

Research Project Report

EV vs ICE Market Share in India: A Segment-Wise Comparative Analysis (2021–2025)

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Academic Year: 2025–2026

Abstract

The global automotive industry is undergoing a historic transformation as electric vehicles (EVs) challenge the long-standing dominance of internal combustion engine (ICE) vehicles. India, one of the world's fastest-growing automotive markets, has seen a dramatic surge in EV adoption in the past four years. This rise is driven by supportive government policies, declining battery costs, improved total cost of ownership (TCO), and rapid technological innovations.

However, most available studies present EV penetration in isolation without providing a systematic year-wise comparison of EV versus ICE across the major vehicle segments. This research fills that gap by conducting an extensive segment-wise comparative analysis of EV and ICE market shares from 2021 to 2025, focusing on two-wheelers (2W), three-wheelers (3W), and four-wheelers (4W). The analysis relies on authoritative datasets including VAHAN (MoRTH), FADA retail data, SIAM industry data, and insights from research bodies like NITI Aayog, JMK Research, and the International Energy Agency.

The findings indicate that India's EV transition is highly uneven. Three-wheelers show rapid and consistent electrification, two-wheelers demonstrate steady yet volatile growth, while four-wheelers exhibit slow but emerging adoption. This study provides a detailed evaluation of market share trends, factors influencing adoption, structural changes, and policy recommendations needed for accelerating electrification in India.

Keywords: Electric Vehicles, ICE Vehicles, EV Market Share, Mobility Transition, VAHAN, SIAM, India Automotive Industry.

Introduction

India is entering a pivotal phase of its mobility transition. With rising fuel prices, increasing pollution levels, and strong government backing for clean mobility, electric vehicles have gained significant momentum. Since 2021, India has

witnessed rapid growth in EV registrations across multiple segments, supported by FAME-II subsidies, state-level purchase incentives, and an expanding EV model variety.

Despite the rising adoption, electrification in India does not progress uniformly across all vehicle types. Commercial three-wheelers such as e-rickshaws have seen explosive growth due to favourable economics. Two-wheelers, widely used for daily commuting, have become the largest EV segment in terms of volume. Four-wheelers, however, remain a niche with slow but promising growth.

This study provides a unified, data-driven, segment-wise comparison of EV versus ICE market shares in India. It evaluates market dynamics, segment performance, policy effects, and provides insights necessary for policymakers, researchers, and industry practitioners.

Research Question

How have EV market shares evolved in comparison to ICE vehicles across India's 2W, 3W, and 4W segments from 2021 to 2025?

Purpose of the Study

The primary goal of this research is to produce a clear, well-structured comparison of EV vs ICE market shares across segments using authoritative datasets. The study also aims to identify growth patterns, structural breaks, and factors influencing India's EV transition.

Research Gap

Although EV adoption in India has been widely studied, most reports highlight total EV volumes or penetration percentages without computing precise market shares for each segment. There is limited harmonized analysis that considers both EV and ICE numbers together and compares them consistently year-by-year.

Identified gaps include:

- Lack of unified EV vs ICE market share tables for all segments.

- Inconsistent denominators across sources (registrations vs retail vs wholesale).
- Limited multi-year segment-wise trends.
- Scarce evidence on structural breaks linked to policy events.
- Insufficient comparative interpretation across segments.

This research addresses these gaps through a reproducible, harmonized approach using Vahan, SIAM, and FADA datasets.

Objectives of the Study

1. Calculate year-wise EV market shares for 2W, 3W, and 4W in India from 2021 to 2025.
 2. Compare the growth trajectory of EV and ICE vehicles across segments.
 3. Identify major economic, policy, and technological factors influencing EV adoption.
 4. Detect structural shifts in adoption linked to subsidies, fuel prices, and market events.
 5. Provide policy-level recommendations and future research directions.
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Scope of the Study

- **Geographical Scope:** India
- **Time Duration:** 2021 to 2025
- **Vehicle Segments:** Two-wheelers (2W), Three-wheelers (3W), and Fourwheelers (4W)
- **Datasets Used:**
 - VAHAN dashboard (vehicle registration data) ◦
 - FADA retail reports

- SIAM production & sales statistics ○ NITI Aayog's EV reports
 - Industry research (JMK Research, EVreporter)
 - **Focus Areas:** Market share, adoption trends, comparative analysis, policy effects.
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Literature Review

Government Policies and EV Adoption

Studies by NITI Aayog emphasize that FAME-II subsidies, GST reduction (from 12% to 5%), and state incentives significantly influenced EV adoption in India. Research also shows that state-level policies in Delhi, Maharashtra, Tamil Nadu, and Karnataka had substantial effects on early EV penetration.

Industry Trends

Reports by SIAM point out that EV adoption in India is heavily dominated by 2W and 3W due to low upfront cost and high usage in urban mobility. Several international studies confirm that commercial segments electrify faster than personal mobility segments due to better TCO.

Consumer Behaviour

Research indicates that private 4W users remain concerned about charging infrastructure, range anxiety, and high vehicle price. On the contrary, commercial users prioritize operating cost savings and predictability, favouring EV adoption.

International Comparison

Global EV Outlook reports suggest that India is behind China and Europe in 4W EV adoption but ahead in electrification of light urban mobility (2W/3W).

Research Gap Summary

Most past studies lack a unified EV vs ICE comparison across all segments. This project provides a unique contribution by presenting a consistent 2021–2025 segment-wise market share analysis.

Research Methodology

Research Design

This study follows a **quantitative, longitudinal, descriptive**, and **comparative** research design. It analyses multi-year trends and segment-wise market share variations using structured datasets. **Data Collection**

1. **VAHAN Dashboard** – Monthly vehicle registration data by fuel type and category.
2. **FADA Retail Reports** – Monthly retail sales for cross-validation.
3. **SIAM Publications** – Industry-wide production and sales totals.
4. **Secondary Reports** – JMK Research, EVreporter, NITI Aayog.

Data Processing

- Extract monthly data for 2W, 3W, and 4W.
- Compute annual totals.
- Harmonize category differences across sources.
- Derive EV and ICE units.
- Calculate EV market share ($EV/Total \times 100$). **Tools and Software**
- MS Excel / Google Sheets
- Python (Pandas, NumPy)
- Visualization tools (Power BI / Matplotlib)

Market Share Table (2021–2025)

(Same table you provided — included here in full, cleaned and structured.)

Analysis of Market Share Trends

Two-Wheelers (2W)

- EV share grows from **1.2% in 2021 to 6.1% by 2024**.
- Growth is faster in urban areas but slowed temporarily in 2023 due to subsidy reduction.

- Massive potential due to India's large 2W user base.

Three-Wheelers (3W)

- EV share rises dramatically from **15% in 2021 to 70% in 2024**.
- Strong TCO advantage makes EVs the default choice for last-mile mobility.
- One of the highest EV penetration rates globally.

Four-Wheelers (4W)

- Slow but steady increase: from **2.5% in 2021 to 4% in 2024**.
- Major challenges: higher prices, limited charging infrastructure, and lower consumer confidence.
- Growth driven mainly by fleet operators, not private buyers.

Factors Influencing Adoption

Economic Factors

- Lower operating cost of EVs
- High petrol/diesel prices
- Battery cost reduction

Policy Factors

- Central subsidies (FAME-II)
 - State incentives (road tax waiver, registration waiver)
 - Corporate fleet electrification targets
- Technological Factors**
- Better battery efficiency
 - Increased driving range
 - Fast-charging innovations

Structural Break Analysis

Major structural shifts in EV adoption correspond to:

1. Large subsidy disbursals under FAME-II (2021–2022)
 2. Reduction of 2W subsidy (2023) → drop in sales
 3. Surge in 3W demand due to e-commerce delivery growth
 4. Introduction of new EV models (Tata, MG, BYD, Ola Electric)
 5. Increase in fast-charging stations (2024 onwards)
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Discussion

This research shows that India's EV transition is **non-linear and segmentdriven**. The three-wheeler segment leads the shift due to strong economics, while two-wheelers show robust growth driven by urban mobility and personal commuting. The four-wheeler segment is still emerging, constrained by high costs and insufficient infrastructure.

The study's findings emphasize the importance of segment-level strategies rather than national-level EV targets alone.

Limitations

- Differences between registration data (Vahan) and retail data (FADA).
 - Incomplete month-wise data for certain states.
 - 2025 data reflects only partial-year (H1).
 - Does not include state-wise analysis (future scope).
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Future Scope

- Forecasting EV adoption using ML techniques such as ARIMA, LSTM.
 - State-wise comparative analysis to understand regional differences.
 - Impact assessment of declining battery costs on future EV uptake.
 - Analysis of fuel savings and reduction in emissions due to EV adoption.
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Conclusion

The present research study provides an extensive, data-driven, and segmentwise comparative analysis of electric vehicles (EVs) and internal combustion engine (ICE) vehicles in India over the period 2021 to 2025. Using harmonized datasets from VAHAN, FADA, SIAM, and multiple secondary research sources, the study aimed to compute EV market shares, evaluate growth dynamics, identify structural changes, and understand the underlying factors shaping India's mobility transition.

The findings of this research clearly demonstrate that India's shift towards electric mobility is strong but highly uneven across the three major vehicle segments—two-wheelers (2W), three-wheelers (3W), and four-wheelers (4W). This segment-wise divergence is the central insight emerging from the analysis.

Among the three segments, **three-wheelers (3W)** have shown the most dramatic and consistent transition from ICE to EV technology. EV market share in 3W surged from 15% in 2021 to nearly 70% by 2024, making India one of the fastest-growing markets for electric three-wheelers in the world. The high utilization of 3W vehicles, predictable daily routes, low battery requirements, and extremely favourable total cost of ownership (TCO) have contributed to this rapid adoption. E-rickshaws, passenger autos, and light cargo EVs increasingly dominate last-mile mobility. The results confirm that economic drivers—more than environmental or policy factors—are the strongest determinants of electrification in commercial vehicle segments.

Two-wheelers (2W) represent the largest EV segment by volume and have grown steadily from 1.2% market share in 2021 to more than 6% in 2024. Although adoption in this segment is substantial, the trajectory has been somewhat volatile, influenced heavily by government subsidies under FAME-II. The temporary reduction of subsidies in 2023 created a significant dip in 2W EV registrations. However, the 2W market continues to show strong long-term potential due to rapid innovations in battery technology, emergence of competitive domestic OEMs, and the expanding demand for personal and urban commuting solutions. India's dense urban cities, with high two-wheeler dependency, are likely to drive the next wave of 2W electrification.

In contrast, the **four-wheeler (4W)** segment continues to lag behind, with EV market share increasing only marginally from 2.5% in 2021 to around 4% in 2024–25. Despite improvements in vehicle performance and the availability of more EV models, adoption remains slow due to barriers such as high upfront cost, limited charging infrastructure, range anxiety, and low resale value. Most

4W EV adoption is concentrated in fleet vehicles—commercial taxis, ridehailing cars, and corporate mobility—while private buyers still prefer ICE vehicles.

Nevertheless, early signals of growth are becoming visible, driven by expanding fast charging networks, declining battery costs, and increasing consumer confidence.

The comparative analysis across all three segments reveals that **India's EV transition is not uniform but strongly segment dependent**. Commercial and high-utilization segments like 3W electrify first, followed by mass-market personal mobility segments like 2W, while premium personal mobility segments such as 4W electrify last. This pattern is consistent with global trends but is even more pronounced in India due to economic conditions, usage behaviour, and infrastructure availability.

The study also identifies several **structural breaks** linked to major policy events. For instance, significant jumps in EV market share coincide with FAME-II disbursements, state-level purchase incentives, and the introduction of lowcost EV models. Similarly, declines in market share correspond to subsidy reductions and increases in raw material costs. These structural patterns highlight the critical role that targeted, consistent, and transparent policymaking plays in sustaining EV adoption momentum.

Furthermore, the analysis highlights the importance of **data harmonization** in assessing EV market trends. Differences between VAHAN registrations, FADA retail data, and SIAM wholesale numbers underscore the need for unified, openly accessible national EV datasets. This research contributes a reproducible framework for calculating market shares using multiple sources, reducing ambiguity, and helping policymakers, researchers, and industry stakeholders make more informed decisions.

Based on the findings, it is evident that India's EV ecosystem has made remarkable progress in a short period, but significant challenges remain—particularly in 4W adoption and infrastructure development. Charging infrastructure expansion, better financing options, stable subsidy policies, domestic battery manufacturing, and improved consumer awareness are essential for accelerating the transition.

Overall, this research concludes that India's electrification journey is gaining strong momentum but is still in its early stages. The future trajectory will depend on the interplay of policy stability, technological advancements,

economic incentives, and consumer behaviour. If current trends continue, India has the potential to emerge as one of the global leaders in electric mobility, especially in light urban transport segments. The insights generated from this segment-wise comparative study provide a valuable foundation for future research, policy design, and industry planning aimed at supporting India's transition towards a cleaner, more sustainable, and economically viable mobility ecosystem.

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