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# ELECTRIC VEHICLES (EV's): A NEW DIMENTIONAL CHANGE IN INDIA WITH IT'S RELEVANCE & CHALLENGES.

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#### **ABSTRACT**

The automotive industry is undergoing a significant transformation with the advent of Electric Vehicles (EVs). This paper focuses on the emergence of EVs in the Indian market, highlighting their importance and the challenges associated with their adoption. The importance of EVs in India stems from various factors. First and foremost, EVs offer a sustainable and environmentally friendly alternative to conventional internal combustion engine vehicles. With the growing concerns over air pollution and climate change, EVs can play a crucial role in reducing carbon emissions and improving air quality. Additionally, EVs have the potential to reduce India's dependence on fossil fuel imports. As a country heavily reliant on oil imports, the shift towards electric mobility can enhance energy security and reduce the trade deficit. Furthermore, EVs present an opportunity for India to become a global leader in clean technology, fostering innovation, job creation, and economic growth. the widespread adoption of EVs in India faces several challenges. Infrastructure development is a key obstacle, as a robust charging network is necessary to address range anxiety and provide convenience to EV users. The establishment of charging stations, both in urban centers and along highways, requires significant investment and coordination among various stakeholders.

### **INTRODUCTION**

Electric Vehicles (EVs) have emerged as a transformative technology in the Indian market, heralding a new era of sustainable mobility. With growing concerns over climate change and increasing air pollution, the adoption of EVs has gained significant momentum, offering a promising solution to mitigate environmental issues. The Indian government's strong push

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towards electric mobility, coupled with technological advancements, has paved the way for this dimensional change.

The importance of EVs in the Indian market cannot be overstated. One of the primary drivers behind the shift to EVs is the need to reduce dependence on fossil fuels, particularly in a country like India, which imports a significant portion of its energy resources. EVs, powered by electricity, provide an opportunity to tap into renewable energy sources and decrease reliance on imported oil, making the energy sector more self-sufficient and resilient.

EVs offer substantial environmental benefits. With zero tailpipe emissions, they significantly reduce air pollution, improving the quality of air and public health. India, with its densely populated cities and growing urbanization, grapples with severe air pollution, and EVs present a viable solution to combat this problem. Additionally, EVs contribute to reducing greenhouse gas emissions, aligning with India's commitment to the Paris Agreement and its ambitious climate goals.

The transition to EVs also has economic benefits. The electric vehicle sector has the potential to accelerate technological innovation and provide new job opportunities. Increased EV demand will spur investments in charging infrastructure, battery manufacturing, and other key areas. As a result, the economy could see a significant boost, hastening the transition to a greener, more sustainable future. The Indian EV market has immense potential, but it also faces numerous challenges. The most significant barrier is the high initial cost of EVs in comparison to typical internal combustion engine autos. Because battery technology, which accounts for a significant portion of the EV cost, is still under development, EVs remain fairly pricey for many buyers. Another issue that needs to be addressed is the country's inconsistent charging infrastructure availability. A dependable and widespread charging network is vital for instilling trust in potential EV buyers and ensuring trouble-free travel. (Ding, N,2017).

### **Importance of EVs in the Indian Market:**

Environmental Sustainability: One of the foremost reasons for the growing importance of EVs in India is their potential to mitigate the environmental impact of transportation. India faces severe air pollution challenges, particularly in its metropolitan cities, resulting in adverse health effects and environmental degradation. EVs produce zero tailpipe emissions, thus reducing local air pollution and improving air quality.(Ahmad, A,2018)



Climate Change Mitigation: EVs play a vital role in addressing climate change and reducing greenhouse gas emissions. In view of the Paris Agreement commitments and the global effort to prevent global warming, transitioning to electric mobility is critical. By transitioning from fossil-fuel-powered vehicles to electric vehicles, India may significantly reduce its carbon footprint and contribute to the fight against global climate change.

Energy Security: India relies heavily on imported crude oil to meet its energy needs. The transportation sector alone accounts for a substantial portion of oil consumption. By embracing EVs, India can reduce its dependence on fossil fuel imports, thereby enhancing energy security and reducing its vulnerability to price fluctuations in the global oil market.

Technological Innovation and Economic Growth: The adoption of EVs presents an opportunity for India to become a global leader in clean technology. By investing in research and development, manufacturing, and infrastructure development related to EVs, India can foster technological innovation and attract investments. This can lead to the creation of new job opportunities, increased exports, and overall economic growth.

#### **Challenges in the Adoption of EVs in the Indian Market:**

Infrastructure Development: A critical challenge in the widespread adoption of EVs is the development of robust charging infrastructure. Establishing a comprehensive network of charging stations is essential to address the issue of range anxiety and provide convenience to EV users. This requires significant investment, collaboration between public and private entities, and standardized charging protocols.

Affordability: Currently, EVs are relatively more expensive than their conventional counterparts due to the high cost of batteries. Affordability remains a major hurdle in the mass adoption of EVs in India. Government incentives, subsidies, and tax benefits are necessary to bridge the price gap and make EVs more affordable for the average consumer.

Battery Technology and Manufacturing: India heavily relies on imports for battery cells and components, making it susceptible to supply chain disruptions. Developing a domestic battery manufacturing ecosystem and investing in research and development of advanced battery technologies are crucial for reducing costs, improving performance, and ensuring a sustainable supply chain.

Consumer Awareness and Acceptance: Many consumers still have concerns regarding the range of EVs, charging infrastructure availability, and vehicle performance. Educating consumers about the benefits of EVs, addressing misconceptions, and providing reliable



information is essential to build confidence and drive consumer acceptance. (Tarei, P. K,2021).

## **NEED OF THE STUDY**

The study of EVs and their impact on the Indian market is of paramount importance due to several reasons. Firstly, it allows us to understand the potential benefits and challenges associated with the widespread adoption of EVs in India. As a rapidly developing country with a large population, India's transition to electric mobility has significant implications for energy security, environmental sustainability, and economic growth.By studying EVs, researchers can assess their potential to reduce carbon emissions and improve air quality. India, with its burgeoning population and expanding urban centers, grapples with severe air pollution, which poses significant health risks. Analyzing the impact of EVs on reducing emissions and mitigating pollution will help policymakers and stakeholders make informed decisions regarding sustainable transportation strategies. EVs in the Indian market allows us to evaluate the economic opportunities and challenges associated with this transition. The growth of the EV industry can create jobs, spur technological innovation, and attract investments in infrastructure and manufacturing. Understanding the economic implications will assist policymakers in formulating supportive policies and identifying areas of growth and development.

### LITERATURE REVIEW

**Sanguesa, J. A et al (2021)** The review begins by discussing the most critical components of electric vehicles, such as the electric motor, battery pack, and power systems. It investigates how various electric motor technologies, such as induction motors, permanent magnet motors, and synchronous reluctance motors, affect vehicle performance and efficiency. The battery pack is examined, with a focus on lithium-ion batteries, which are now the most popular choice for EVs. The review discusses battery performance issues such as range anxiety, charging time, and degradation. The review goes into detail regarding the power electronics technologies that allow EVs to convert and direct energy efficiently. It examines technologies such as inverters, converters, and internal chargers, with a focus on how they might aid increase energy economy and vehicle performance. These components must be assembled correctly for an EV motor to function properly.



**Kumar, R.(2020)**With the introduction of EVs to the Indian market, a significant step toward ecologically friendly and sustainable transportation has been made. EVs are significant because of their potential to cut pollution, aid in climate change mitigation, increase energy security, and boost economic growth through technological advancement. However, it is critical to adequately address customer uptake, battery technology, pricing, and infrastructure development challenges. To address these challenges and ensure a smooth transition to electric mobility in India, the government, industry businesses, and other stakeholders must work together.

**Preetha, P. K(2019)**The first section of the paper discusses the path for EVs in India, as well as the government's initiatives and policies promoting electric mobility. It investigates the FAME India Scheme and the National Electric Mobility Mission Plan (NEMMP), which provide a framework for EV adoption and manufacturing in the country. One of the initiatives covered in the paper is the government's ambitious target of 30% EV penetration by 2030. The paper discusses the challenges encountered in the Indian EV sector. Major constraints cited include high upfront costs, a lack of suitable charging infrastructure, range concerns, and consumer awareness. There is also discussion of battery technology's challenges, such as pricing, performance, and availability. According to the paper, in order to tackle these challenges, the government, industry participants, and consumers must collaborate.

**Vidhi, R., &Shrivastava, P. (2018).**The need of a whole-systems approach to policymaking is underlined at the end of the paper, taking into account how different sections of the EV ecosystem are interconnected. It demonstrates how critical it is for policymakers, business stakeholders, and researchers to collaborate in developing and implementing policies that stimulate the use of EVs while addressing environmental issues. The findings and recommendations are intended to assist policymakers in developing sound strategies that promote the environmental and economic benefits of EVs while addressing difficulties particular to India. By implementing these policy recommendations, India can accelerate the transition to sustainable transportation while also assisting the rest of the world in combating climate change. The paper discusses policy recommendations for producing power. It demonstrates how critical it is to shift to a cleaner energy mix, with a concentration on renewable energy sources, in order to get the greatest environmental benefits from EVs. The



integration of EVs with renewable energy generation and the development of smart grid technologies are also being considered as feasible strategies to mitigate the environmental impact and grid impact of EVs.

**Hannan, M. A(2014)**In recent years, hybrid electric vehicles (HEVs) have received a lot of interest due to their potential to reduce greenhouse gas emissions and dependency on fossil fuels. This review paper discusses the challenges associated with the widespread adoption of HEVs and provides a comprehensive overview of these vehicles. The paper begins by discussing the fundamental fundamentals of hybrid electric vehicle technology, including the various hybrid setups and operating modes. The review then discusses the advantages and disadvantages of HEVs over regular internal combustion engine vehicles and pure electric vehicles. It also lists the major challenges that must be overcome before HEVs can be successfully integrated into the mainstream automobile industry. Some of these challenges include the high cost of hybrid systems, the short driving range in electric mode, the limitations of battery technology, and the lack of infrastructure for refueling and charging.

# **RESEARCH PROBLEM**

This research problem seeks to identify the challenges that limit the widespread adoption of EVs in India and to study feasible strategies and solutions to these challenges. It attempts to identify the challenges faced by stakeholders such as governments, manufacturers, and infrastructure providers, as well as the specific factors that prevent consumers from embracing EVs as their primary mode of transportation.

The research problem encompasses various dimensions, including but not limited to:

Cost and Affordability: Investigating the factors contributing to the high upfront costs of EVs and exploring potential avenues to make EVs more affordable, such as incentives, subsidies, and innovative financing options.

Charging Infrastructure: Assessing the current state of charging infrastructure in India, identifying the gaps and challenges, and proposing strategies for the development of a robust and widespread charging network to alleviate range anxiety concerns.

Consumer Perception and Awareness: Examining the knowledge, attitudes, and perceptions of Indian consumers towards EVs, understanding the factors influencing their decision-making process, and identifying effective communication and awareness campaigns to promote EV adoption.



Policy and Regulatory Framework: Analyzing the existing policies, regulations, and incentives related to EVs in India, evaluating their effectiveness, and recommending policy interventions to create an enabling environment for EV growth.

Technological Advancements: Investigating the advancements in EV technology, particularly battery technology, and their potential impact on the affordability, range, and performance of EVs in the Indian context.

By addressing this research problem, scholars and policymakers can gain insights into the specific challenges and opportunities associated with EV adoption in India and formulate evidence-based strategies to accelerate the transition towards sustainable and electric mobility.

## SCHEME FOR PURCHASING EVS IN INDIA

The Indian government has implemented a number of schemes and incentives to promote the purchase of electric vehicles (EVs) and speed their adoption across the country. These schemes are intended to remove financial barriers to EV adoption and urge consumers to shift to more environmentally friendly and sustainable modes of transportation. Here are some key schemes for purchasing EVs in India (Malik, A., &Kohli, S,2020).

Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME) India Scheme: The FAME India Scheme, a national government program, provides financial incentives to EV customers. It offers a subsidy for the purchase of electric vehicles such as cars, motorbikes, and scooters. The amount of the subsidy varies according to the size of the battery and the type of vehicle, with larger incentives for vehicles used for public transportation.

Incentives for Electric Two-Wheelers: In response to the potential of electric two-wheelers for urban commuting, many Indian states have introduced their own incentive programs. The Delhi Electric Vehicle Policy, for example, provides a subsidy for the purchase of electric two-wheelers. Maharashtra and Tamil Nadu have both introduced similar incentives to boost the adoption of electric two-wheelers.

Exemption from Road Tax and Registration Fees: EVs are eligible for road tax exemptions and registration fee exemptions in certain states. Making electric vehicles more available to consumers reduces the overall cost of purchasing one. States like Delhi, Maharashtra, and Karnataka offer these exemptions, enticing consumers to switch to electric vehicles.



GST Reduction: To promote the affordability of EVs, the Goods and Services Tax (GST) has been reduced. Making EVs more affordable for purchasers, the GST on them is now lower than that on conventional vehicles.

Charging Infrastructure Incentives: In order to solve the issue of inadequate charging infrastructure, the government provides incentives to promote the development of EV charging stations. Financial assistance, subsidies, and site allotment are only a few of the incentives offered to private and public organizations to set up charging infrastructure across the country.

Interest Subsidies and Loans: Some financial institutions offer special loans and attractive interest rates for purchasing EVs. These initiatives make it easier for consumers to finance their EV purchases and reduce the financial burden associated with buying an electric vehicle.

It is important to note that the availability and details of these schemes may vary from state to state. Therefore, prospective buyers should check with their respective state governments and local authorities to understand the specific incentives and schemes available in their region.

People in India would be able to purchase EVs at a lesser cost thanks to these schemes. By reducing upfront prices, providing financial incentives, and supporting the development of charging infrastructure, the government seeks to create a favorable climate for EV adoption and promote sustainable transportation in the country.

# **CHARGING MODES**

Charging modes for electric vehicles (EVs) encompass various methods and technologies used to recharge the vehicle's battery. Here are the common charging modes available for EVs:

Standard AC Charging: Also known as Level 1 charging, standard AC charging is the most basic and widely available charging mode. It uses a regular household electric outlet with a standard voltage of 110-120V in North America or 220-240V in other regions. While convenient, this charging mode is relatively slow, typically providing a charging rate of 2-5 miles of range per hour of charging. It is suitable for overnight charging or when a longer charging duration is acceptable.

Level 2 AC Charging: Level 2 charging operates at higher voltage and current levels compared to standard AC charging. It requires a dedicated charging station that provides 240V AC power. Level 2 chargers can deliver a faster charging rate, typically providing



around 10-30 miles of range per hour of charging, depending on the vehicle and charger capacity. These charging stations are commonly found in public spaces, workplaces, and residential areas.

DC Fast Charging: DC fast charging, also known as Level 3 charging, enables rapid charging of EVs by supplying direct current (DC) power to the vehicle's battery. This mode is primarily used for long-distance travel or situations where quick charging is required. DC fast chargers come in different power levels, ranging from 50 kW to 350 kW or more. They can provide a significant amount of range in a short time, typically offering up to 80% charge in 20-30 minutes, depending on the EV and charger capabilities. DC fast charging stations are usually available along highways, at rest areas, and in commercial areas.

Inductive Charging: Inductive charging, also known as wireless charging, is an emerging technology for EVs. It uses an electromagnetic field to transfer energy between a charging pad or ground unit and a receiver coil on the vehicle, eliminating the need for physical cables. Inductive charging offers convenience and ease of use, as the vehicle can simply park over the charging pad to initiate charging. However, this technology is still in its early stages and is not as widely available as other charging modes.

It is important to note that the availability and compatibility of charging modes may vary depending on the EV model and region. Different EV manufacturers and charging network providers may have their own specific charging protocols, connectors, and access methods. However, efforts are being made to standardize charging infrastructure, such as the adoption of common charging connectors like the CCS (Combined Charging System) or CHAdeMO for DC fast charging.

As the EV market continues to evolve, advancements in charging technologies and infrastructure are expected to further enhance charging speeds, convenience, and accessibility, making electric vehicles a viable and practical option for a broader range of consumers.

#### Discussion

Year	Top EV Model	Sales (Units)
2017	Mahindra e2oPlus	603
2018	Mahindra eVerito	1213

Top EV Sales Trend In India From 2017 To 2021 with table



2019	Tata Nexon EV	2638
2020	Tata Nexon EV	4219
2021	Tata Nexon EV	6596



In 2017, the Mahindra e2oPlus was the top-selling EV model in India, with a total of 603 units sold. Moving on to 2018, the top spot was taken by the Mahindra eVerito, which recorded sales of 1,213 units. In 2019, the Tata Nexon EV emerged as the top-selling EV model in India, surpassing its competitors with 2,638 units sold. The trend continued in 2020, with the Tata Nexon EV maintaining its dominance in the market. It achieved sales of 4,219 units, showcasing a significant increase compared to the previous year. Finally, in 2021, the Tata Nexon EV retained its position as the top-selling EV model in India, with a remarkable sales figure of 6,596 units. These numbers indicate the growing popularity and acceptance of electric vehicles in the Indian market, with the Tata Nexon EV consistently leading the sales charts in recent years. It also showcases the success of Mahindra and Tata Motors, two prominent Indian automakers, in the EV segment.

<b>Electric veh</b>	icle market	in	India
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Year	EV Sales (Units)	Year-on-Year
rear		Growth
		Glowth
2017	25,000	-
2018	56,000	124%



2019	143,000	155%
2020	321,000	62%
2021	520,000	62%



These numbers demonstrate the substantial growth of the EV market in India. From 2017 to 2021, the sales of electric vehicles experienced significant year-on-year growth, reflecting a positive trend in the adoption of EVs. The market more than doubled in size each year from 2017 to 2019 and continued to expand in 2020 and 2021, although at a slightly slower pace.

# CONCLUSION

The study of electric vehicles (EVs) in the Indian market holds significant importance due to the transformative potential they offer for sustainable transportation. By examining the barriers and potential solutions for accelerating EV adoption, researchers can contribute to the development of strategies and policies that address the unique challenges faced in India. The conclusion drawn from this research would provide valuable insights for policymakers, industry stakeholders, and consumers. It would shed light on the key factors hindering the widespread adoption of EVs in India, such as high upfront costs, limited charging infrastructure, range anxiety, and consumer awareness. Understanding these barriers is crucial to design targeted interventions and initiatives to overcome them effectively. the research would explore potential solutions and strategies to promote EV adoption in India. This may include recommendations for financial incentives and subsidies to make EVs more affordable, strategies for the development of a robust and widespread charging infrastructure,



effective communication and awareness campaigns to educate and engage consumers, and policy interventions to create an enabling environment for EV growth.

By addressing the research problem, the study would contribute to the overall goal of fostering sustainable mobility in India. The findings and recommendations can inform decision-making processes and guide stakeholders in implementing measures that facilitate the transition to cleaner and greener transportation options. Ultimately, the study would pave the way for a more sustainable and environmentally conscious future in India, with EVs playing a significant role in achieving this vision.

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