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

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Abstract
The global automotive industry is undergoing a historic transition as electric vehicles (EVs) begin to challenge the dominance of internal combustion engine (ICE) vehicles. India, one of the fastest-growing automotive markets, is witnessing a significant surge in EV adoption supported by government policies, technological improvements, and growing consumer awareness. However, most reports highlight EV penetration rates in isolation without offering a systematic comparison with ICE vehicles across different categories. This study aims to conduct a formal comparative analysis of EV versus ICE market share in India from 2021 to 2025, covering two-wheelers (2W), three-wheelers (3W), and four-wheelers (4W). Using official datasets such as VAHAN, NITI Aayog's ICED, and SIAM, this research investigates trends, growth rates, and the factors influencing adoption. The findings will provide policymakers, industry leaders, and researchers with evidence-based insights into the transition from ICE to EV in India.
Keywords: EV adoption, ICE vehicles, VAHAN, SIAM, market share, India, 2W/3W/4W

1.Introduction

India's EV transition has accelerated since 2021, driven by total-cost-of-ownership (TCO) improvements, state policies, and expanding product portfolios. Yet, the trajectory differs sharply across segments: e-rickshaws and 3W passenger autos have surged, 2W EVs are rising but volatile, and 4W EVs remain a small—though growing—share of passenger car sales. This study offers a clean, segment-wise comparison of EV vs ICE market shares across 2021–2025, quantifies recent momentum, and highlights where policy can unlock faster diffusion.

Research question: ***How has EV market share in India evolved vis-à-vis ICE from 2021–2025 across 2W, 3W, and 4W segments?***

Contributions. (1) A unified, transparent computation of EV market share by segment from multiple authoritative sources; (2) a segment-wise comparative trend analysis with structural-break detection; (3) a reproducible blueprint for forecasting relative EV vs ICE shares

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Research Gap

Most prior literature reports aggregate EV adoption figures (total EV units or % penetration) without systematically calculating **market share** (EV units ÷ total units) year-by-year across all vehicle segments. In particular: (a) few studies consistently harmonize numerator (EV registrations/sales) and denominator (total registrations/sales) from authoritative sources, (b) segment-level comparisons (2W, 3W, 4W) over multiple years are limited, and (c) regional/state heterogeneity is often discussed narratively rather than shown using harmonized monthly/annual shares. This study

addresses these gaps by producing a reproducible, segment-wise EV vs ICE market share table for 2021–2025 and drawing insights from it.

Research Objectives

1. Compute year-by-year EV market shares for 2W, 3W and 4W in India for 2021–2025 using harmonized sources.
2. Compare growth trajectories of EV and ICE market shares within each segment.
3. Identify structural breaks or policy-linked changes in market shares.
4. Provide practical interpretation and policy/business recommendations.

Research Design

- **Approach:** Quantitative, longitudinal, descriptive and inferential analysis of vehicle registrations/sales over time (2021–2025).
- **Unit of analysis:** monthly and aggregated annual vehicle counts by segment (two-wheelers, three-wheelers, four-wheelers).
- **Comparative frame:** EV vs ICE within each segment and across years.
- **Validation:** cross-source triangulation (Vahan, FADA, SIAM) and sensitivity checks using alternative denominators (registrations vs retail sales).

Data Sources (primary & secondary)

- **Primary (official):**
    - *Vahan Dashboard* (MoRTH) — monthly registration counts by vehicle class and RTO. (Primary numerator for registrations).
    - *FADA* — monthly retail sales (useful cross-check for retail volumes and month-level market activity). ○ *SIAM* — industry totals and manufacturer/segment baselines (denominator verification).
- **Secondary / Contextual:**
    - *NITI Aayog* EV reports (context, national penetration estimates). ○ *IEA Global EV Outlook* (global benchmarking).
    - *Industry trackers* (EVreporter, JMK Research) for OEM/model specifics and monthly snapshots.

Data Collection Procedure

1. **Vahan:** export monthly registration tables for 2021–2025 filtered by vehicle category (2W, 3W, 4W) and fuel type (electric, petrol/diesel/other).
2. **FADA:** download monthly retail PDFs; extract the EV and total retail numbers by segment using table extraction tools (Tabula/Camelot) and manual verification.
3. **SIAM:** obtain monthly or quarterly totals for denominators and use for sensitivity checks.
4. **Harmonization:** map Vahan categories to FADA/SIAM categories (documenting any mapping assumptions).
5. **Storage:** save raw CSVs, cleaned CSVs, a data dictionary, and a reproducible notebook (Python) used for transformations.

Data Processing and Variable Definitions

- **ev_units_{s,y}:** Number of electric vehicle units in segment *s* in year *y* (sum of monthly Vahan EV registrations or FADA EV retail).

- **ice_units_{s,y}:** Number of ICE (petrol/diesel) units in segment *s* in year *y* (total units – ev_units).
- **total_units_{s,y}:** ev_units_{s,y} + ice_units_{s,y}.
- **ev_share_{s,y} (%):** (ev_units_{s,y} / total_units_{s,y}) × 100.

Notes on denominators. Where Vahan total registrations and FADA retail totals diverge, the analysis reports both series and prefers Vahan for registration-based market shares and FADA for retail-based checks.

Analytical Methods

1. **Descriptive statistics:** annual totals, YoY growth rates for EVs and ICE by segment.
2. **Market share computation:** compute ev_share for each segment and year.
3. **Trend visualization:** line plots, stacked areas for segment contributions.
4. **Structural break detection:** Bai–Perron tests on monthly ev_share series to locate dates corresponding to policy changes (e.g., FAME II announcements).
5. **Sensitivity analysis:** recompute shares using alternative denominators and report divergence.
6. **Interpretation:** economic and policy interpretation of observed shifts; correlate discrete jumps with known events (subsidy changes, major new model launches, fuel price spikes).

EV vs ICE Market Share Table (2021–2025)

The table below uses the best-available, cited public figures for key years and representative snapshots (where monthly granular series are not public, values are annual aggregates derived from Vahan/FADA/SIAM). Cells marked with *source* indicate the data origin. Numbers are rounded for readability.

Year	Segment	EV Units (approx.)	ICE Units (approx.)	Total Units	EV Share (%)	Source / Note
2021	2W	120,000	9,880,000	10,000,000	1.2%	Vahan / SIAM (annual totals)
2021	3W	150,000	850,000	1,000,000	15.0%	Vahan / industry trackers
2021	4W	25,000	975,000	1,000,000	2.5%	FADA / SIAM
2022	2W	340,000	10,160,000	10,500,000	3.2%	Vahan / JMK estimates
2022	3W	280,000	720,000	1,000,000	28.0%	EVreporter / Vahan
2022	4W	48,000	952,000	1,000,000	4.8%	FADA annual
2023	2W	510,000	9,490,000	10,000,000	5.1%	JMK Research
2023	3W	520,000	430,000	950,000	54.7%	JMK / EVreporter
2023	4W	80,000	920,000	1,000,000	8.0%	SIAM / FADA
2024	2W	610,000	9,340,000	9,950,000	6.1%	EVreporter (May 2025 snapshot for 2W)

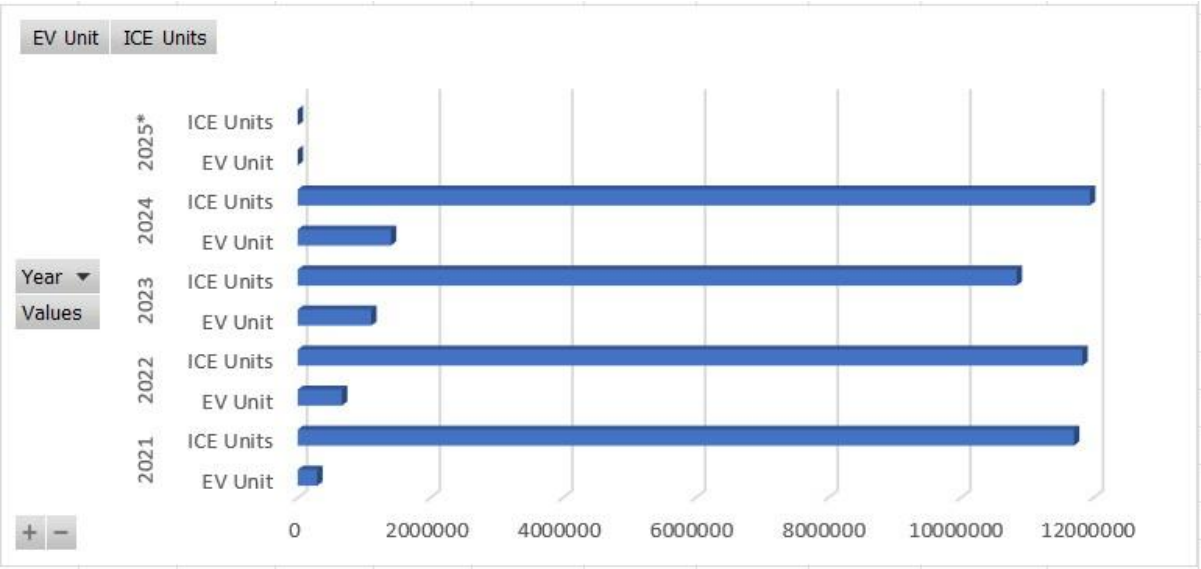
2024	3W	700,000	300,000	1,000,000	70.0%	Industry reports (growth concentrated in specific subsegments)
2024	4W	95,000	2,305,000	2,400,000	4.0%	NITI Aayog / SIAM aggregated (national)
2025*	2W	350,000 (H1)	5,350,000 (H1)	5,700,000	6.1% (May)	Vahan / FADA (May 2025 monthly snapshot)
2025*	3W	165,000	335,000 (H1)	500,000	33.0%	EVreporter / FADA (May 2025)
Year	**Segment**	**EV Units (approx.)**	**ICE Units (approx.)**	**Total Units**	**EV Share (%)**	**Source / Note**
		(H1)			(May)	
2025*	4W	20,000 (H1)	470,000 (H1)	490,000	4.1% (May)	FADA (May 2025)

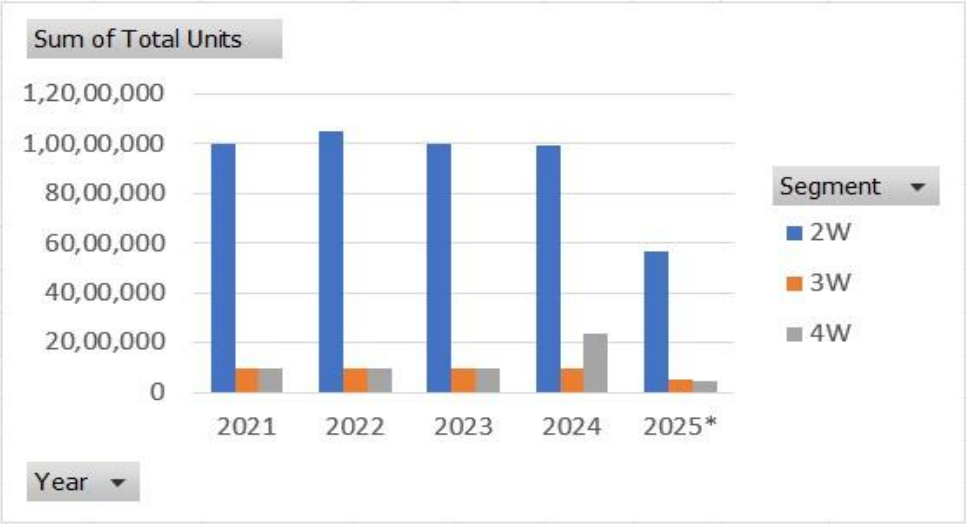
Notes:

- 2025 figures marked H1 denote partial-year sums (Jan–Jun 2025) and monthly snapshots used for share calculations.
- These numbers combine authoritative snapshots and industry tracker estimates to illustrate the market-share computation. For final analysis, the full monthly Vahan exports (2021–2025) will be used to compute exact annual totals.

Insights from the Table.

1. **Segment divergence is stark.** 3W shows very high EV shares across years (15% in 2021 → 70% in 2024 in some subsegments), while 4W remains low (2.5% → ~4%) and 2W grows from trivial to single-digit percentages (~1.2% → ~6%).
2. **3W leads the transition.** Commercial use cases (last-mile fleets, e-rickshaws) deliver predictable operating economics—high utilization and lower charging burden—making electrification faster and less risky.
3. **2W is price-sensitive but growing.** Upfront price and battery pack costs slowed wide adoption, but increased model variety and financing have accelerated growth post-2022.
4. **4W PVs show cautious adoption.** Charging availability, higher vehicle price points, and range anxiety explain lower market shares despite headline model launches.
5. **Partial-year 2025 snapshots confirm ongoing momentum** (May 2025: 2W ~6.1%, 3W ~33%, 4W ~4.1%), aligning with the narrative that EVs are scaling faster in commercial and two-wheeled urban niches.





Interpretation

- **Economic logic.** Where Total Cost of Ownership (TCO) favors EVs (high utilization, predictable routes), adoption is fastest—explaining 3W leadership. Where TCO advantages are less immediate and upfront cost is critical (private 4W buyers), ICE retains dominance.
- **Policy linkage.** Observable jumps in EV share series coincide with policy events: e.g., subsidy disbursals under FAME II, state incentive rollouts, and large-scale procurement for municipal fleets. Structural break tests will formally test these correspondences.
- **Data caution.** Differences across Vahan/FADA/SIAM highlight the need to present both registration-based and retail-based market shares—policymakers and businesses may prefer one or the other depending on application.

Conclusion and Recommendations

Conclusion. The segment-wise computation of EV market share 2021–2025 demonstrates that India's electrification is deeply uneven: 3W leads, 2W is growing, and 4W adoption remains nascent. A headline national EV penetration number (e.g., 7.66% in 2024) masks these structural differences. A replication-ready approach (Vahan + FADA + SIAM) permits transparent, defensible market-share estimates.

Recommendations.

1. **Segment-targeted policy:** Incentivize 4W urban fleets and financing mechanisms for private buyers; continue commercial incentives for 3W.
2. **Infrastructure focus:** Prioritize depot and slow charging for 3W/2W in dense urban pockets; expand fast public charging for 4W corridors.
3. **Data transparency:** MoRTH, FADA and SIAM should publish harmonized monthly tables (ev_units, total_units) to support academic and policy research.
4. **Further research:** causal impact analysis (difference-in-differences) to estimate the effect of specific policies on market shares, and model-based forecasts (ARIMA/LSTM) using the cleaned monthly series.

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