



Future Of Electric Vehicles in India: A Comprehensive Review

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Abstract- Electric Vehicles (EVs) are emerging as a sustainable solution to address environmental and energy challenges in India. With increasing concerns over air pollution, fossil fuel dependency, and climate change, EVs offer a cleaner and more efficient alternative to conventional internal combustion engine (ICE) vehicles. This review paper analyzes the current scenario, technological advancements, government policies, opportunities, and challenges associated with EV adoption in India. The study highlights that EVs are 3–4 times more energy efficient and can significantly reduce greenhouse gas emissions. Despite challenges such as high initial costs and lack of charging infrastructure, strong government support and advancements in battery technology are expected to drive EV growth. The paper concludes that EV adoption in India will increase rapidly by 2030, contributing to sustainable development and energy security.

Keywords: Electric Vehicles (EVs), Sustainable Transportation, Green Mobility, Battery Technology, Charging Infrastructure, Renewable Energy.

I.INTRODUCTION

India is one of the fastest-growing automobile markets in the world. Rapid urbanization, population growth, and industrial development have significantly increased the demand for transportation. This has resulted in higher fuel consumption, increased air pollution, and heavy dependence on imported fossil fuels. According to recent data, the transport sector is a major contributor to CO₂ emissions in Indian metros.

Electric Vehicles (EVs) provide a promising solution to these challenges. Unlike conventional vehicles, EVs use electric motors powered by batteries, which eliminate the need for petrol or diesel. This results in lower emissions, improved energy efficiency, and reduced environmental impact. The transition to electric mobility is no longer a choice but a necessity for India's urban sustainability.

The need for EVs in India is driven by several critical factors:

II. LITERATURE REVIEW

Several research studies highlight the importance and growth potential of EVs in India. Studies indicate that EV adoption is expected to increase significantly by 2030, particularly in the two-wheeler and three-wheeler segments. EVs are found to be 3–4 times more efficient than internal combustion engine vehicles and can reduce emissions by up to 80% if the grid is decarbonized.



Kesari, Sharma, & Saini (2019):

This study explores the initial opportunities and the broad scope for electric vehicles within the Indian market, setting the foundation for understanding potential growth.

Yadav & Kumar (2025):

Provides a contemporary 2025 perspective on the sector, specifically analyzing the evolving growth patterns and the persistent challenges facing adoption.

Kambli (2022):

Focused on the future outlook of Indian electric mobility and the specific hurdles that need to be overcome to achieve mass adoption.

NITI Aayog (2021):

This report outlines the progress of India's electric mobility transformation and identifies future opportunities for the country to lead in this space.

IIT Delhi Research Group (2023):

Conducted a techno-economic study that specifically examined battery life cycles and the technical requirements for charging infrastructure.

Ministry of Heavy Industries (2024):

An annual report providing an impact analysis of the FAME-II implementation, detailing how government subsidies have influenced market demand.

Singh, V. et al. (2022):

Investigated the environmental impact of transition, particularly focusing on how EVs affect air quality and emissions in major Indian metropolitan areas.

BloombergNEF (2023):

Offers a market outlook for 2023, providing data-driven projections for the Indian EV market trajectory.

III. METHODOLOGY

This review paper is based on secondary data analysis collected from various authoritative sources, including peer-reviewed research papers, international journals, and official government reports (NITI Aayog, Ministry of Heavy Industries). The study uses comparative analysis between ICE and EV technologies, trend evaluation of sales data from 2020-2024, and a comprehensive policy review to understand the current scenario and predict future trends in EV adoption across the Indian subcontinent.

IV. TYPES OF ELECTRIC VEHICLES

Electric Vehicles can be classified into different types based on their powertrain and fuel source:

- **Battery Electric Vehicles (BEVs):** Fully electric vehicles with no fuel engine. They rely solely on chemical energy stored in rechargeable battery packs.
- **Plug-in Hybrid Electric Vehicles (PHEVs):** Use both a battery-powered electric motor and an internal combustion engine. They can be plugged into an external power source.
- **Hybrid Electric Vehicles (HEVs):** Combine a conventional fuel engine with an electric motor. The battery is charged through regenerative braking and the engine, not an external plug.
- **Fuel Cell Electric Vehicles (FCEVs):** Use hydrogen gas to power an electric motor. They emit only water vapor.

V. CURRENT SCENARIO OF EVS IN INDIA

The EV market in India is still in its early stage but growing rapidly. Currently, the adoption is led by segments that are more price-sensitive and used for short-range travel.

EV Sales Share by Segment in India (2025 Projection)

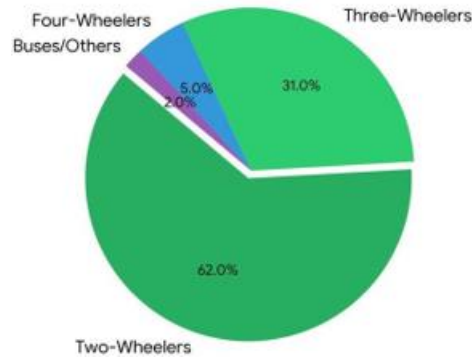


Figure 1: Market Segmentation of EV Sales in India

Key observations include:

- **Two-wheelers:** Dominate the market due to lower price points and ease of home charging.
- **Three-wheelers:** Widely used for "last-mile connectivity" and commercial transport in urban areas.
- **Electric cars:** Increasing slowly as more affordable models are launched by domestic manufacturers like Tata and Mahindra.
- **Infrastructure:** Charging infrastructure is currently limited to major tier-1 cities but is expanding via public-private partnerships.

VI. GOVERNMENT POLICIES AND INITIATIVES

The Indian government has introduced a robust regulatory framework to accelerate the transition:

- **FAME I&II:** Direct subsidies to buyers to reduce the price gap between EVs and ICE vehicles.
- **GST Reduction:** Goods and Services Tax on EVs was slashed from 12% to 5%, and on chargers from 18% to 5%.
- **PLI Scheme:** A \$2.4 billion Production Linked Incentive scheme for Advanced Chemistry Cell (ACC) battery storage.
- **Section 80EEB:** Allows a tax deduction of up to Rs 1.5 lakh on the interest paid on loans taken to purchase EVs.

VII. OPPORTUNITIES AND CHALLENGES

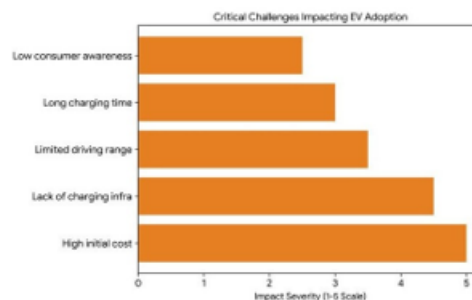


Figure 2: Analysis of Barriers to EV Adoption

The transition offers massive economic benefits. India spends over \$60 billion annually on oil imports; a 30% shift to EVs could save billions. Furthermore, the sector is expected to create 10 million direct and indirect jobs by 2030, ranging from battery manufacturing to infrastructure maintenance.

Despite the momentum, several hurdles remain:

- High Initial Cost: EVs are still 20-40% more expensive than their petrol counterparts upfront.
- Range Anxiety: Concerns about the vehicle running out of power before reaching a charging station.
- Charging Time: While petrol takes 5 minutes, EVs take 1-8 hours depending on the charger type.

VIII. ENVIRONMENTAL IMPACT

EVs have a profound positive impact on the environment. They reduce CO2 emissions by 50-80% over their lifecycle, even when considering battery manufacturing. Crucially, they improve urban air quality by eliminating tailpipe pollutants like Nitrogen Oxides and Particulate Matter (PM2.5), which are major health hazards in cities like Delhi and Mumbai.

IX. FUTURE SCOPE (2030 VISION)

The next decade will be transformative for Indian mobility. By 2030, we expect:

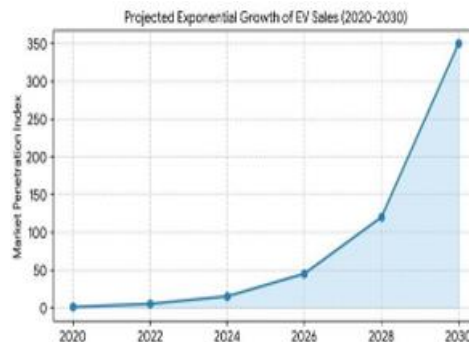


Figure 3 : Growth Trajectory Projection (2020 – 2030)

X. CONCLUSION

Electric Vehicles are the cornerstone of the future of sustainable transportation in India. They offer a unique convergence of environmental protection, economic energy security, and technological innovation. While initial costs and infrastructure remain challenges, the synergy between government policy, falling battery prices, and consumer awareness will drive exponential growth. By 2030, India is poised to be a global hub for EV manufacturing and adoption.

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