difficulties and cutting-edge technologies for the future advancement of EV safety, dependability, and efficiency.

Index Term: Battery technology of Evs; batteries; charging technology; electrical motor and control; charging infrastructure;

I. INTRODUCTION

Energy and environmental problems have been brought on by the growing number of internalcombustion automobiles that use non-renewable conventional fuels. To lessen their reliance on oil and the air pollution that conventional automobiles produce, many nations have adopted new energy vehicles (NEVs) as alternatives to conventional vehicles. China, the biggest vehicle market in the world, is dedicated to developing NEVs in order to lower oil imports and consumption. Germany wants to cut CO2 emissions in Europe by putting one million electric vehicles (EVs) into use by 2020[2]. France and the UK similarly want to stop selling conventional cars domestically by 2040. Many nations gave incentives and unique tax policies to encourage the use of NEVs, such as plug-in vehicle subsidies in the UK and the clean vehicle rebate.

EVs have been around for more than a century as a post-industrial revolution emergent technology. Tom Parker invented the first usable electric vehicle in 1884. The electric car built in Germany in 1899 by Ferdinand Porsche is another well-known example of an early electric vehicle. Electric cars at the period were silent, simple to operate, and did not release any offensive-smelling pollutants, unlike steam and gasoline engines. In the 1920s, when 28% of all vehicles built in the U.S. were electric, EV manufacturers saw some degree of success before Henry Ford created the Model T with a revolutionary mass production method.

II. OBJECTIVES

The study looks at the factors that influence how EVs and related regulations proliferate. While new technologies, like EVs, compete with the established sector in their early stages, policies are crucial to their proliferation. In order for EVs to compete with ICEVs, policy support is initially necessary (Lieven, 2015; Rietmann and Lieven, 2019). The advantages of lock-ins, unaccounted-for externalities, and preconceptions favour ICEVs [8]over innovative technology. The disparities in the national distribution of EVs can be attributed to the early governmental assistance, namely financial incentives (Münzel et al., 2019; Santos and Davies, 2019), that was made available.

What explains the variance in the timing of EV take off (as a result of EV policy support) across nations is examined in the research along with why some countries implement EV policies early and others lag behind. In addition to being a study for policymaking, this is a study of policymaking.

The study intends to provide insights into whether or not nations will reach take off, which countries will, when, and why. It also wants to contribute to the understanding of the explanatory variables of EV take off across countries, first, among other things, as a policy support outcome. By examining the explanatory factors, the focus of the investigation into technology adoption can be changed to emphasise the circumstances necessary for take off (Kauffman et al., 2012). Conceptually sound and empirically supported responses to these concerns are crucial in order to build global transition paths that reflect regionally distinct technology transitions. A better way to provide guidance to policymakers is to identify some of the obstacles to policy evolution.

There is not much empirical data in this area globally. Previous quantitative studies have concentrated on the effectiveness of incentives in a specific nation, such as Sweden (Egnér and Trosvik, 2018), Norway (Mersky et al., 2016), the United States (Clinton and Steinberg, 2019;

Jenn et al., 2018; Plötz et al., 2016); and China (Wang et al., 2017); or on a region, such as Europe (Münzel et al (e.g., Wesseling, 2016). The latter, in a rare move, took political aspects into consideration.

The diffusion of EVs from a consumer goods perspective (Gass et al., 2014; Altenburg et al., 2015; Liu et al., 2017; Meckling and Nahm, 2018); identifying the predictors of EV adoption among consumers for individual markets (Priessner et al., 2018; Zarazua de Rubens, 2019); or diffusion of policies, including energy technology policy, across countries, are some examples of other literature (e.g., Vinichenko, 2018).

Similar research has not been done on the diffusion of EV support policies or technologies or the underlying political and economic factors that influence policy engagement. A deeper comprehension of the differences across nations can aid in making more accurate forecasts about which nations will adopt policies and when they will take off. Despite having a lot of promise, the transport sector has so far received little attention in the literature on policy diffusion (Schmidt and Fleig, 2018).

III. METHODOLOGY

A. Battery Technology Of EVs

Since traction batteries power the propulsion system of EVs, the technology development of these batteries has a significant impact on the EV business. An EV was equipped with a rechargeable lead-acid battery when they first arrived. With the advancement of battery technology, the market for batteries has seen an [3]increase in the variety of power batteries available. The needs for the traction battery haven't changed much despite advances in battery technology. EV batteries need to supply constant power, which is different from the batteries used for starting, lights, and ignition. Thus, having more energy capacity is crucial. High energy density, high specific energy, and high specific power are also essential. Currently, the major types of rechargeable batteries utilised in EVs.

1) Lead-Acid Batteries

Invented by French physicist Gaston Plante in 1860, the lead-acid battery is rechargeable. In an electrolyte made of diluted sulfuric acid, it has a negative plate made of lead metal and a positive plate made of brown lead dioxide. It is possible to transform chemical energy into electrical energy, which is stored in lead-acid batteries. As the first and currently most popular form of rechargeable battery, lead-acid batteries are still in use today. The least expensive battery option and historically the most used power source are flooded lead-acid batteries. The great availability, high durability, and low cost of lead-acid batteries made them a popular choice for some EVs. When it came to lead-acid batteries, the largest issue was the effects their manufacturing had on the environment. The health of humans is gravely harmed by lead. The collection and recovery rate for lead-based batteries has now exceeded 99% in the EU and the USA. When compared to other items, this is a relatively high level. 95% to 99% of spent batteries are recycled in the majority of affluent nations. However, due to their lower specific energy and lower energy density, lead-acid batteries are not widely used in EVs. Lead-acid batteries store less energy per unit mass or volume than lithium-ion batteries do, as illustrated in Fig. 1. For EVs, battery volume and mass are crucial. An EV may travel further between charges if the battery is smaller or lighter. Presently, low-speed EVs are the principal application for lead-acid batteries.

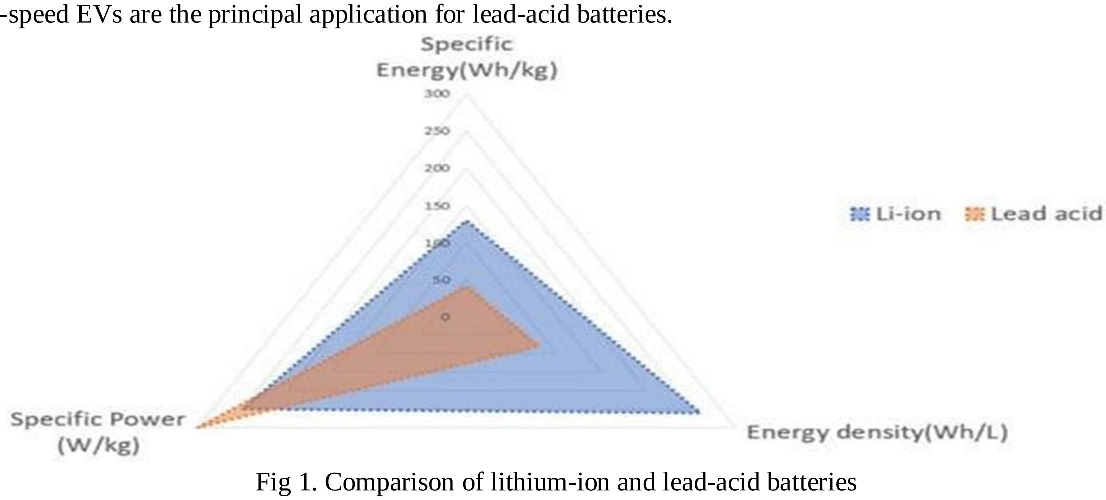

Fig 1. Comparison of lithium-ion and lead-acid batteries

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2) Nickel-Metal Hydride Batteries

To positive electrode in nickel-metal hydride batteries is made of nickel hydroxide, the negative electrode is made of various materials, and the electrolyte is a solution of potassium hydroxide. Nickel batteries come in a variety of forms, including nickel-iron (Ni-Fe), nickelcadmium (Ni-Cd), nickel-zinc (Ni-Zn), nickel-metal hydride (Ni-MH), and nickel-hydrogen (Ni-H2).

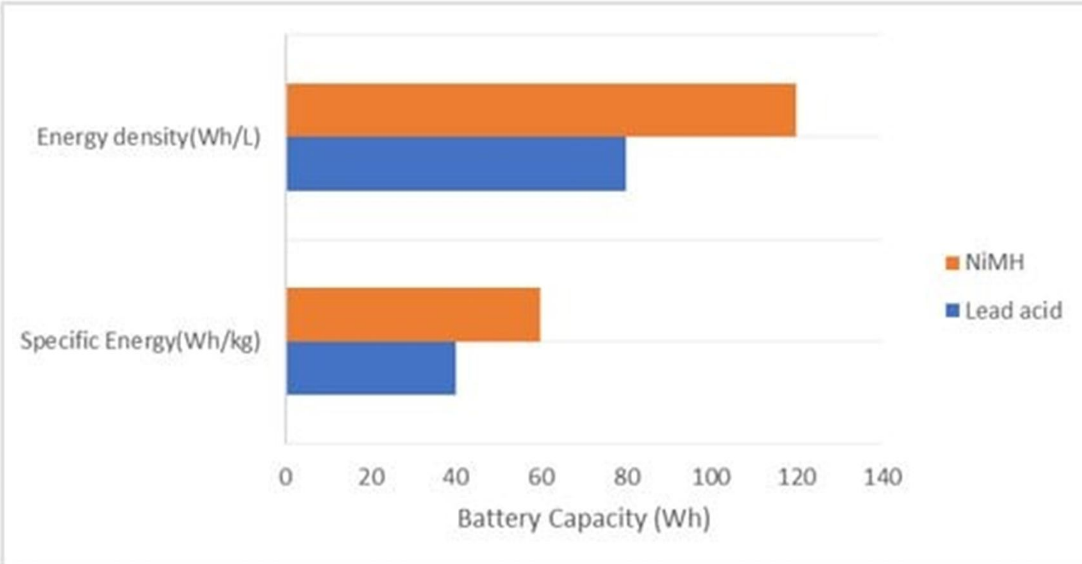

Fig 2. Comparison of Ni-MH and lead-acid batteries

3) Lithium-Ion Batteries

With the release of the first commercially viable lithium-ion battery by the Sony Company in 1991, this technology quickly dominated the markets for energy storage and portable electric devices. In addition to being compact and lightweight, they also offer a huge power storage capacity. When it comes to specific energy and energy density, the lithium-ion battery offers a lot of benefits over the other batteries in Fig. 3.

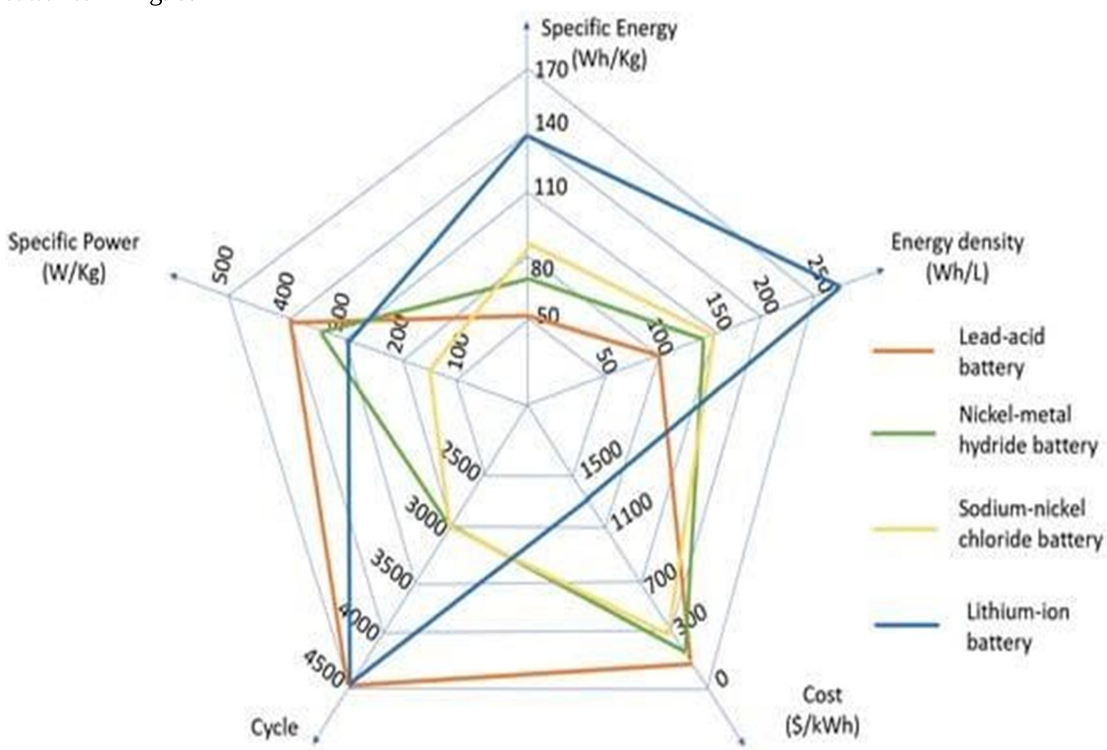

Fig.3 Comparison of the characteristics of various power batteries.

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B. Charging Technology

Another difficulty with BEVs, besides battery capacity, is charging. Technology for batteries and charging systems complement one another. Charging technology is essential to easing EV drivers' "range anxiety" and is significant to the BEV [4]sector. With the growth of charging infrastructure and the quick development of charging technologies, charging is becoming easier and quicker.
Battery charging for EVs can be divided into two categories: conductive charging and inductive charging.

1) Conductive Charging

The actual connection of the charger and car is made possible by the conductive charging system. Power is transferred from the power source to the battery through an unmediated interface. It is made up of converters for alternating current (AC), direct current (DC), and DC/DC with some power factor correction (PFC), and it can be an on-board or off-board charger. The charger serves as the energy transmission link. Transferring electricity from the power grid to the EV battery is done during the charging process. Because EV batteries can only be charged using DC, a charger is necessary to change the power grid's AC into DC. An on-board battery charger's fundamental design is depicted in Fig. 4.

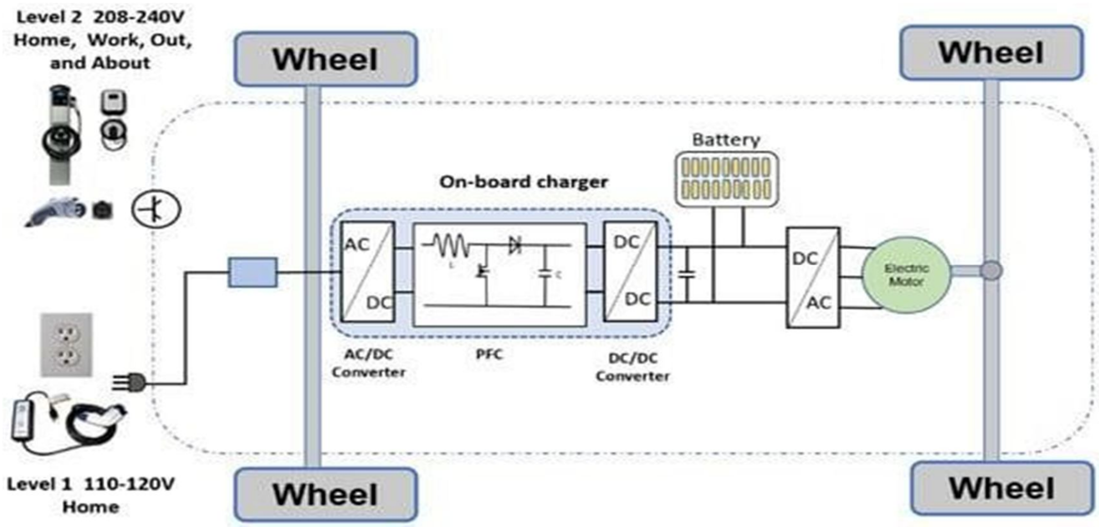

Fig.4.The basic layout of an on-board battery charger

2) Inductive Charging

A more adaptable and simple charging technique that has gained widespread interest is inductive charging, commonly referred to as wireless charging. The wireless link, which may be utilised in place of a direct cable connection, essentially prevents sparking that could be brought on by plugging in and out of an appliance and expands the use of electric vehicles (EVs) in some circumstances, such as in and around gas stations and airports. Also known as dynamic charging, inductive charging may make it feasible to charge while driving.

3) EV Charging Standards

The standards for EV charging vary between nations. The Society of Automotive Engineers (SAE, Warrendale, PA, USA), International Electrotechnical Commission (IEC, Geneva, Switzerland), Japan Electric Vehicle Association Standards (JEVS), and Chinese National Standard (GB) standards are the most widely used ones globally. Countries like the United States and the European Union, who now have some of the greatest EV statistics internationally, publicise these requirements.

C. Electric Motors

The electric motor, which is at the heart of the propulsion system of EVs, transforms the battery's electrical energy into mechanical energy to propel the cars. For EVs, a variety of electric motor types have been used, each with[5] a different design and technology. They include switching reluctance motors, induction motors, and permanent magnet motors (SRMs).
The PM type is the one that is most specifically designed to satisfy automobile needs.

1) Induction Motor

In the General Motors EV1, IMs were used successfully. They are also used in Tesla EVs like the Model S and Roaster. An IM is a feasible option for EV applications in all commutatorless motors because to their dependability, robustness, need for less maintenance, mature technology, and low cost. The fundamental drawback of IMs is their poor performance under modest loads. Vector control is used to make sure IMs comply with the needs of EV systems. Vector control, also known as field-oriented control (FOC), which fundamentally altered how the IM was controlled, can provide a broad range of speed up to three to four times base speed, but the high-speed range efficiency is limited.

2) Permanent Magnet Brushless Dc Motor (PMBLDC)

PMBLDCs are widely used in EVs due to their excellent efficiency and power density. On its rotor, premium rare earth permanent magnet components like samarium cobalt (Sm-Co) and neodymium-iron-boron (Nd-Fe-B) have been utilised. There is no rotor copper loss since the rotor lacks windings. The PMBLDC achieves commutation with electronic switches that deliver synchronous current to the motor winding with the rotor position rather than a commutator and brush gear. Since the rotor position is crucial for regulating the PMBLDC, it can be detected using Hall sensors, resolvers, or optical encoders. The motor becomes more expensive, larger, and more challenging to operate due to position sensors. Control methods without sensors are typically used to lower the overall cost of propulsive devices.

3) Switched Reluctance Motor

Switched reluctance motors are gaining popularity for use in electric vehicles not only because of their superior performance, straightforward design, low cost, robustness, and fault tolerance but also because they don't use rare-earth materials, which eliminates the costs and environmental harm associated with mining and refining minerals. Despite the fact that classic AC machines and SRMs both have their merits, Acoustic noise, which is a by-product of radial vibration and torque ripple, is a glaring drawback. As a result, the primary goal of SRM research is to reduce noise. Motor topology enhancement and control strategy design have both been studied as ways to reduce noise. investigated a novel rotor profile to reduce the SRM's torque ripple.

D. Charging Infrastructure

Infrastructure for charging EVs is crucial to their adoption. The development of a reliable charging infrastructure network must be considered when implementing electromobility. Coordinating the present state of the [6]charging infrastructure, comprehending the effects of charging on the power grid, and taking into account the implementation of a fair charging payment system are all necessary steps in creating a strong charging infrastructure network.

1) Organisation Of Charging Infrastructure

Governments in several nations, especially those with high EV stocks, have encouraged charging infrastructure in response to the "chicken-and-egg" issue for EV implementation. At the regional level, there are significant geographical variations in public charging infrastructure accessibility. The American Recovery and Reinvestment Act of 2009 provided federal financing through a few EV infrastructure programmes to build up roughly 18,000 public charging sites in the U.S. between 2010 and 2013. This helped to develop the initial charging infrastructure in the country. Since then, numerous government, state, and private organisations have started to fund the development of charging infrastructure. Governments, automakers, energy providers, and private organisations were among the stakeholders in Europe's charging infrastructure. Norway, which sells more EVs than any other country in Europe, has had problems with the infrastructure needed to charge them. Their government made large contributions to the creation of the charging infrastructure and will continue to spend in the region. Norway's charging infrastructure has received six million euros annually since 2009 from a Norwegian organisation named Trans nova (commonly known as "Enova") to lower greenhouse gas (GHG) emissions. The UK government's Office of Low Emission Vehicles (LOEV) covered 75% of the hardware costs for the building of public charging stations through a number of programmes. Along the main road network, the UK also planned to build charging stations every 30 kilometre. A large portion of the early charging infrastructure was paid for by EL aadNL, a foundation connected to six Dutch energy network providers. Also, since 2011, the Dutch government has spent over 16 million euros building a charging infrastructure to guarantee that every dwelling has access to charging stations. In Asia, China has experienced a notable increase in the number of charging stations in recent years, particularly in Shanghai, Beijing, and Shenzhen, which are pilot cities supported by the national government.

These cities want to create high density charging networks in downtown districts with one charging station for ek as part of its Road Investment Programme. Since 2013, the "Next Generation Vehicle Charging Infrastructure Development Promotion Project" of the Japanese government has supported the construction of charging stations along the country's highway network and in other towns. The Japanese Bank, automakers, and power providers are building a charging network in Japan that presently has more than 7500 stations. Preliminary charging networks have been developed in numerous nations and regions, especially in metropolitan areas, thanks to ongoing government sponsorship. The condition of public charging stations in many global cities is depicted in **Fig. 5**.

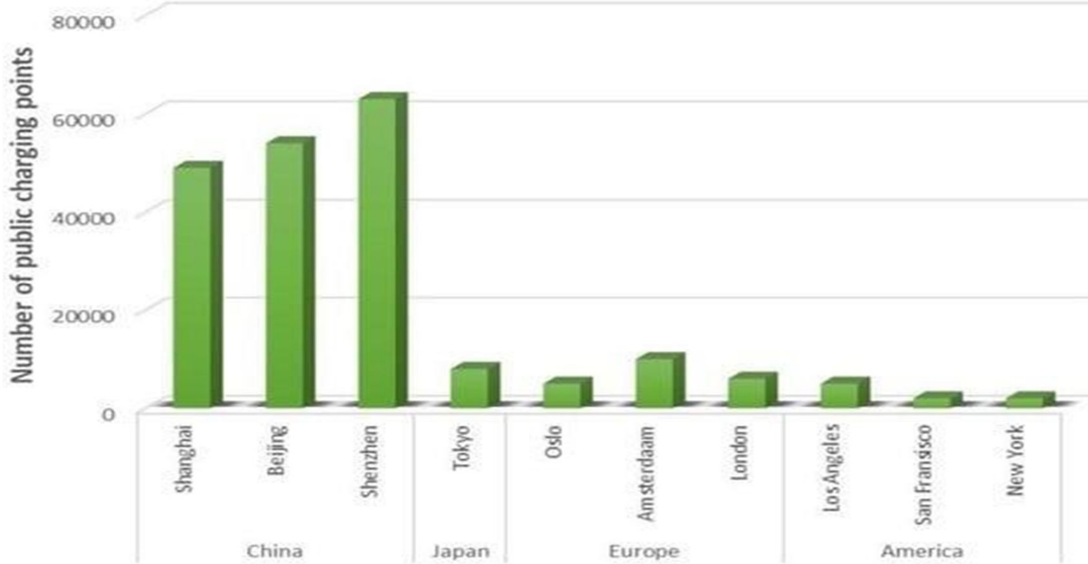

Fig 5. Number of public charging points in metropolitan areas.

2) Possibility Of Fair Payment For Ev Charging

Because it relies on the battery's condition and age, the prospect of receiving a reasonable price for EV charging is especially crucial for EVs. Data on the status of the batteries can be obtained with the use of a battery management system (BMS). Every driver ought to be aware of how long their automobile will last after charging. Other elements including battery size, charging rate, and electricity cost should also be considered. Studies in this area have been carried out by a variety of researchers. introduced a battery State-of-Health (SOH) estimate approach in their work to examine the link between voltage and battery ages within the same power grid and presented a compensation concept to be. obtaining precise data on a battery's State-ofCharge (SOG) and State-of-Health (SOH). by rigorously regulating parameters inside a battery circuit model, a new estimation technique was proposed. Wang suggested that there was still some energy in the online BMS. They offered a compensation approach to be used when taking battery ageing into account in their article, along with a robust technique for aggregating distributed loads within the same power grid. Notwithstanding significant infrastructure and economic challenges, it was discussed that fast charging was necessary to assist overcome EV adoption barriers. By providing a real-time suggestion system for charging stations, we have assisted taxi drivers in reducing the overall charging time.

E. Emerging Technologies for the Future Development of EVs

In recent years, EV technology has advanced incredibly swiftly. EVs are desired for many reasons than just low emissions. Improved traffic safety and efficiency can be achieved by utilising cutting-edge technology in real-time[7] communication and transportation, such as vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian (V2P), and vehicle-to-grid (V2G). Vehicle-to-everything (V2X) refers to communication between automobiles and any smart device at the roadside. As a component of V2X, V2I communication can enhance driving performance through velocity judgements based on traffic light distance and time gap and by lowering the frequency of vehicle starting and stopping to make driving more stable and smoother. In V2G, the batteries of EVs can be viewed as distributed energy and power resources or as loads. Battery deterioration, a fee for communicating between the EV and the grid, effects on grid distribution equipment, and infrastructure upgrades are all included in the price of V2G. According to a study, grid operators and EV owners are paying more attention to the economic benefits of V2G technologies, which are strongly correlated with charging and vehicle aggregation tactics.

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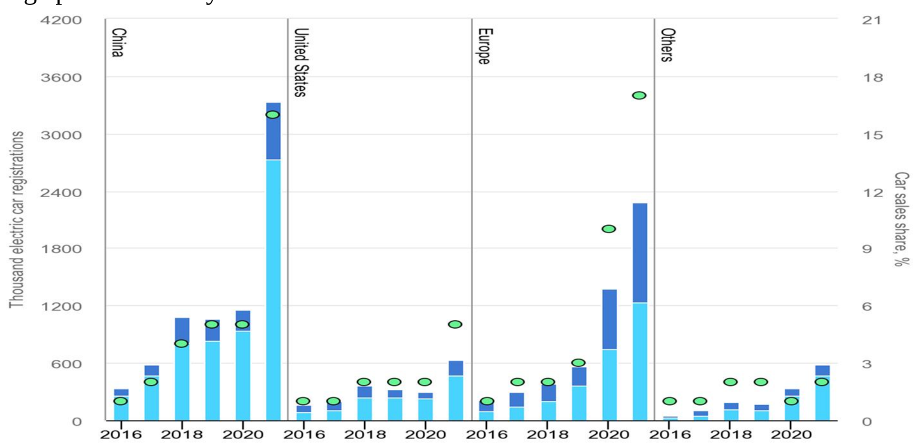
V2P communication technologies for convenience or safety have also drawn more and more attention. Recent studies have shown that various V2P systems have used various communication technologies and strategies to deal with various consumers. V2X is primarily driven by concerns for energy conservation, traffic efficiency, and road safety. However, this technology is still in the exploratory stage and confronts several difficulties, including those brought on by cybersecurity and traffic safety applications for V2X.

IV. IMPLEMENTATION

1) Lowered rates for EV registration and stamp duty
2) The Grant Scheme for EV Chargers
3) Assisting with the installation of additional EV charging stations
4) Supporting local EV technology innovation
5) Developing EV maintenance and EV repair abilities
6) Installation of infrastructure charges
7) Spreading the word about EV charging stations
8) Raising the proportion of EVs in the NT

V. RESULT ANALYSIS

Sales of electric cars surpassed previous records in 2021 despite supply chain hiccups and the lingering Covid-19 outbreak. In comparison to 2020, sales more than quadrupled to 6.6 million, or almost 9% of all sales, bringing the total number of electric vehicles on the road to 16.5 million. The percentage of electric vehicle sales increased by 4 percentage points in 2021[9]. The Net Zero Emissions by 2050 Scenario predicts that by 2030, there will be more than 300 million electric cars and trucks on the road, accounting for 60% of all new automobile sales. For them to stay on pace with the Net Zero Scenario, their sales share must increase by less than 6% percentage points annually.



VI. CONCLUSION

In this article, major EV technological advancements in areas such the battery, charging, electronic motor, charging infrastructure, and new technology are reviewed. For the adoption of EVs, battery technology improvement is crucial. A greater variety of battery types, in addition to the conventional lead-acid batteries, are being employed in EVs. EVs use lithiumion, nickel-metal hydride, and Zebra batteries as their power source because they have higher specific energy, higher power densities, and are more environmentally benign. At the moment, lithium-ion batteries are the most popular. Although currently under investigation, all electric vehicles may eventually use supercapacitors and metal-air batteries. Range concern may be lessened by battery charging. There have been numerous attempts to address the issue of charging EVs. On-board chargers have been created with the qualities of lightness, compactness, excellent performance, and ease of use. In order to charge EVs more quickly, with less thermal stress, and without over-voltage, conductive chargers use CV, CC, CC-CV, or pulse charging currents. The ability to charge without being constrained by a physical cable connection is made possible via inductive charging. With the technology of dynamic charging, charging becomes more adaptable and the price of the EV may also be decreased. Changing batteries.

REFERENCES

[1] Qinyu, Q . ; Fuquan, Z.; Zongwei, L.; Xin, H.; Han, H. Life cycle green-house gas emissions of Electric vehicles in China:Combining the vehicle cycle and fuel cycle- Energy **2019**,177,22223

[2] Siqin,X.; Junping J.; Xiaoming, M.Comparative Life Cycle Energy and GHG emission Analysis for BEVs phEVs: A Case Studyin Chinaenegie 2019, 12, 834, doi:10.3390/en12050834

[3] Shi L., Hao Y., Lv S., Cipcigan L., Liang J.A comprehensive charging network scheme For Promoting EV charging infrastructure considering the chicken-egg Res.Transp.Econ.(2020), Article 100837, 10.1016/j. retrec. 100837

[4] Sun X.,Chen Z.,Yi Integrated planning of static and dynamic charging infrastructure for Electric Vehicles Transp. Res. D, 83 (2020), Article 102331

[5] Transport & Environment X.Recharge EU: how many charge points will europe and its Member States needed in 2020s. (2020)

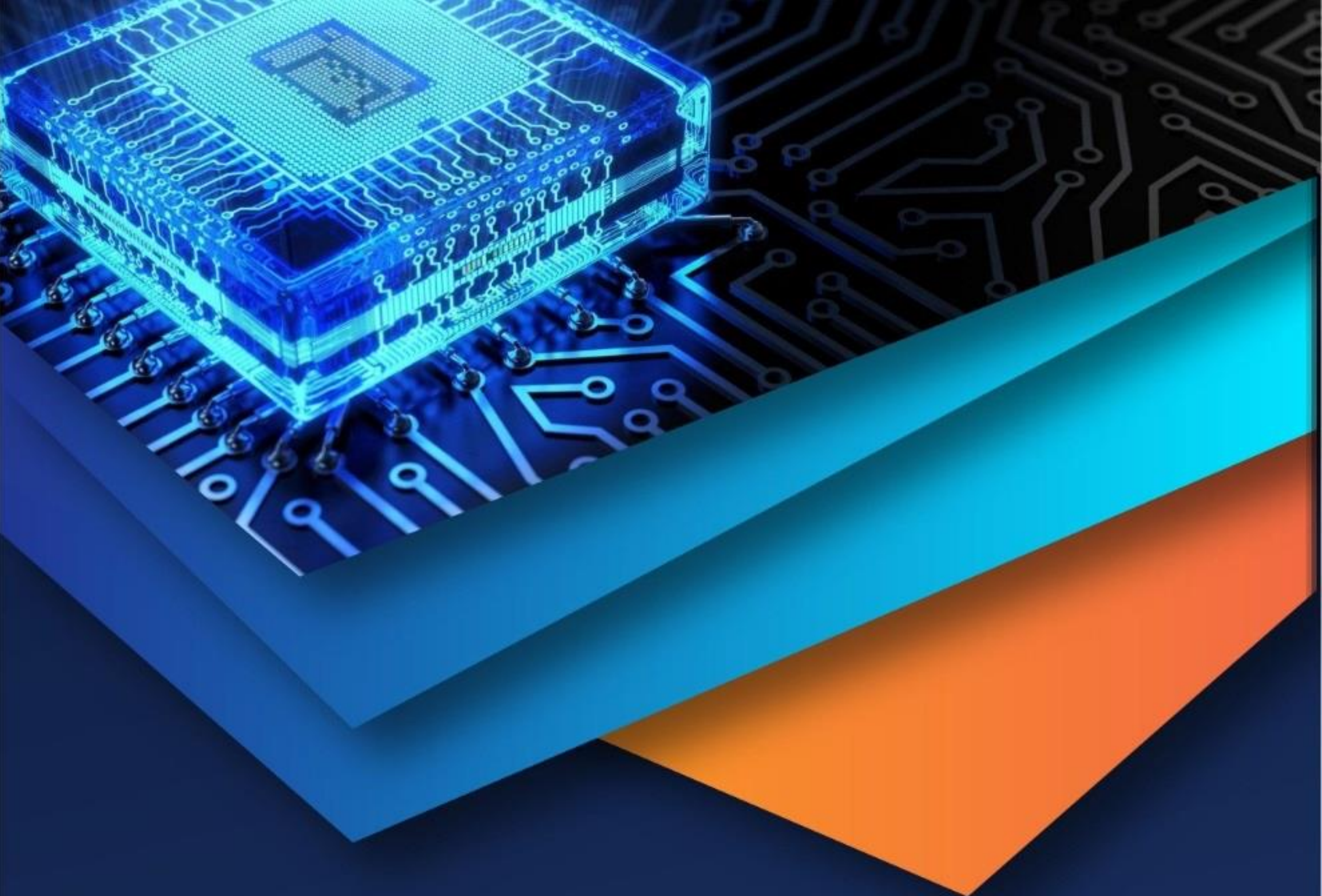
[6] Wappelhorst S., Hall D., Nicholas M., Lutsey Analysing policies to grow the electric Vehicle market in European cities. (2020)

[7] D.Tran,M.Vafaeipour, M.El Baghdadi,R. Barrera, J. Van Mierlo a Hegazi,"Through State of-the-art analysis of electric and hybrid vehicle powertrains: Topologies and integrated energy Management strategies ", Renew. Sustain. Energy Rev., vol.119, Mar.2020.

[8] K.V. Singh, H.O. Bansal and D. Singh, "Development of an adaptive neuro-fuzzy Inference system-based equivalent consumption minimisation strategy to improve fuel economy in hybrid electric vehicles ", IET Electr syst. Transp., vol.11,no.1, pp.1-15

[9] V system for electric vehicle", Iranian J. Sci. Technol. Trans. Electra. Eng., vol. 21, pp. 1-16 Mar. 2021.Shende, K. V. Singh, H. O. Bansal and D. Singh, "Sizing scheme of hybrid energy Storage

[10] Global Greenhouse Gas Emissions by Source—Industry Tap,Jul.2020,[online] HEVPHEV and EV Architectures, Jan.2021, [online]Available



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