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Disadvantage of Electric Vehicles

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Abstract*: Electric vehicles (EVs) offer environmental benefits but face challenges hindering widespread adoption. Key obstacles include limited range, long charging times, and high upfront costs, largely due to battery technology limitations. Charging infrastructure is also underdeveloped, creating a "chicken-and-egg" problem. Auxiliary loads like air conditioning further reduce range. Strategies to overcome these challenges include expanding fast-charging infrastructure, improving battery technology (energy density, cost, charging speed), and developing smart charging solutions. Research into advanced battery materials like graphene and innovative thermal management systems is crucial. Government incentives and public-private partnerships are essential for building robust charging networks and driving EV adoption. Addressing these issues will pave the way for EVs to become a dominant force in sustainable transportation.*

Keywords: Electric Vehicles (EVs), Charging Infrastructure, Range Anxiety, Sustainability, Innovation, Graphene, Battery Technology

I. INTRODUCTION

The automobile industry has become a major player in both the global economy and the world of Research and Development (R&D). With the constant advancement of technology, vehicles are now equipped with features that prioritize the safety of both passengers and pedestrians . This has led to an increase in the number of vehicles on the road, providing us with the convenience of quick and comfortable travel. However, this progress has come at a cost. Urban areas have seen a sharp rise in environmental contaminants such as sulfur dioxide (SO2), nitrogen oxides (NOX), carbon monoxide (CO), and particulate matter (PM) . It is important to acknowledge the impact that the automobile industry has had on our daily lives, both positive and negative. While industry has brought about significant advancements in technology and transportation, it has also contributed to the deterioration of our environment. As we continue to move forward, we must prioritize finding solutions to mitigate the negative effects of the automobile industry on our planet.

It is commonly acknowledged that the earth faces growing hazards from carbon emissions and the availability of oil. Regarding energy users, the transport industry has the largest overall environmental effect, contributing more than 25% of the world's energy usage and greenhouse gas emissions. Road transport accounts for over 70% of the sector's emissions [. To find answers to the problems of dependency on oil and emissions reduction, the concept of "sustainable transportation" has been promoted The Electric Power Research Institute (EPRI) claims that even in contrast to more efficient conventional vehicles, the widespread use of EVs would considerably reduce greenhouse gas emissions [. Additionally, EVs on "tank to-wheels" often have an efficiency three times greater than those powered by internal combustion engines. (ICVs). Additionally, noise and vibration are reduced with electric automobiles

Due to its benefits and the immediate need to tackle climate change and energy stability, several nations are promoting EVs. More than 275,000 plug-in electric vehicles (PEVs) are currently on the road countrywide in the United States, a considerable increase in PEV deployment since 2011 . Since the introduction of EVs to the market in 2010, their sales have quadrupled annually in Europe, and by 2013, approximately 60,000 PEVs had been sold. As of September 2021, more than 2 million electric vehicles had been sold in Europe. China, the fastest-growing country in terms of EVs, has set a target of having electric vehicles (EVs) account for 20% of total new car sales by 2025. The government has also set a longer-term target of having all new cars sold in China be "new energy" vehicles (NEVs), which include both pure electric and plug-in hybrid cars, by 2035 .

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Nevertheless, despite this marketing approach and the numerous advantages of EVs, their market share in terms of overall sales is still tiny, with EVs accounting for only 14% of all passenger cars purchased globally One of several obstacles that must be removed for EVs to become widely used is their undeveloped battery technology. EVs are less appealing to the typical customer because of their limited range, lengthy charging periods, and expensive upfront prices The limited availability of charging infrastructure is another significant obstacle to the widespread adoption of EVsEstablishing EV infrastructure is challenging because of the well-known "chicken-and-egg problem". Many drivers won't pick EVs unless a significant infrastructure for charging them is established. But if there aren't enough EVs on the road, it's highly doubtful that charging service providers would make significant investments in infrastructure development

High-quality services are urgently required to resolve these challenging problems, specifically to enable EVs to capture the market, and states will, of course, do a crucial job in establishing the EV industry Recent studies have focused on various service operations issues that are considered important in driving the growth of the EV industry. For instance, how innovative business models might succeed long-term, how governments should encourage the EV market through incentive programs, and how charging infrastructures can be built to satisfy consumer needs while minimizing social costs .

However, the massive increase in the use of electric cars has brought up several difficulties, issues, uncertainties, and concerns, including the high cost of infrastructure, the price of electric vehicles, the scarcity of charging stations, and the limited range of electric vehicles. Batteries continue to be the most significant issue. In the subsequent years, EVs will be a considerable component of smart cities, along with interconnected transportation, public transit, and other elements. Therefore, more effort is needed to improve batteries and simplify the charging process. The main problem with EVs is their autonomy. Scientists are developing better battery technology to increase driving range while reducing weight, cost, and charging time. These factors will eventually determine the direction of EVs. The critical hazards and difficulties related to using electric cars in smart cities are covered in this study, along with solutions to these issues.

II. CHALLENGES OF IMPLEMENTING ELECTRIC VEHICLES

Public sector operators in the EV market include utilities, state and municipal governments, and private sector players, including EV service contributors, fleet workers, and individual car holders. Variable adopters, such as private automobile owners, managers of private business fleets, and public fleets, make varied operational decisions. Following the types and distribution of adopters, at-home charging, public charging, and battery-swapping stations should be optimized for the charging models. The customer type is also connected to incentive programs and infrastructure deployment . An overview of the EV service industry's members and some of the key problems they deal with is shown in

EV service operations/participants-

According to this definition, an "EV" is any vehicle in which most of the driving energy comes from a battery of electricity. (e.g., battery electric vehicles [BEVs], plug-in electric vehicles [PEVs], and plug-in hybrid electric vehicles [PHEVs]). A BEV is powered only by its battery pack, which can be charged from the electrical grid. In contrast, PHEVs use an internal combustion engine, an electric motor for mobility, and a battery that can be charged from the power grid. BEVs and PHEVs are also called "PEVs", which are EV varieties that can be charged using energy from the grid . Lithium-ion batteries are the most popular alternative for electric vehicles (EVs), followed by lead-acid, nickel-metal hydride, and sodium-nickel chloride batteries [. Various charging levels can be used to recharge an EV's battery. A battery requires 2–8 h to fully charge at level 1 or level 2, which is at 110–240 voltage, also known as ordinary charging, but level 3 (480 V), also known as rapid charging, requires just 20 to 40 min. The expense of an EV's battery is still significant. From up to USD800 (2012), the cost of electric vehicle lithium-ion battery bundles (per kWh) is anticipated to fall to USD125 by 2022. Battery degeneration happens while the battery is stored, corresponding to annual aging, and when it is charged and discharged .

The EV sector differs from the traditional ICV industry in several ways, making challenges with growing EV service operations more difficult. Below is a summary of these broad problems.

Charging Infrastrcture

EV-related technologies are still developing; hence, their future course is yet unknown. For instance, one of the most important elements influencing EV acceptance is the battery performance, which is still not at its peak. Despite recent advancements in the construction of charging infrastructure, it is still not as accessible or practical as conventional petrol stations. This can make it challenging for EV drivers to locate charging outlets when needed, especially when traveling long distances or in remote places. The speed of battery recharging is another ambiguous technological aspect. It has long been anticipated that fast and secure charging will let Electric vehicles replace Individually Constructed Vehicles. Global-scale fast charging would, however, increase the stress on the electric grid and, as a result, pose several stability issues for power systems. Another source of misunderstanding in technical standards are those for charging interface standards. Prior agreement on recharging standards will be essential for developing the EV market, as more diverse standards require more significant infrastructure expenditure. Additionally, many charging standards make producing their goods more challenging for EV suppliers and automakers.

Interconnected Public Policies

The EV industry is still in its infancy, given the total dominance of Individually Constructed Vehicles in the international car market. The public sector has a crucial role in encouraging the use of EVs. Many nations are implementing various policies to make it easier for EVs to be introduced and consolidated into the market. These rules and associated laws cover gasoline taxation, carbon emission controls, public charging infrastructure, monetary incentives and public subsidies, and support for electric vehicle study and development. Incorporating three interconnected factors—investment in electric vehicle charging infrastructure, state subsidies, and public acceptance of EVs—will help to increase EV adoption. Various new decision-making difficulties must be resolved for these policies to be successfully implemented. Public policymaking is complicated and made more difficult by the high levels of uncertainty and market dynamics for EVs.

Business Strategies

How a firm or group of businesses provides one or more goods or services is called its “business strategy”. The EV sector has suggested cutting-edge ownership models, including battery swapping and EV sharing, to address problems such as range anxiety and high upfront costs. For this, the Beijing EV firm, a top electric vehicle manufacturer in China, set up battery switching places for electric taxi cabs in 2015. Sinopec, a firm benefiting from a vast transportation network, worked with Beijing Electric Vehicle Company to implement these stations

Vehicle sharing is a well-liked type of business where people hire automobiles for brief intervals, frequently per hour/day. Customers can access a sizable fleet of automobiles by signing up for a car-pooling program and paying a yearly fee. EV sharing mixes the business concepts of EVs and automobile sharing. Many local states are increasingly pushing electric vehicle sharing schemes by providing numerous forms of monetary incentives because of the growth of the sharing economy. This approach is appealing since it enables users to utilize EVs on a budget. Car2go, a division of Daimler AG, runs a car-sharing program with all-electric fleets in San Diego (USA), Amsterdam (The Netherlands), and Stuttgart (Germany)

Therefore, it is probable that developing business strategies will provide several approaches to get over obstacles to broaden EV implementation. However, specialists and scholars must examine the pertinent issues with these service operations’ business models.

III. STRATEGIES FOR OVERCOMING CHALLENGES

It is generally known that, as compared with cars powered by internal combustion engines (ICEs), electric vehicles (EVs) have the potential to provide significant societal and personal advantages. Recent research has looked at the many obstacles EVs encounter and has typically determined that the most common ones are cost, range, infrastructure for charging, and customer perceptions.

Compared with refueling ICEVs, the range of BEVs is presently constrained, and charging still takes much longer. As a result, route design is excessively optimistic, and some routes are too lengthy for battery electric vehicles (BEV). Therefore, this research paper proposes suitable strategies for implementing electric vehicles (EVs) in smart cities.

Charging Infrastrcture

Since electric vehicles often have a smaller driving range than conventional vehicles, their owners may be concerned that they may run out of juice before reaching their destination. Even though the range of EVs is expanding, some drivers, particularly those who need to go long distances, still find it challenging However, the consumer will be aware of the open slots if they can reserve charging times in advance. Customers can thus research alternative slots besides those already waiting in line. By answering consumers' queries and easing their worries over the charging network, good charging infrastructure will also help to reduce their "range anxiety" [1].

There are several ways to effectively alleviate range anxiety, even if it makes customers unhappy and presents an economic hurdle to EV adoption.

First, fast DC charging is a practical method for reducing the time it takes to recharge and extending the range when traveling between cities by highway. Various driving styles have various energy and recharge requirements; thus, EV infrastructure planners should consider this. Properly and dynamically building EV recharging infrastructure helps alleviate range anxiety

.Second, a mathematical vehicle model that can forecast "real road" driving energy consumption and drivable range may be utilized to estimate accurate energy consumption and drivable range.

Third, developing countrywide charging stations can also help alleviate range anxiety, but this cannot be done without government incentives or public-private collaboration.

Finally, range anxiety can be decreased by using a network path selection model. For EV drivers, this model chooses the quickest and best route using an algorithm. These models, meanwhile, might be improved by judging the exit time and duration of a stop at a charging station. The driving range can be increased by employing series, parallel, and series-parallel charging arrangements with extremely efficient electric motors. To partially alleviate range anxiety, some EV manufacturers even provide complimentary rental automobiles for local trips outside the EV range

Balancing Auxiliary Loads

Auxiliary loads greatly impact how much energy electric cars use, which cuts down on how far they can go. First, heavy auxiliary loads drain batteries in city driving circumstances, reducing the EV's range. The driving range decreases by 17.2–37.1% (under simulated settings) when the AC is activated in the summer. Similar to how EVs employ PTC (Positive Temperature Coefficient) heaters, the range spans from 17% to 54% (under simulations) owing to the need for heating in the cold . Second, when electric cars are driven at highway speeds, the effects of auxiliary loads such as air conditioning and heating have not yet been fully investigated. Finally, there are significant differences in the impact of supplementary loads in a lab setting and on actual roadways. Under ideal conditions, such as with little auxiliary loads and the help of a regenerative brake system (RBS), electric vehicle producers may achieve low energy consumption and an extended driving range; nevertheless, this ideal outcome is different when EVs are driven on highways amongst towns

One way to address the problem of limited range and high energy usage brought on by auxiliary loads is to utilize a heat pump to heat EVs in the winter. This can increase the driving range by 7.6–21.1% thanks to a higher heating coefficient of performance (CoP). The vapor compression cycle of a heat pump oversees both cooling and heating. Additionally, a four-way valve that reverses refrigerant flow is included. Additionally, its coefficient of performance is 1% greater than that of PTC heaters. Additionally, a precise assessment of EVs' heating and cooling demands may significantly reduce the energy used by the AC system. An appropriate energy management technique can also lower the total energy consumption when cooling. Consequently, a suitable energy management strategy may regulate energy use instead of the ON/OFF technique .

Another approach is the system configuration that has been suggested, which uses a traction shaft to clutch the AC compressor motor during braking intervals. This method not only helps the EV to weigh less but also uses less energy .

Improved Battery Technology

The limitations of battery technology are one of the main obstacles to the widespread use of electric vehicles (EVs). The present battery design for EVs has a poor energy density, which impacts the vehicle's driving range . To improve EV efficiency, a variety of battery technologies and combinations have been created over time. Users see electric vehicles as a real alternative to internal combustion engine vehicles because of the development of better, more affordable, and higher-capacity batteries, which will increase vehicle autonomy.

Since batteries are vital to EVs, more manufacturers (such as LG, Panasonic, Samsung, Sony, and Bosch) are investing in creating better, more affordable batteries.

The battery bundle is the costliest part of any EV. For instance, the Nissan LEAF's lithium-ion batteries originally accounted for one-third of the total cost of the car. However, it is anticipated that this cost will gradually decrease; as of the end of 2014, the battery pack cost around $500 per kWh (half the price in 2009); now, the price per kWh is $200, and it is anticipated to drop to approximately $100 in 2025. The fact that Tesla Motors is creating a "Mega factory" to lower manufacturing costs and enhance battery output is another piece of data supporting the trend towards lower battery costs .

The price of EVs would naturally decrease because of decreasing battery costs, making them more competitive with other types of cars.

depicts the battery capacity of various EVs from 1983, when the Audi Duo was first sold, when it had an 8-kWh battery, through 2022, when Tesla claimed it would sell a Tesla Roadster with a 200-kWh battery. The GMC Hummer EV Pickup Edition 1 has the largest battery capacity at 212 kWh .

Future Research Recommendations

Even though there has been a lot of advancement in the evolution and development of electric vehicles, especially in recent years, this section discusses the problems that are still being worked on or that may be worth looking into to find better and more innovative resolutions.

EV Batteries: Recent Developments and Innovations

As we have previously stated, in electric cars (EVs), batteries are among the most critical components because they account for most of the vehicle's cost and directly affect the EV's performance.

Due to the growth in durability, charging density, and charge and discharge processes, the creation of new technologies that can exceed the current lithium-ion batteries primarily used in vehicles has forced the employment of various resources

Keeping in mind all the parameters, it is seen that there is more work to be done in this area, mainly due to the importance of batteries, which might significantly speed up the development of EVs and the acceptance of these vehicles. New components and technologies are now the subject of investigation. In this regard, new research is underway utilizing pure carbon, which makes up the substance known as graphene, which is very light and has a high thermal conductivity.

Graphene-based batteries scarcely warm-up, which is one of their main advantages, allowing for quick or ultra-quick charges without suffering considerable power losses from heat .

A 900 horsepower GTA Spano car with a graphene battery attached has a range of 800 km, according to Graphenano, a Spanish business. This battery can be charged in about 5 min using a high-power outlet. Although graphene batteries are still in the development phase, there are prototypes with a specific energy of 1.0 kWh/kg, and it is projected that they will soon reach 6.4 kWh/kg

According to this theory, the technology that can make EVs more autonomous and significantly shorten the time needed for a full charge will be the one that prevails in the market.

Artificial Intelligence in EV

As was already noted, several things will need to come together for electric cars to fully replace other modes of transportation on our roads and in our towns .

There is a large research gap in this area as the world moves towards AI. Battery temperature regulation, better and more intelligent charging, and energy-efficient routing are just a few of the artificial intelligence (AI) ideas for EV themes that have been proposed. Ref.]offers a unique machine learning-based approach for successful routing. Their method may be used to forecast the energy consumption of the multiple road segments that make up the planned or actual vehicle routes. Ref. [104] addresses the problem of planning the routes for a fleet of electric vehicles. Their

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approach considers the vehicle's maximum battery capacity and the concurrent use of charging stations along the route and employs a developing genetic algorithm with a learning process.

To improve the thermal management system and lower overall energy consumption, ref. recommends employing Artificial Neural Networks (ANNs) for battery thermal management. The battery temperature may be maintained within acceptable limits under the scheme.

Ref. examines the relationship between battery thermal behavior and design factors. Their computational analysis reveals that a cooling method based on distributed forced convection may result in uniform temperature and voltage distributions across the battery pack at different discharge rates.

Based on that, artificial intelligence (AI) will promote the development of new solutions, which are:

1. Streamline the battery charging process (by enabling early booking of the charging point, providing automatic power balancing capabilities, allowing adaptive charges based on context, etc.)
2. Improve the power generation process to handle the significant increase in electric demand on the grid (by providing predictions of the required power at every moment, mobility analysis of the E-mobility, etc.).

Thus, the Internet of EVs (IoEVs) is about to become a reality, which will undoubtedly impact how we move about but also offer up a whole new universe of exploration containing new applications and servic

As mentioned earlier, government subsidies are a significant element in promoting EV adoption. Few models have been developed to explore how governments may utilize subsidies to stimulate EV adoption among customers with restricted budgets, even though the influence of subsidies on EV production has been studied in previous studies.

Further study is primarily needed to better understand subsidies' objectives and the design of government subsidy programs and policies to maximize EV market demand or consumer surplus while considering the objectives of EV manufacturers, retailers, and consumers. Game models provide a solution to this problem. Some elements will significantly impact the objectives and plans of subsidy programs, including customers' negotiation power when choosing between individually constructed vehicles and electric vehicles.

Government subsidies will impact the transition and expansion of the automotive sector. It's still unclear how governments should balance competing goods (such as BEVs and ICVs) with the goals of various supply chain structures (such as the producer, retailer, or client). Government subsidies, for instance, will impact manufacturer output and price, retailer orders and pricing, and consumer demand if a manufacturer offers battery electric vehicles and individually constructed vehicles and sells them through distinct retailers. Different circumstances can be characterized using game models. It is possible to determine the optimum industrial structure by comparing the outcomes of several situations.

IV. CONCLUSION

The paper discusses electric vehicles (EVs), their benefits and potential, and the obstacles to their adoption and integration into smart cities such as range anxiety, infrastructure, and battery cost. The study indicates that integrating EVs into smart cities can create a sustainable and efficient urban environment with lower operating costs, reduced greenhouse gas emissions, and improved air quality. Smart cities can overcome the challenges associated with EV adoption by developing robust charging infrastructure, implementing smart grid technologies, and utilizing data analytics. By promoting the use of EVs in smart cities, we can build more livable and sustainable cities that prioritize the health and well-being of residents while reducing our carbon footprint.

Implementing electric vehicles (EVs) faces challenges such as high upfront costs, limited driving range, charging infrastructure inadequacy, and public perception. However, these challenges can be addressed via government policies, private sector investment, and public education to increase EV adoption, develop new business models that enable EV use, invest in charging infrastructure, improve battery technology and charging speeds, and increase awareness about the benefits of EVs. Overcoming these challenges can accelerate the transition to a sustainable transportation system and mitigate climate change impacts.

The article discusses strategies to promote the adoption of electric vehicles (EVs) as a sustainable mode of transportation. These strategies include supportive policies and regulations, investment in charging infrastructure, and public education and outreach initiatives. Governments can help by providing financial incentives, mandating minimum EV sales targets, and funding charging infrastructure. Private companies can invest in charging infrastructure, develop new business models, and partner with automakers to promote EV adoption. Public education programs can help overcome obstacles such as range anxiety and a lack of knowledge about the benefits of EVs. By implementing these strategies, we can transition to a more sustainable transportation system while reducing our dependence on fossil fuels and combating climate change.

The future of electric vehicles looks positive with advancements in battery technology, charging infrastructure, and supportive policies. Battery prices are expected to drop significantly, making EVs more affordable and convenient for consumers. Switching to EVs can help reduce reliance on fossil fuels and combat climate change, and incorporating them into smart city programs can improve efficiency. As the market grows, we can expect new models with improved driving ranges and faster charging times, potentially including self-drived