# Market Segmentation of the Indian EV Market

**by**

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GitHub

*https://github.com/francisfebin/FeynnLabs_Internship_P2.1-Market_Segmentation-Indian_EV_Market*

## Introduction to the EV Market in India

India's EV market is witnessing rapid growth, driven by factors like rising fuel prices, government incentives, environmental consciousness, and urbanization. By 2030, the EV industry in India is expected to reach significant growth rates, with increased adoption of two-wheelers, three-wheelers, and electric cars across urban and semi-urban regions. Government initiatives, such as the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) schemes, are pivotal, offering subsidies to manufacturers and buyers, making EVs more affordable.

The market is also evolving to meet local consumer needs, with advancements in battery technology, increased charging infrastructure, and collaboration between government and private enterprises. However, EV adoption faces challenges, including limited charging infrastructure, battery efficiency concerns, and high costs. Market segmentation is vital to understanding diverse customer profiles and tailoring EV products to meet these varying needs.

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## Objective of the Analysis

The purpose of segmenting the EV market in India is to understand distinct consumer groups, preferences, and purchasing behavior to support targeted strategies for manufacturers and policymakers. Through segmentation, EV companies can identify clusters, such as eco-conscious young professionals, budget-conscious buyers, and luxury-seeking individuals, to optimize product offerings and marketing approaches.

Expected insights include understanding how factors like income, geographic location, eco-consciousness, and age influence EV adoption. This will aid stakeholders in prioritizing investments in technology, product features, and marketing channels for each identified segment, leading to better customer engagement and increased adoption of EVs in India.

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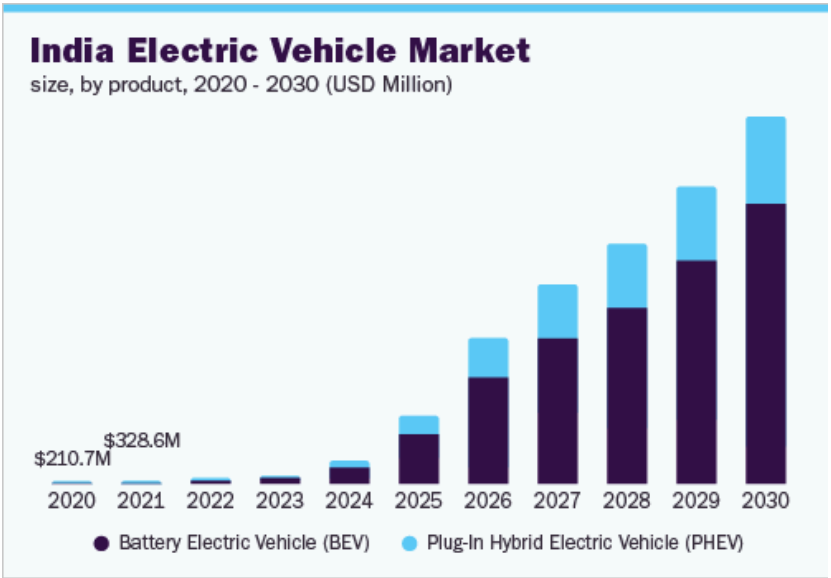
## Analysis: EV Market in India

- The Indian electric vehicle (EV) market is among the fastest-growing globally.
- Projected to achieve a **compound annual growth rate (CAGR)** of **94.4%** from **2021 to 2030**.
- Electric two-wheelers currently dominate the market, but interest in electric cars and buses is increasing.




## Government Initiatives

- The Indian government has implemented various **incentives** to promote EV adoption:
  - Tax reductions and subsidies for electric vehicle purchases.
  - Preferential access to certain roadways for electric vehicles.
- The government aims for **30% electrification** of the vehicle fleet by **2030**.

## Impact of COVID-19 on the Indian Electric Vehicle Market

- The COVID-19 pandemic has significantly affected the Indian electric vehicle (EV) market, primarily due to:
  - Disruptions in supply chains.
  - Temporary shutdowns of manufacturing units caused by continuous lockdowns and travel restrictions across the country.
- Despite these challenges, the EV market in India remains in its early stages and is anticipated to grow at an accelerated pace during the forecast period. This growth is supported by various government initiatives and policies aimed at promoting electric mobility.

## E-Mobility Initiatives

- Several e-commerce companies, including Amazon, are launching initiatives to incorporate e-mobility for last-mile deliveries, aiming to minimize their carbon footprint.
- The Indian government is actively exploring e-mobility solutions for public transport:
  - Electric inter-city buses have been deployed in several major cities to improve transportation sustainability.

## Role of State Governments

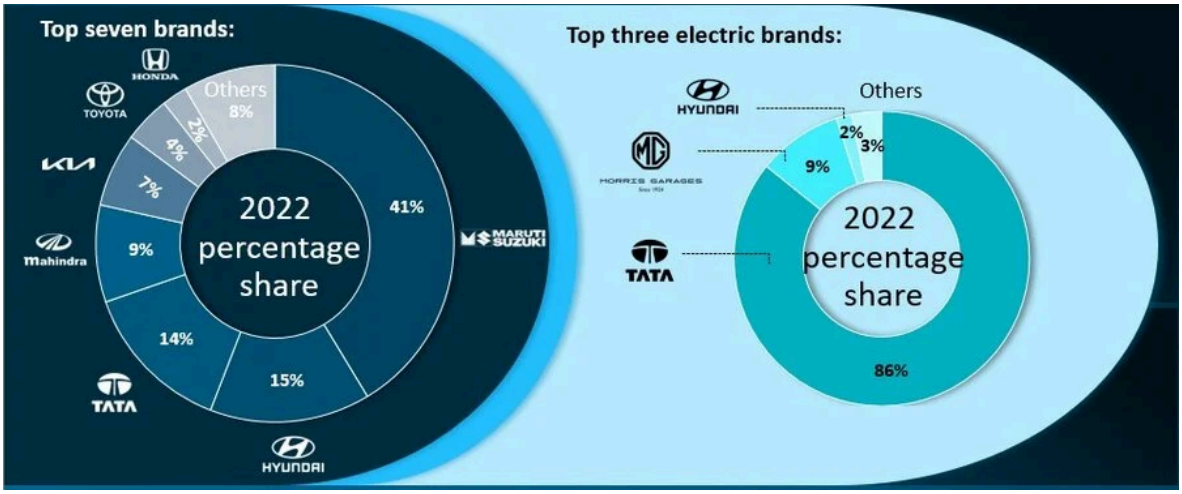
- State governments are also playing a crucial role in fostering policies that encourage EV adoption. Notable initiatives include:
    - **Kerala**: Aims to deploy one million EV units by 2022 and introduce 6,000 electric buses for public transport by 2025.
    - **Telangana**: Has set EV sales targets for 2025, which include:
        - 80% of 2- and 3-wheelers (motorcycles, scooters, auto-rickshaws).
        - 70% of commercial vehicles (e.g., ride-hailing services like Ola and Uber).
        - 40% of buses, 30% of private cars, and 15% electrification of all vehicles.
    - **Bengaluru**: Recently purchased 90 electric buses for city transport under the Bengaluru Metropolitan Transport Corporation (BMTC) and aims to transition to a fully electric fleet by 2023.

## Momentum in the EV Market

- The implementation of the **FAME India scheme** has catalyzed significant momentum in the Indian EV market, facilitating the shift towards e-mobility amid increasing international policy commitments and environmental concerns.
- India represents the world's largest untapped market for electric vehicles, particularly in the electric two-wheeler segment. The allowance of **100% foreign direct investment (FDI)** in this sector is expected to further stimulate market growth through the automatic route.

## Market Valuation

- The EV market in India is expected to reach an estimated valuation of **USD 152.21 billion** by **2030**.
- As of **2022**, the market size was valued at approximately **USD 4.15 billion**:
    - Two-wheelers accounted for **96%** of total sales.
    - Electric cars made up **3%** of sales.
    - Electric buses represented **1%** of sales.




## Incentives for Consumers

- Substantial incentives include:
  - **Tax rebate** of up to **INR 1.5 lakh** (approximately **USD 19,000**) for electric cars.
  - **INR 50,000** (around **USD 6400**) for two-wheelers.
- A **Production-Linked Incentive (PLI)** scheme has been introduced:
  - Expected to attract investments of about **INR 45 billion** (around **USD 570 million**).
  - Projected to create over **75,000 jobs** in the EV sector.

## Environmental Impact

- Transitioning to electric vehicles aligns with India's goals to:
  - Reduce carbon emissions.
  - Decrease reliance on fossil fuels.
- The EV sector contributes to economic development through job creation and domestic manufacturing.

## Challenges Ahead

- The Indian EV market faces several challenges, including:
  - Affordability of electric vehicles.
  - Need for enhanced charging infrastructure.
  - Addressing consumer concerns such as range anxiety.
- Overcoming these challenges will require sustained efforts and innovative strategies.

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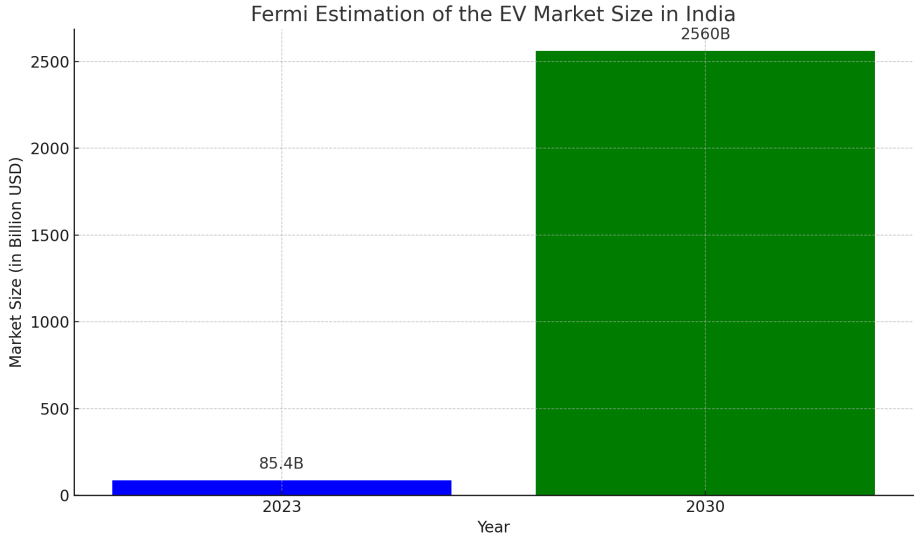
## Fermi Estimation for the EV Market in India

*This estimate provides a rough idea of the current and future potential of the electric vehicle market in India. Keep in mind that Fermi estimates are based on assumptions and approximations, so actual figures may vary significantly.*

1. **Population of India**: Approximately **1.4 billion**.
2. **Total Number of Vehicles**:
    - Assume about **0.5 vehicles per person** on average.
    - **Total Vehicles** = 1.4 billion × 0.5 = **700 million** vehicles.
3. **Current EV Penetration**:
    - Assume that as of **2023**, about **1%** of vehicles are electric.
    - **Total EVs** = 700 million × 0.01 = **7 million** EVs.
4. **Average Price of an Electric Vehicle**:
    - The average price of an electric vehicle in India is around **INR 1 million** (approximately **USD 12,000**).
5. **Current Market Size of EVs**:
    - **Total Market Size** = Number of EVs × Average Price
    - **Total Market Size** = 7 million × 1,000,000 INR = **7 trillion INR**.
    - In USD:
        - 7 trillion INR ÷ 82 INR/USD ≈ **85.4 billion USD**.
6. **Projected Growth of the Market**:
    - If we estimate that by **2030**, EV penetration will increase to **30%**:
    - **Total EVs in 2030** = 700 million × 0.3 = **210 million EVs**.
    - **Total Market Size in 2030** = 210 million × 1,000,000 INR = **210 trillion INR**.
    - In USD:
        - 210 trillion INR ÷ 82 INR/USD ≈ **2.56 trillion USD**.



**Summary of the Fermi Estimate**

- **Current Market Size of EVs in India**: Approximately **85.4 billion USD**.
- **Projected Market Size by 2030**: Approximately **2.56 trillion USD**.

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## Data Selection

### Description of Datasets Used

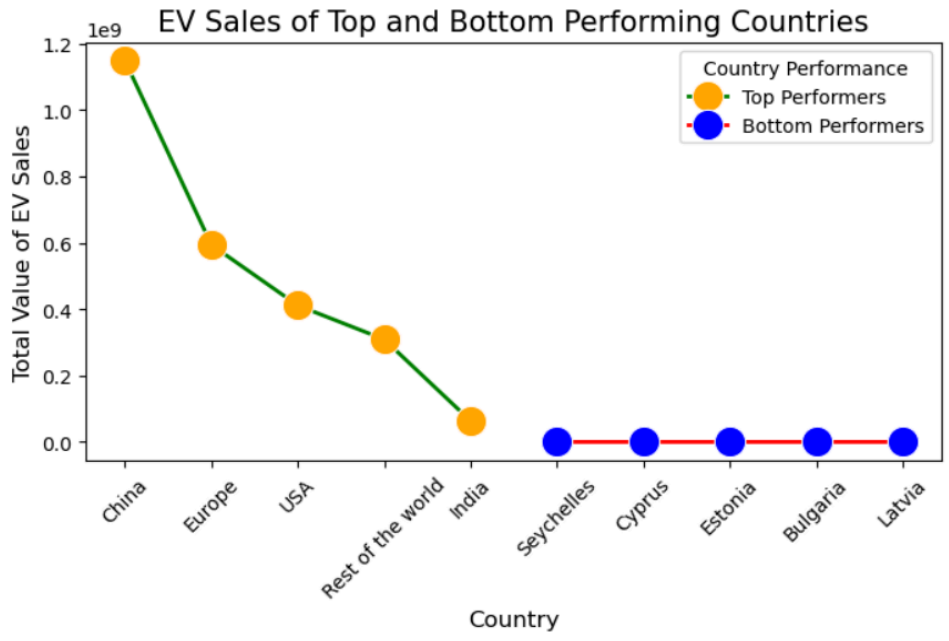
- https://www.data.gov.in/keywords/Electric
- https://tn.data.gov.in/resource/stateuts-wise-current-sales-electric-vehicles-ev-country-various-segments-reply-unstarred
- https://vahan.parivahan.gov.in/vahan4dashboard/
- https://www.kaggle.com/datasets/patricklford/global-ev-sales-2010-2024

## Exploratory Data Analysis and Results

## Analyzing Global Data

In 2023, global electric vehicle (EV) sales surpassed 14 million units, with significant contributions from the top five areas: China, Europe, the United States, Rest of the World, and India. Here's a summary of the sales figures for each:

### Top Areas for EV Sales:



1. **China:**

China continues to dominate the global EV market with approximately 8.1 million new electric car registrations, representing about 60% of global sales. This marks a 35% increase from 2022.

2. **Europe:**

The entire European region recorded around 3.2 million new electric car registrations, with major contributions from countries like Germany, France, and the UK. In the European Union alone, sales were about 2.4 million, reflecting a robust market despite subsidy reductions.

3. **United States:**

The U.S. saw new registrations of around 1.4 million electric cars, a growth of over 40% compared to the previous year. The increase was driven by favorable tax credits and a growing range of electric models available to consumers.

4. **Rest of the World:**

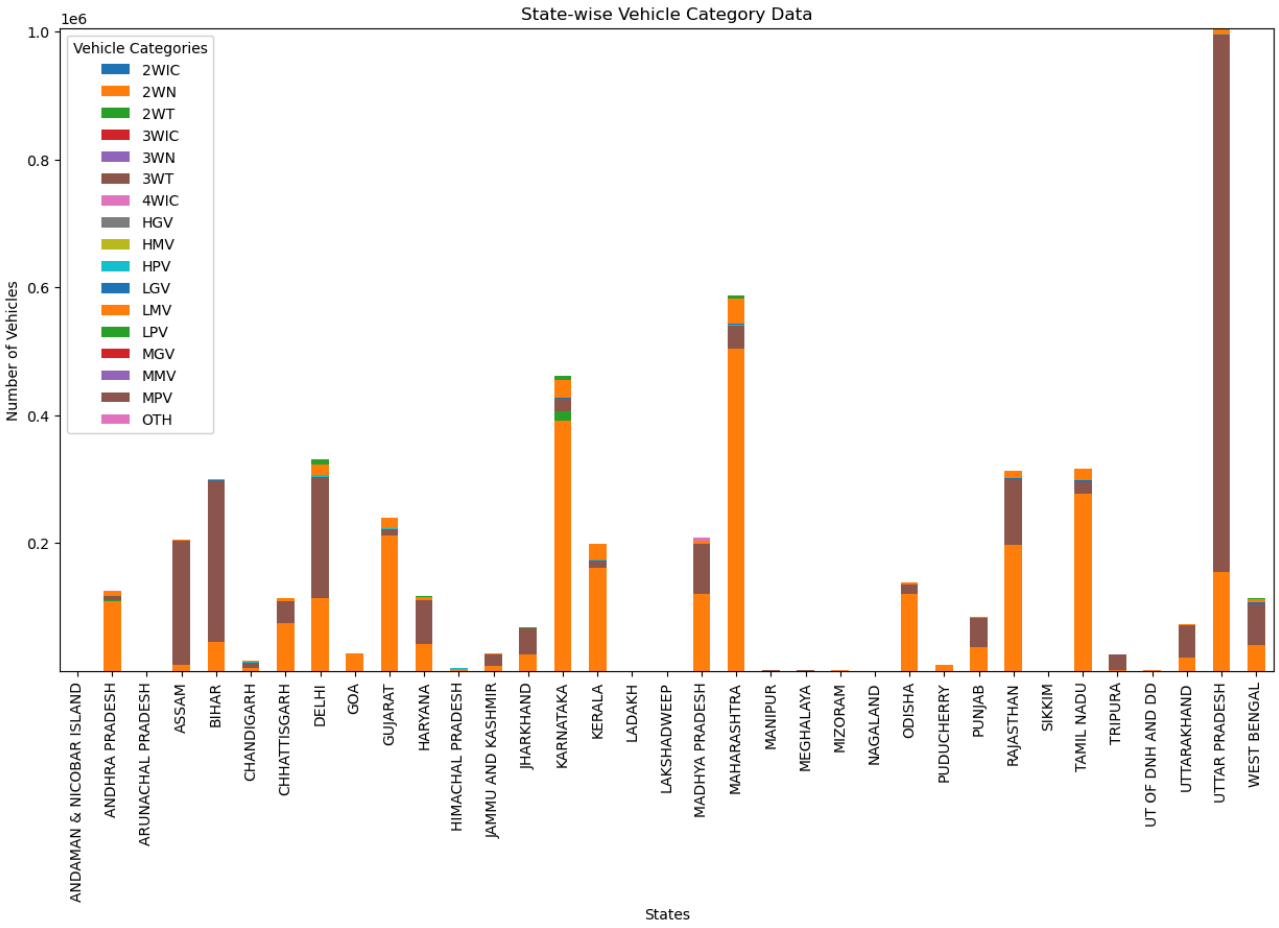
This category includes emerging markets where EV sales are growing from a low base. While specific figures vary, regions like Southeast Asia and Brazil are witnessing increased sales, particularly in two- and three-wheeled electric vehicles, though overall passenger car sales remain low.

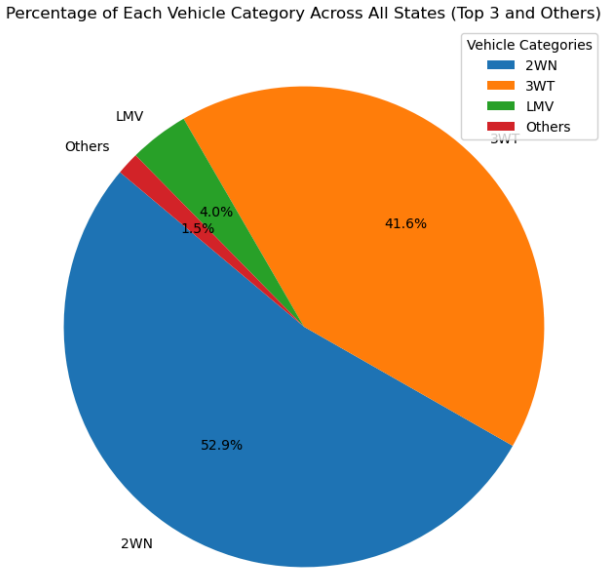
5. **India:**

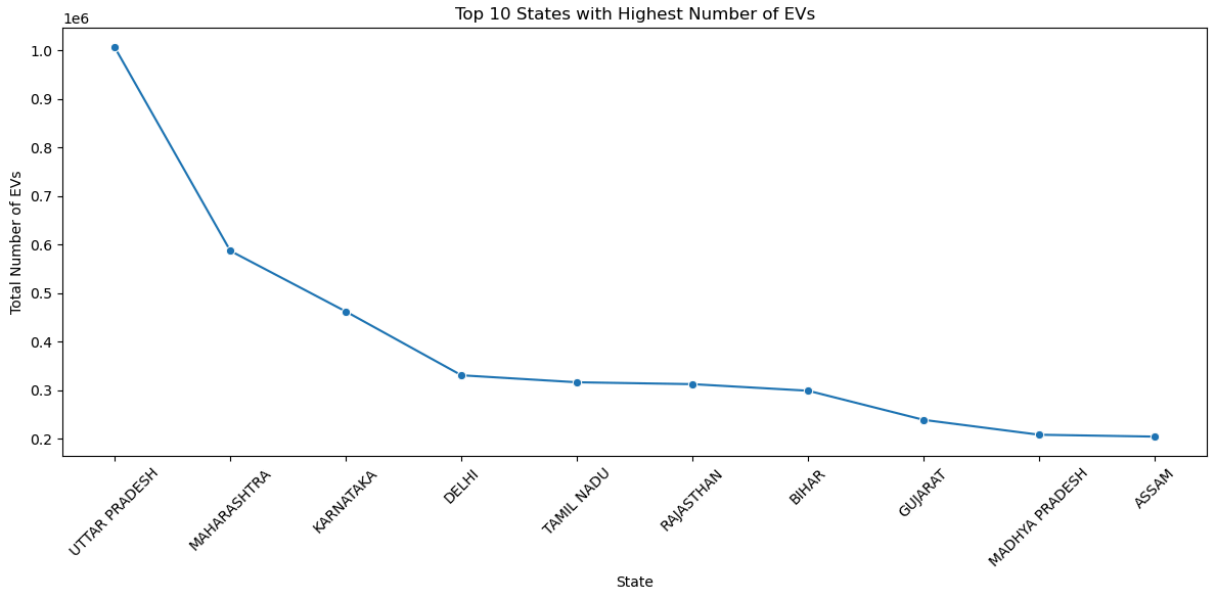
India experienced a remarkable growth rate, with 80,000 electric vehicles registered, reflecting a 70% increase year-on-year. However, this still represents only about 2% of total car sales in the country.

# Analyzing & Visualizing Indian Data

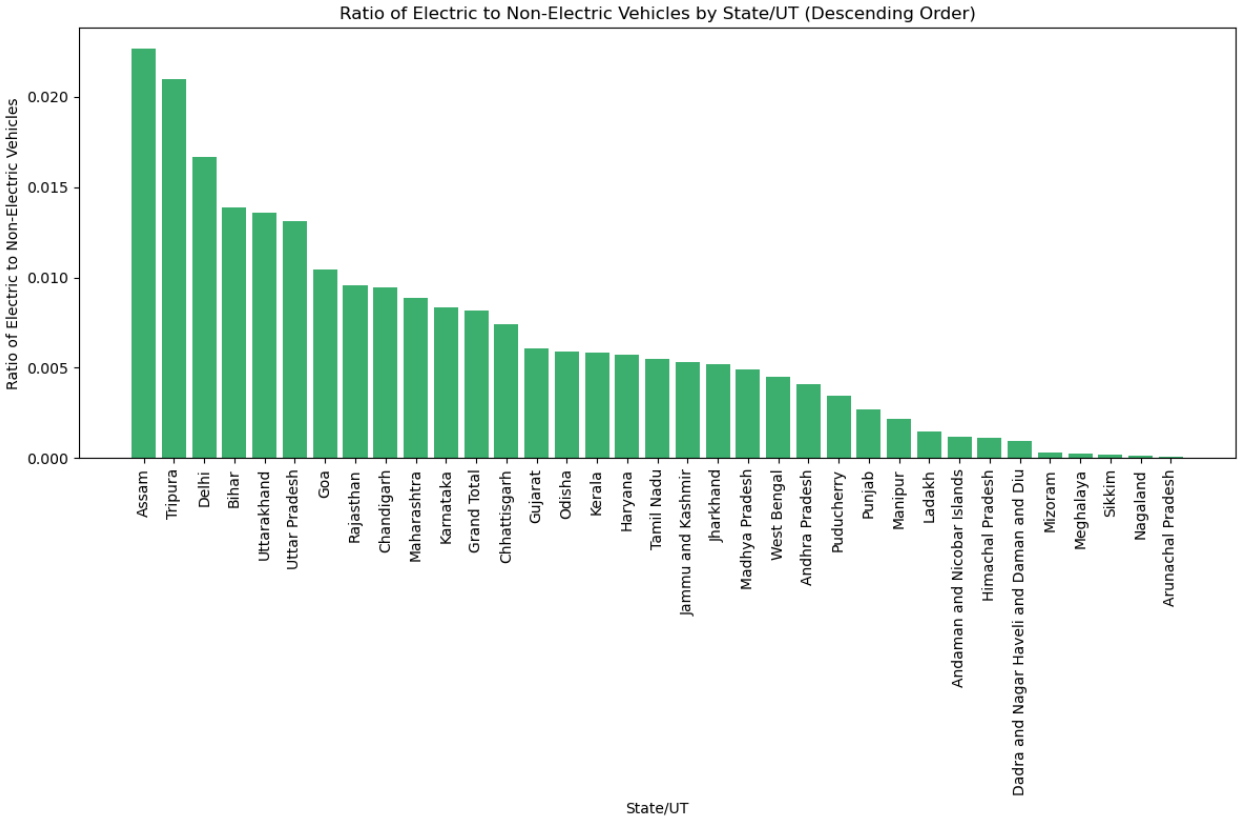
## Vahan Dashboard: State Wise Vehicle Category Data For All State ( Till Today )



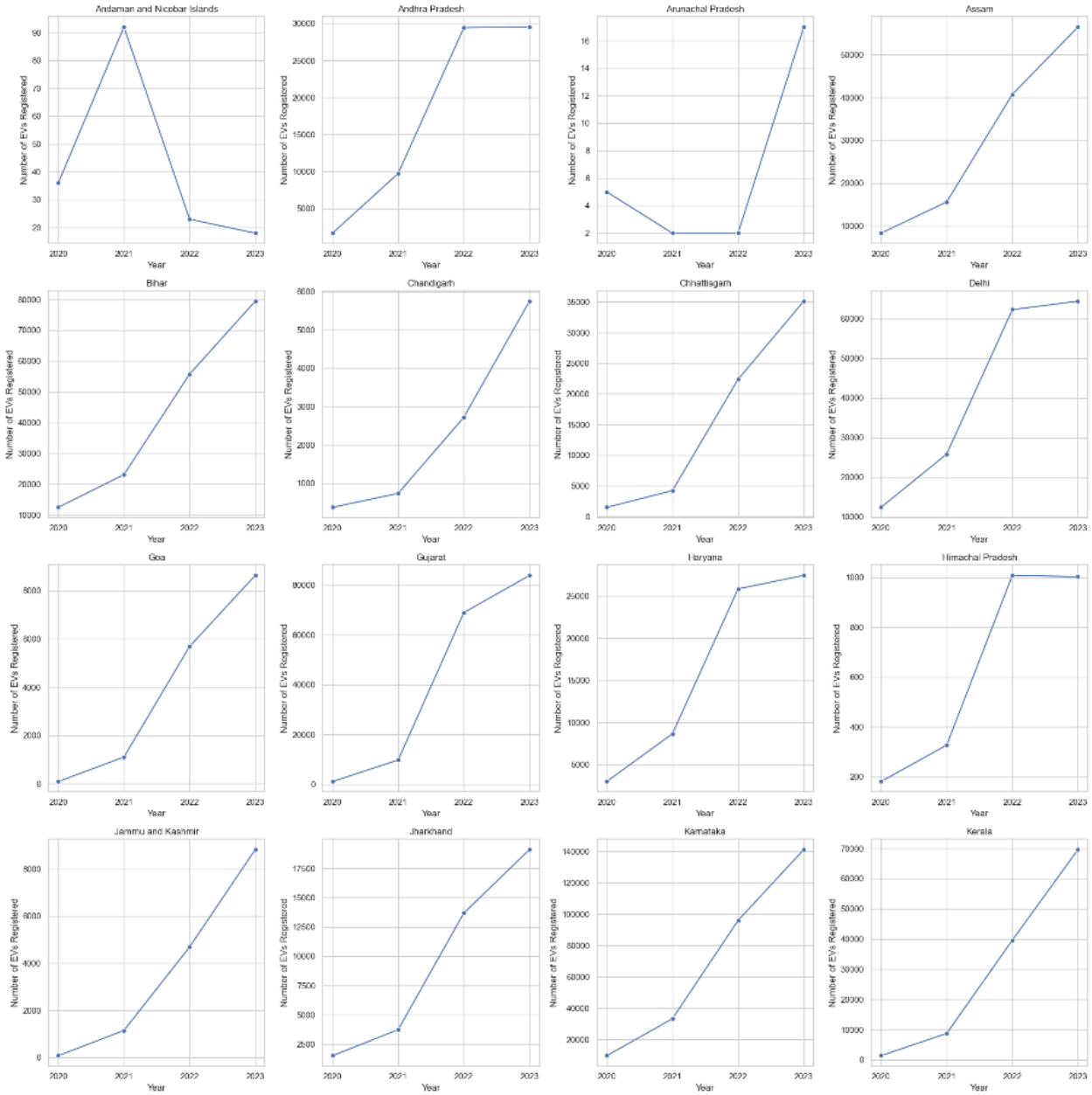





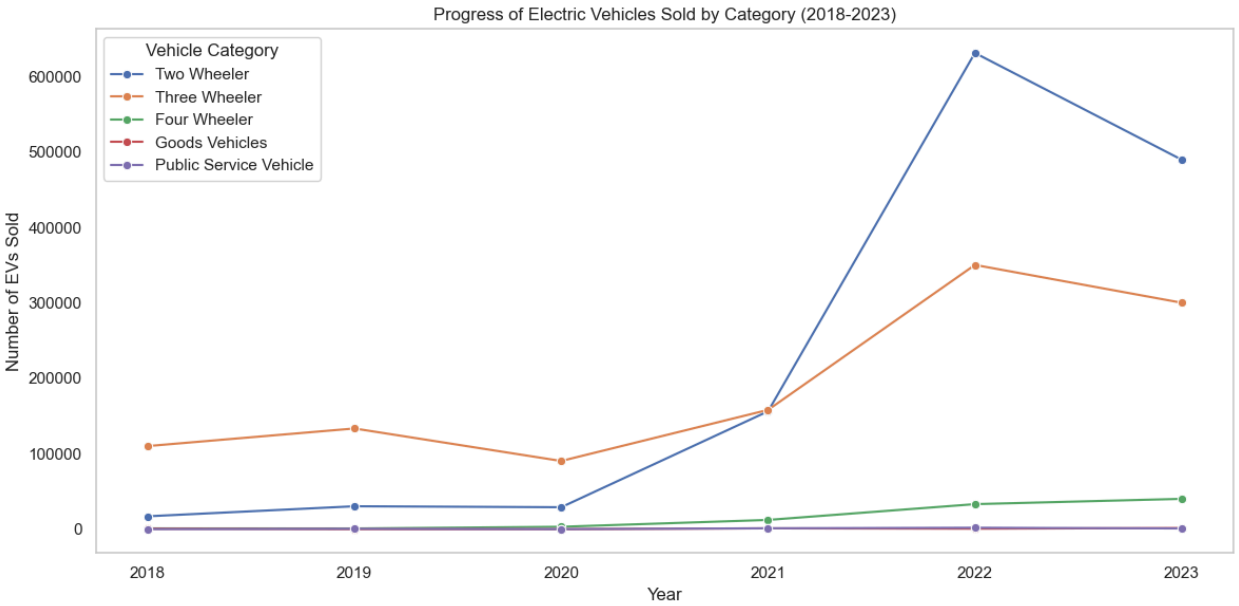

## StateUT-wise Details of Electric and Non-Electric Vehicles in the Country as on 03-08-2023



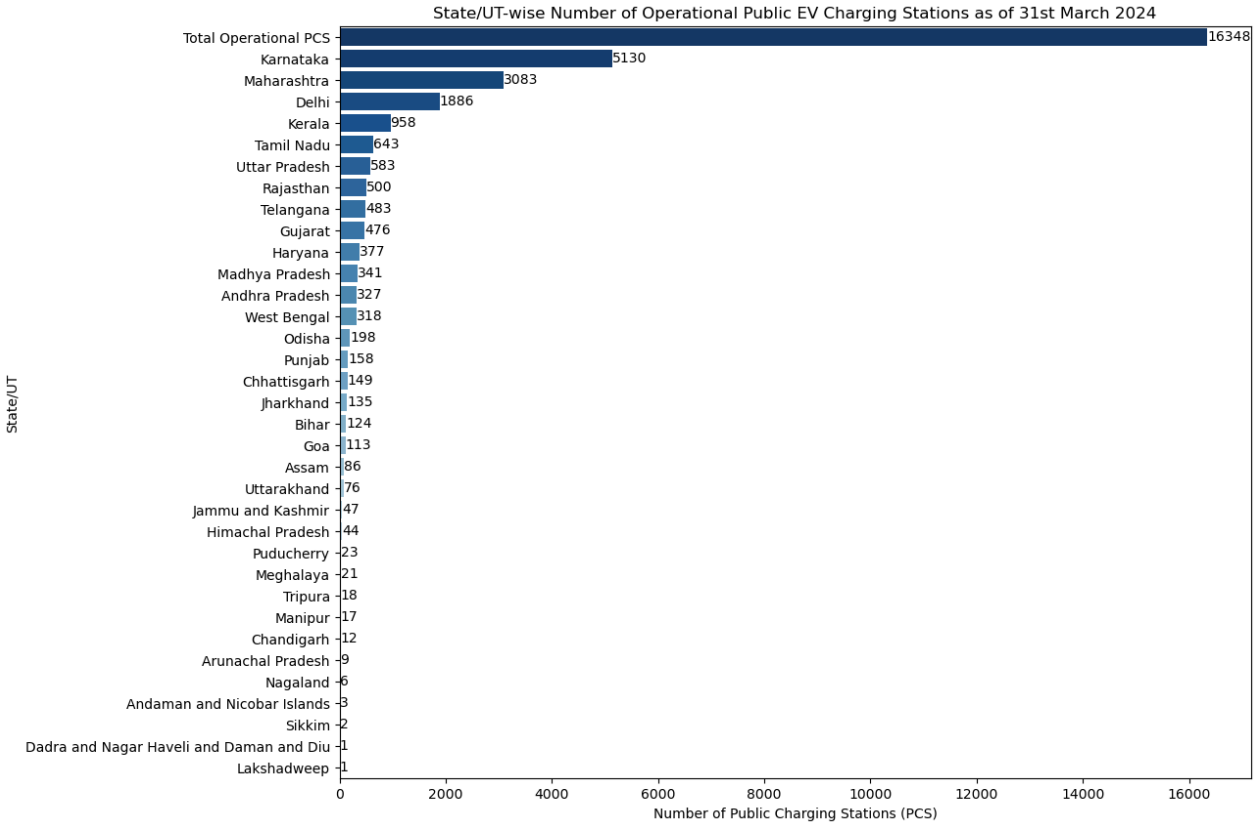
# StateUT-wise Number of Electric Vehicles (Evs) Registered in Vahan4 from 2020 to 2023



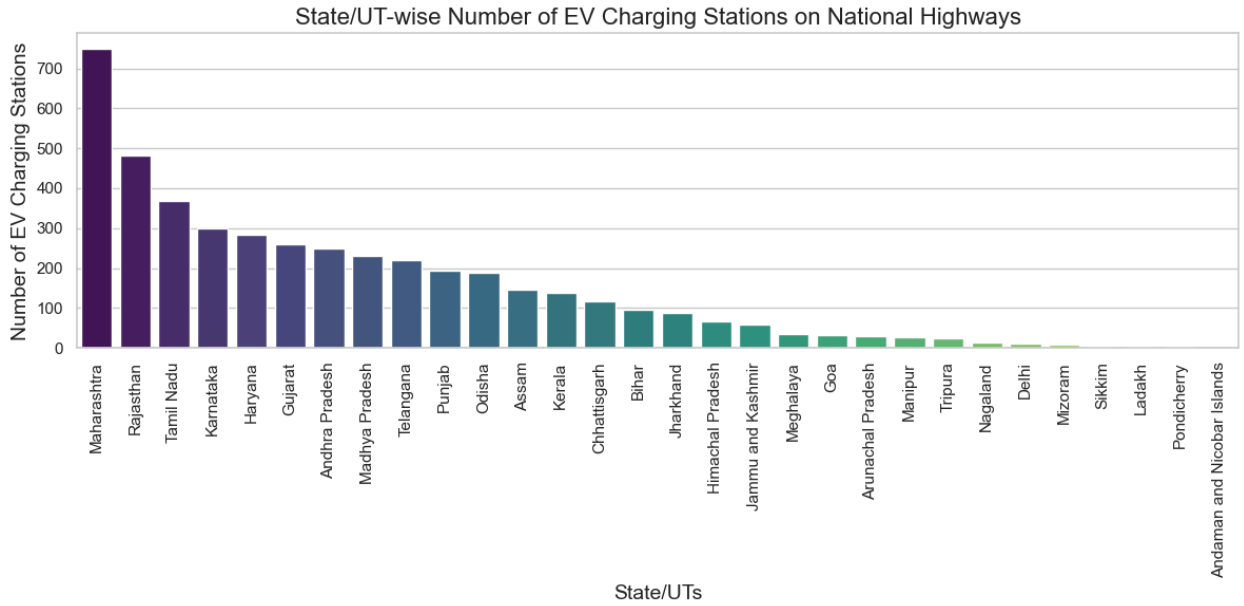
## Category-wise Details of Electric Vehicles Sold as per the e-vahan Portal in the Country from 2018 to 2023



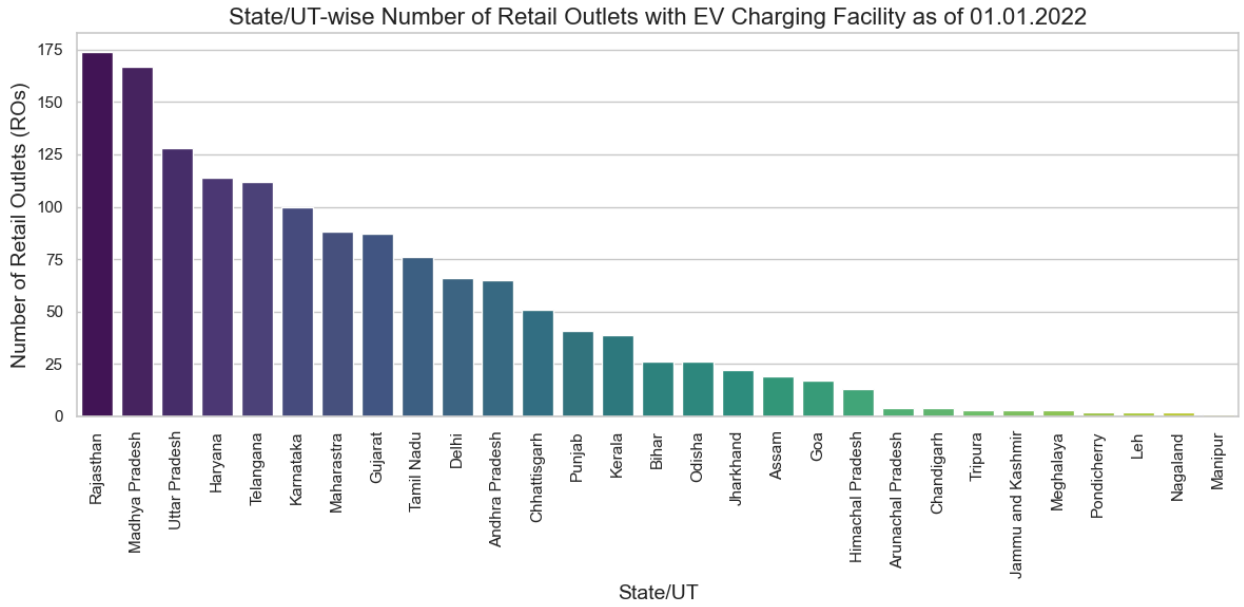

## StateUT-wise Number of Operational Public Electric Vehicles (EVs) Charging Stations (PCS) as on 31st March 2024



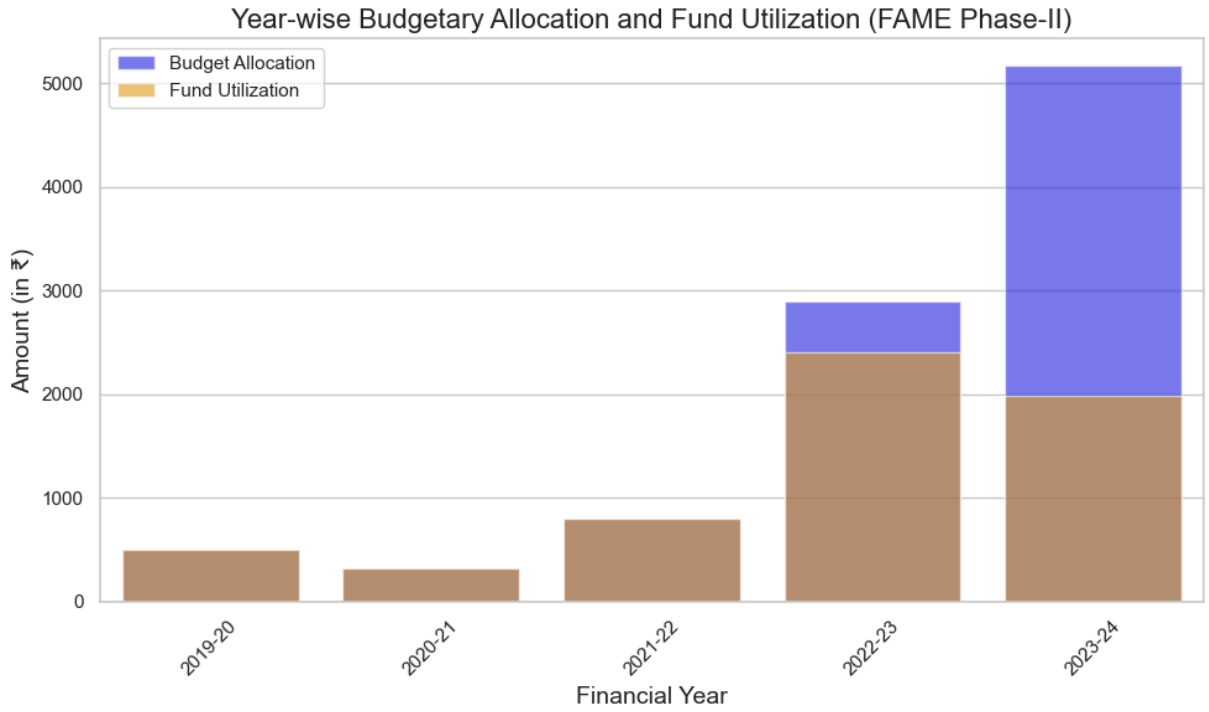
**StateUT-wise Details of 5293 Electric Vehicle Charging Stations established along National Highways**



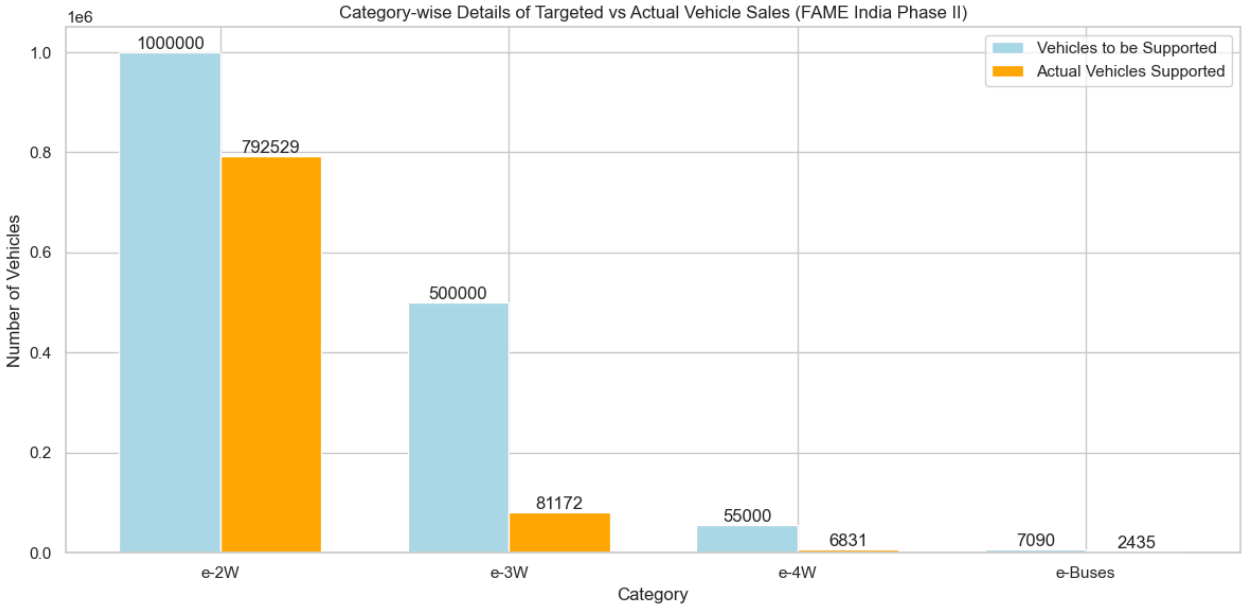

**StateUts-wise No. of Retail Outlets (Ros) where Electric Vehicle (EV) Charging Facility as on 01.01.2022**



**Year-wise Details of Budgetary Allocation and Expenditure of Funds under Phase-II of Faster Adoption and Manufacturing of (Hybrid) Electric Vehicles (FAME) from 2019-20 to 2023-24**




**Category-wise Details of the Targeted Vehicles to be Supported vs Actual Vehicle Sales under Faster Adoption and Manufacturing of Electric Vehicles in India Phase II (FAME India Phase II)**




*Note: Telangana is not included in the VAHAN data, which may result in incomplete insights regarding EV adoption and infrastructure development in the region. Please consider this data gap when assessing market opportunities in Telangana.*

**1. Top 10 States with the Highest Number of EVs**

- **Insight**: The highest EV concentration is in populous and economically developed states, led by Uttar Pradesh, Maharashtra, and Karnataka. This suggests a correlation between population, urbanization, and EV adoption. States with robust industrial sectors like Maharashtra and Karnataka are likely fostering more EV adoption through local industry incentives, greater awareness, and better infrastructure.
- **Recommendation**: Focusing on these states for market entry could be strategic, especially if targeting two-wheelers and three-wheelers, which are popular in urban and semi-urban areas.

**2. EV Type Distribution in India (2WN, 3WT, LMV)**

- **Insight**: Two-wheeler EVs dominate the market at 52.9%, followed closely by three-wheelers at 41.6%. This pattern likely reflects the demand for cost-effective, low-maintenance urban transport and delivery vehicles. Light Motor Vehicles (LMVs) make up a smaller share, possibly due to higher costs and limited charging infrastructure.
- **Recommendation**: Investments in two-wheeler and three-wheeler segments appear most promising for rapid returns, especially in urban areas. However, with the expected growth of charging infrastructure, the LMV segment might become more viable in the coming years.

**3. EV to Non-EV Ratio by State**

- **Insight**: States like Assam, Tripura, and Delhi lead in the EV to non-EV ratio, indicating a higher relative penetration of EVs. This could be due to state incentives, population density, and shorter commute distances in urban areas. States with lower ratios, such as Arunachal Pradesh and Nagaland, may have geographical or economic barriers to EV adoption.
- **Recommendation**: Focusing initial market entry in the top-ranked states may yield quicker adoption. For lower-ranking states, further investigation into local policies and incentives could identify opportunities to encourage adoption.

**4. Growth in Two-Wheelers and Three-Wheelers Over the Last 5 Years**

- **Insight**: The dominance of two- and three-wheelers in EV growth aligns with India's demographic and economic landscape, where cost-effective, short-distance transport is crucial. Their higher growth may be driven by affordability, maintenance simplicity, and increasing awareness.
- **Recommendation**: The company could prioritize partnerships with manufacturers of two- and three-wheel EVs, targeting urban and peri-urban markets where these types of

vehicles are most used. Tailoring financing options for these EV types could further boost sales.

**5. Operational Public EV Charging Stations by State**

- **Insight**: Karnataka, Maharashtra, and Delhi are leading in terms of operational public EV charging stations. This indicates robust infrastructure growth in high-population or economically significant states, which may encourage faster EV adoption in these areas.
- **Recommendation**: These leading states are ideal for launching EV models that may have longer charge times or need reliable public charging infrastructure. This infrastructure also provides an anchor for building customer confidence in EV accessibility.

**6. EV Charging Stations on National Highways**

- **Insight**: Maharashtra, Rajasthan, and Tamil Nadu top the list of states with EV charging stations on national highways, which is crucial for intercity EV travel and logistics. This distribution is beneficial for long-distance transport and could potentially open avenues for EV trucks and commercial fleets.
- **Recommendation**: Targeting highway-linked regions with EV-compatible commercial vehicles or higher-capacity EV models could fill a growing demand for sustainable long-distance travel solutions.

**7. Retail Outlets with EV Charging Facilities by State**

- **Insight**: States like Rajasthan, Madhya Pradesh, and Uttar Pradesh are expanding EV charging at retail outlets. This development shows a growing ecosystem for EV support in places where people often spend more time, like malls or supermarkets, enhancing convenience for EV users.
- **Recommendation**: Collaboration with retail outlets in these states could boost the convenience factor for EV owners and increase brand visibility. Marketing initiatives highlighting accessible charging options at popular retail spots may also attract customers considering EVs for their next vehicle purchase.

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## Market Segmentation


To achieve accurate segmentation, multiple datasets are considered, encompassing:

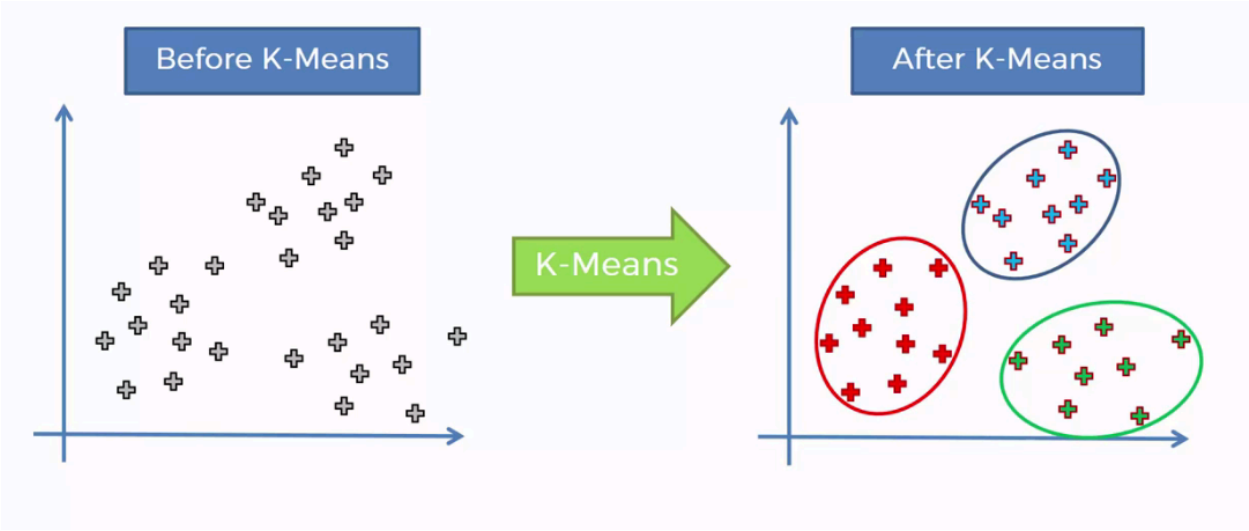
1. **Demographics**: Age, gender, and education levels, revealing customer lifestyles and preferences.
2. **Income Levels**: Essential for categorizing customer segments based on affordability.
3. **Geographical Data**: Urban, semi-urban, and rural areas, highlighting regions with higher EV demand.
4. **EV Awareness**: Awareness about eco-friendly practices and electric vehicles, impacting purchasing motivation.
5. **Preferences for Battery Range**: Preferred range, which affects vehicle choice depending on use cases, like daily commute or inter-city travel.

### Preprocessing Steps

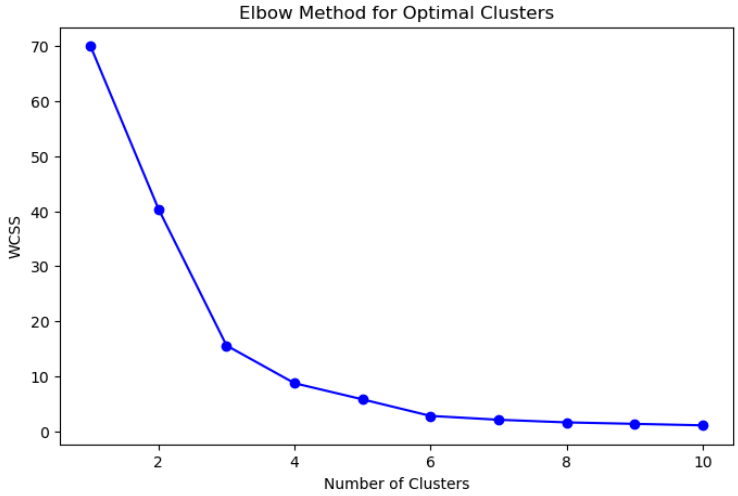
1. **Data Cleaning**: Handle missing values by imputation and remove duplicate records to improve data quality.
2. **Standardization/Normalization**: Normalize features like income and age to ensure uniformity.
3. **Feature Engineering**: Construct new features such as eco-awareness score and urban/rural classification to enhance clustering accuracy.

## Segmentation Methodology

### Explanation of the K-Means Clustering Model




For this EV market segmentation project focused on India, I used the **K-Means Clustering algorithm** due to its effectiveness in segmenting data based on purchasing behavior and demographic information. This unsupervised ML model allowed us to categorize potential EV buyers into distinct groups based on attributes regarding EV features.

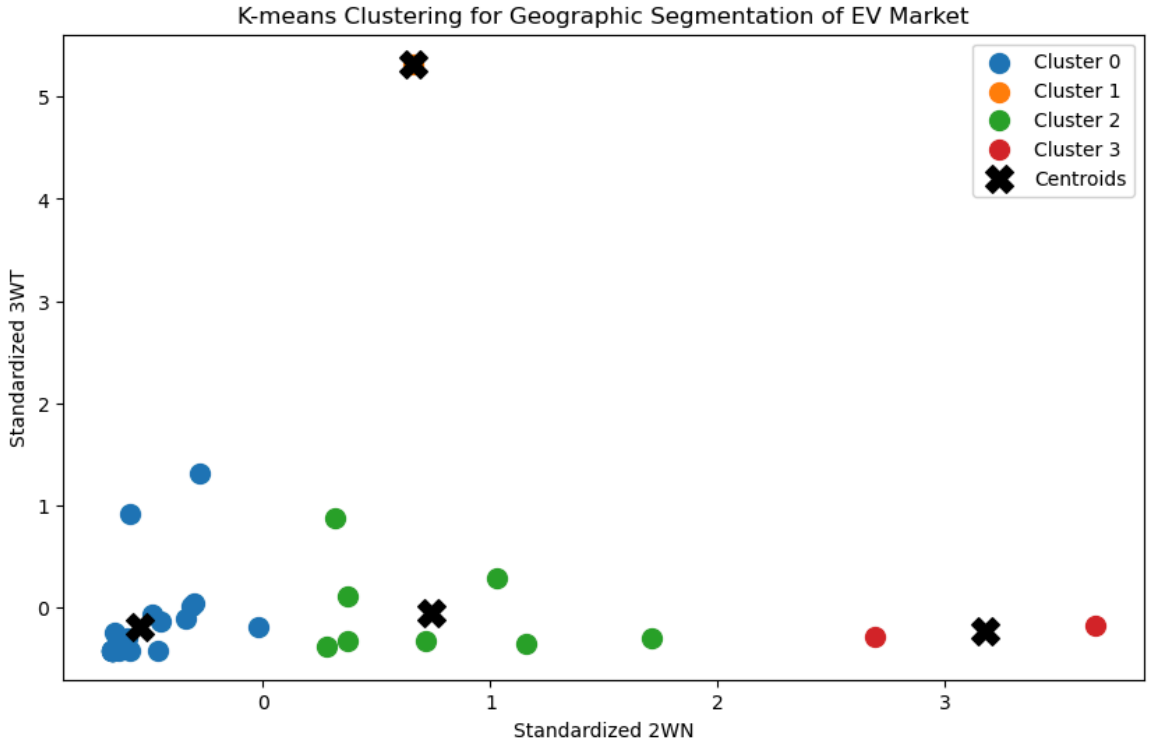



After scaling the data with StandardScaler, I used the **Elbow Method** to determine the optimal number of clusters (k). With **k=4**, K-Means effectively grouped consumers into clusters that align well with typical buyer personas in India's emerging EV market. This clustering helped us pinpoint essential market segments, each with unique purchasing capacities and preferences for EV features (e.g., battery range, price sensitivity, and technology adoption). Using K-Means

allowed us to efficiently handle the data and categorize market segments based on Indian consumers' distinct EV needs.

K-Means is ideal for this project because it is simple, scales well with large datasets, and effectively identifies distinct clusters in demographic and income-based data. The Elbow Method is used to select the optimal number of clusters, ensuring that each identified segment accurately represents a unique customer profile.

## Visualization of Clusters for 2WN and 3WT




### Cluster Insights for 2WN and 3WT

- **Cluster 0 (Low EV Penetration)**:
    - Majority of the states fall into this cluster, indicating relatively lower numbers of both 2WN and 3WT EVs.
    - Many states in this group are smaller in terms of population and geographic size (e.g., **Andaman & Nicobar Islands**, **Mizoram**, **Nagaland**).
    - States with moderate 3WT presence, such as **Bihar**, **Assam**, and **Chhattisgarh**, also fall in this cluster, reflecting localized usage of 3-wheelers despite overall lower EV numbers.
- **Cluster 1 (High 3WT Dominance)**:
    - **Uttar Pradesh** stands alone in this cluster, with an exceptionally high count of 3WT EVs (839,015) compared to 2WN EVs.

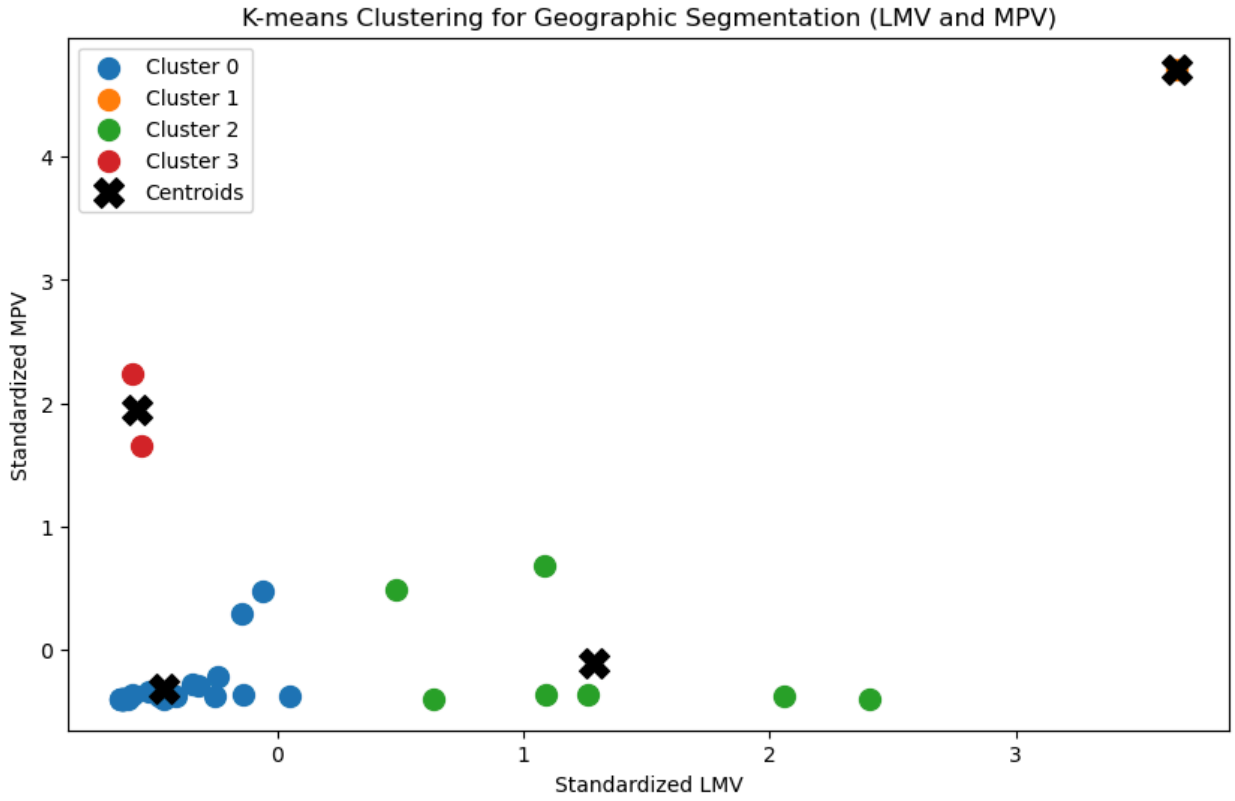
    - This indicates a strong presence of electric 3-wheelers in the state, likely driven by market demand for commercial transport solutions.
    - It suggests potential for continued 3WT growth in the state, which could attract businesses focused on supporting 3-wheeler EV infrastructure.
- **Cluster 2 (Moderate EV Growth)**:
    - States in this cluster, such as **Delhi**, **Gujarat**, **Odisha**, and **Tamil Nadu**, exhibit moderate levels of both 2WN and 3WT EVs.
    - These states have a balanced EV market and may be ideal for further growth and investment in both two- and three-wheeler segments.
    - The presence of urban hubs and industrial centers within these states likely contributes to this balanced EV demand.
- **Cluster 3 (High EV Penetration)**:
    - **Karnataka** and **Maharashtra** are in this cluster, with very high numbers of 2WN EVs compared to 3WT EVs.
    - These states show robust adoption of electric 2-wheelers, possibly due to factors like urban population density, commuter preferences, and government policies.
    - These states may be particularly attractive for businesses focusing on two-wheeler EVs, charging infrastructure, and related services.

**Recommendations for the Client**

- **Target Market Expansion in Cluster 1 (Uttar Pradesh)**:
    - The dominance of 3WT EVs in Uttar Pradesh suggests an opportunity for businesses focusing on three-wheeler EVs, including vehicle sales, parts, and charging stations catering to commercial transport needs.
- **Balanced Investment in Cluster 2 States (Delhi, Gujarat, Tamil Nadu, etc.)**:
    - States in Cluster 2 show balanced demand for 2WN and 3WT vehicles, presenting opportunities for diversified investment across both two- and three-wheeler EV segments.
- **Focus on Urban and Dense Areas in Cluster 3 (Karnataka, Maharashtra)**:
    - The high number of 2WN EVs in Maharashtra and Karnataka indicates strong urban demand, making these states suitable for businesses that provide two-wheeler-specific services, battery-swapping stations, and other urban EV infrastructure.
- **Consider Emerging Markets in Cluster 0**:
    - States in Cluster 0 may benefit from smaller-scale pilot programs to gauge EV adoption potential, especially in states with moderate 3WT usage like Bihar and Chhattisgarh

## Visualization of Clusters for LMV and MPV

### Cluster Insights for LMV and MPV




**Cluster 0 (Low LMV and MPV Presence):**

- A significant number of states, including Andaman & Nicobar Islands, Arunachal Pradesh, and Mizoram, fall into this cluster, indicating low registrations of both LMVs and MPVs.
- States in this group tend to be smaller in population and geographic size, suggesting limited automotive demand.
- Despite overall low vehicle numbers, states like Bihar and Chhattisgarh show localized usage of medium passenger vehicles, reflecting some demand for specific transport solutions despite the low penetration of vehicles overall.

**Cluster 1 (High LMV and Moderate MPV Presence):**

- Maharashtra stands out in this cluster with an exceptionally high count of LMVs (39,424) and a modest number of MPVs (294).
- This suggests strong market demand for light motor vehicles, possibly driven by urbanization and economic activity.

- Other states like Gujarat and Delhi also exhibit high LMV counts, indicating potential for continued growth in the light vehicle market, making them attractive for businesses focused on LMV infrastructure and services.

**Cluster 2 (Balanced LMV and MPV Presence):**

- States in this cluster, such as Tamil Nadu, Uttar Pradesh, and Karnataka, show moderate levels of both LMVs and MPVs.
- The balanced vehicle market in these states suggests opportunities for diversified investment in both light and medium passenger vehicles, supported by urban centers and industrial activity.
- The presence of significant urban populations may contribute to sustained demand for both vehicle categories, indicating potential for growth.

**Cluster 3 (High MPV Presence with Moderate LMV Count):**

- States like Assam and Jammu and Kashmir are included in this cluster due to their higher registrations of MPVs (118 and 152, respectively) compared to their LMV counts.
- This reflects a strong presence of medium passenger vehicles, likely driven by local transport needs, suggesting that these states might prioritize MPVs for passenger transport services.
- These states may present unique market opportunities for businesses focusing on medium vehicle infrastructure and services tailored to local transportation needs.

## Recommendations for the Client

**Target Market Expansion in Cluster 1 (Maharashtra, Gujarat, Delhi):**

- The dominance of LMVs in states like Maharashtra and Gujarat indicates significant opportunities for businesses focusing on LMV sales, charging stations, and related services.
- Leveraging the urban demand in these states could lead to successful market penetration.

**Diversified Investment in Cluster 2 States (Tamil Nadu, Uttar Pradesh, Karnataka):**

- Given the balanced demand for LMVs and MPVs, these states present opportunities for businesses to invest in both vehicle segments.
- Developing targeted marketing strategies to cater to the urban populace can help capture the diverse vehicle demands.

**Focus on Localized Solutions in Cluster 3 (Assam, Jammu and Kashmir):**

- The higher number of MPVs in states like Assam suggests opportunities for businesses that can cater to medium passenger transport needs.
- Exploring localized solutions for public transport could yield beneficial returns in these areas.

**Consider Pilot Programs in Cluster 0 States (Andaman & Nicobar Islands, Arunachal Pradesh):**

- Implementing small-scale pilot programs to assess vehicle adoption potential may be beneficial, particularly in states with low registrations but some localized vehicle usage.
- Understanding the unique transportation challenges in these areas could provide insights for tailored solutions that promote vehicle adoption.

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## Future Enhancements

### A.Estimated Market Size

The estimated market size for the EV domain in India (as of recent trends) is projected to grow significantly:

- India's total vehicle market size is approximately **24 million units** annually, with a current EV penetration of about **1.3%**.
- According to industry projections, EV adoption is expected to reach **30% of the vehicle market** by 2030, suggesting a market size of **7.2 million EVs annually** by the decade's end.
- In terms of revenue, assuming an average EV price of **INR 10 lakhs** (~$12,000), the EV market potential is estimated to be worth **INR 7.2 lakh crore** ($87 billion USD) annually by 2030.

This projection provides a strong basis for the EV sector's growth potential in India, especially with government incentives supporting faster adoption.

### B.Improvement Suggestions

With additional time and budget, I would enhance this project by sourcing more specific data related to Indian EV consumers. Improvements would include:

1. **Data Collection**: Invest in more detailed datasets on customer preferences, such as vehicle usage patterns and charging access.

   **Additional Datasets**:

a. **Driving Behavior Data**: Data on average daily kilometers driven, commonly traveled routes, and primary usage (city commute vs. intercity travel). This data would help tailor EV offerings based on real consumer needs and preferences.
b. **Lifestyle and Sustainability Factors**: Insights into consumer interest in sustainability, recycling practices, and eco-friendly products. This data would strengthen segmentation by identifying those motivated by environmental impact.
c. **Regional Data on EV Infrastructure**: Data showing the density of EV charging stations by city, state subsidies for EVs, and local incentives. Such information would clarify potential geographic focus areas.
d. **Income and Expense Data**: Additional granularity in income levels and household expenses, especially around vehicle maintenance, fuel/energy expenditure, and debt levels, would improve clustering accuracy.

2. **Additional ML Models**: Explore other clustering techniques like Gaussian Mixture Models or hierarchical clustering to identify overlapping interests.
   **Gaussian Mixture Models (GMM)**: As GMM supports probabilistic clustering, it could capture subtle overlaps in buyer behavior, especially in India's diverse demographic landscape.
   **Hierarchical Clustering**: This would allow the segmentation of sub-groups within each cluster, possibly revealing deeper insights (e.g., within budget-conscious buyers, those who prioritize low emissions vs. fuel savings).
3. **Refined Features**: Additional data points, such as individual eco-awareness scores, vehicle budget range, and charging infrastructure access, would enrich segmentation.

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## Summary of Report Findings

**Cluster Insights:**

- **2WN and 3WT Clusters:**
  - **Cluster 0 (Low EV Penetration):** Majority of states, including smaller ones like Andaman & Nicobar Islands and Nagaland, show low EV numbers, with moderate 3WT usage in Bihar and Chhattisgarh.
  - **Cluster 1 (High 3WT Dominance):** Uttar Pradesh has a notably high count of 3WT EVs, indicating strong demand for commercial transport solutions.
  - **Cluster 2 (Moderate EV Growth):** States like Delhi, Gujarat, and Tamil Nadu demonstrate a balanced EV market, making them ideal for further investments.
  - **Cluster 3 (High EV Penetration):** Karnataka and Maharashtra lead in 2WN EVs, reflecting strong urban demand and favorable government policies.
- **LMV and MPV Clusters:**

- **Cluster 0 (Low LMV and MPV Presence):** Many states show low vehicle registrations, with Bihar and Chhattisgarh having some localized MPV usage.
- **Cluster 1 (High LMV and Moderate MPV Presence):** Maharashtra exhibits high LMV demand, indicating strong market potential.
- **Cluster 2 (Balanced LMV and MPV Presence):** Tamil Nadu, Uttar Pradesh, and Karnataka present diversified investment opportunities.
- **Cluster 3 (High MPV Presence):** Assam and Jammu & Kashmir have notable MPV registrations, suggesting a focus on local transport needs.

**General Market Insights:**

- The highest EV concentrations are in populous, economically developed states like Uttar Pradesh and Maharashtra.
- Two-wheelers dominate the market at 52.9%, followed by three-wheelers at 41.6%, reflecting urban transport demands.
- States like Assam and Delhi lead in EV to non-EV ratios, indicating successful adoption driven by state incentives and urbanization.
- Over the last five years, the growth in two- and three-wheelers aligns with India's economic landscape, where cost-effective transport is crucial.
- Infrastructure development is strongest in states with high operational public EV charging stations, facilitating greater adoption.

**Recommendations**

1. **Target Market Expansion in Cluster 1 (Uttar Pradesh):**
    - Leverage the high demand for 3WT EVs by investing in vehicle sales, parts, and charging infrastructure. This could attract businesses focused on commercial transport solutions.
2. **Balanced Investment in Cluster 2 States (Delhi, Gujarat, Tamil Nadu):**
    - Diversify investments across both 2WN and 3WT segments. Targeted marketing strategies can capture urban populations and their diverse vehicle needs.
3. **Focus on Urban and Dense Areas in Cluster 3 (Karnataka, Maharashtra):**
    - Develop services tailored to two-wheeler EVs, including battery-swapping stations and urban EV infrastructure, to capitalize on the high urban demand in these states.
4. **Consider Emerging Markets in Cluster 0:**
    - Implement small-scale pilot programs in states with low registrations but some localized vehicle usage, like Bihar and Chhattisgarh, to assess EV adoption potential.
5. **Target Market Expansion in Cluster 1 for LMV (Maharashtra, Gujarat, Delhi):**

    - Focus on LMV sales, charging stations, and related services, taking advantage of the robust urban demand in these states.
6. **Diversified Investment in Cluster 2 States for LMV and MPV (Tamil Nadu, Uttar Pradesh, Karnataka):**
    - Promote investments in both vehicle segments, capitalizing on balanced demand supported by urban centers.
7. **Focus on Localized Solutions in Cluster 3 (Assam, Jammu and Kashmir):**
    - Explore opportunities for medium passenger transport needs and develop localized public transport solutions.
8. **Consider Pilot Programs in Cluster 0 States (Andaman & Nicobar Islands, Arunachal Pradesh):**
    - Conduct small pilot programs to understand unique transportation challenges and promote vehicle adoption in states with low EV presence.

By implementing these recommendations, the startup can effectively navigate the EV market landscape, capitalize on emerging trends, and position itself for sustainable growth in the Indian EV market.