

INDIAN ELECTRIC VEHICLE MARKET SEGMENTATION

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GitHub link: [GitHub:https://github.com/Tanaya006/India-s-EV-Market-Segmentation](https://github.com/Tanaya006/India-s-EV-Market-Segmentation)

Datasets Used:

[EV Demographic.csv](#)

[ev india.csv](#)

Overview

Analyzing the Indian Electric Vehicle market using market segmentation techniques to help the startup decide in which vehicle/customer space it should develop its EVs and enter the market targeting the segments most likely to use Electric vehicles.

The Indian electric vehicle (EV) market has evolved from a nascent stage to a rapidly growing industry, driven by government policies, technological advancements, and increasing consumer demand. Initial efforts focused on small electric scooters and three-wheelers, primarily to address urban pollution. More recently, the market has seen substantial growth driven by government incentives, technological advancements, and increasing consumer awareness.

Early initiatives like the National Electric Mobility Mission Plan (NEMMP) and the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme laid the groundwork for EV adoption. Recent years have seen substantial growth in EV sales, with a surge in both two-wheelers, three-wheelers, and car/SUV segments. The government has set ambitious targets for EV penetration by 2030, aiming for 30% for private cars, 70% for commercial vehicles, and 80% for two- and three-wheelers.

Market Overview

India's electric vehicle industry is experiencing a transformative phase characterized by increasing domestic manufacturing capabilities and technological advancements. Major automotive manufacturers are establishing dedicated EV production facilities, with companies like Ola Electric and Ather Energy leading significant investments in research and development.

The Indian electric vehicle (EV) market is experiencing significant growth, with sales exceeding 2 million units in 2024 and a projected market size of USD 117.78 billion by 2032.

While the market is still relatively small, accounting for about 2.5% of all cars sold in 2024, it is poised for substantial expansion due to government policies, increasing consumer demand, and technological advancements. The EV industry in India has witnessed a surge in domestic production capacity, with manufacturers focusing on localizing critical components to reduce dependency on imports. This shift towards local manufacturing has been particularly evident in the battery and powertrain segments, where Indian companies are developing indigenous technologies suited to local conditions.

Top Companies in India Electric Vehicle Market

The Indian electric vehicle market is characterized by intense competition and rapid innovation among key EV players in India like Ola Electric, TVS Motor, Ather Energy, and Tata Motors. These EV companies in India are heavily investing in research and development to enhance battery technology, charging solutions, and overall vehicle performance. Product innovation remains a key focus, with manufacturers regularly launching new models with improved range, features, and connectivity options. Operational agility is demonstrated through flexible manufacturing processes and quick adaptation to market demands.

The Indian EV market exhibits a healthy mix of established automotive conglomerates and specialized EV startups, with domestic Indian EV companies holding significant market share. Traditional automotive giants like Tata Motors, Mahindra & Mahindra, and TVS Motor have successfully leveraged their manufacturing expertise and brand presence to establish strong EV divisions. Meanwhile, pure-play EV manufacturers like Ola Electric and Ather Energy have disrupted the market with their technology-first approach and innovative business models. The market structure is evolving from fragmented to moderately consolidated, particularly in the two-wheeler segment where a few EV competitors in India command substantial market share.

EV MARKET SEGMENTATION

1. Vehicle Segmentation

➤ Platform Analysis

Based on platform market is classified into two-wheeler, three-wheeler, and four-wheelers.

Two-wheelers witness significant dominance over four-wheelers and are the fastest-growing segment. Two-wheelers are highly used in India for transportation. Additionally, rising traffic congestion on Indian roads is influencing the populace to adopt micro-mobility for daily commutes and transportation. Moreover, the rising fuel prices and increasing awareness and

availability of electric two-wheelers are anticipated to accelerate the penetration of electric two-wheelers in the Indian market. According to VAHAN, the electric two-wheeler market has seen a significant sales increase of 34.42% in the third quarter of Fiscal Year 2024 (Q3 FY 24) compared to the preceding quarter (Q2 FY 24), indicating a strong growth in the EV sector.

Compared to electric two- and four-wheelers, India's electric **three-wheeler** (e3W) market has shown the fastest adoption rate, largely due to its strong commercial utility and lower total cost of ownership. While electric two-wheelers are more widespread for personal use and dominate in volume, their growth has slowed recently due to subsidy reductions and rising prices. Electric four-wheelers, though gaining traction in urban areas, still face high upfront costs and limited charging infrastructure, making their growth more gradual. In contrast, e3Ws—especially used for public transport and goods delivery—have seen rapid uptake, supported by favourable policies, fleet electrification efforts, and relatively easier financing. Their popularity is particularly strong in semi-urban and rural regions where affordability and fuel savings are critical, positioning them as a cornerstone in India's EV transition.

The **Four-wheeler** segment dominated the market in 2023 and is expected to dominate India electric vehicle market forecast period. It is also expected to dominate during the forecast period with a maximum market share. City commuters find it economical considering the range compared to (IC) Internal Combustion engines. Compared to two-wheelers, four-wheelers have larger space for batteries, which results in a higher range on a single charge. This makes the segment dominant compared to the other two segments.

INDIA ELECTRIC VEHICLE MARKET SHARE, BY PLATFORM 2023

India Electric Vehicle Market Share, By Platform, 2023



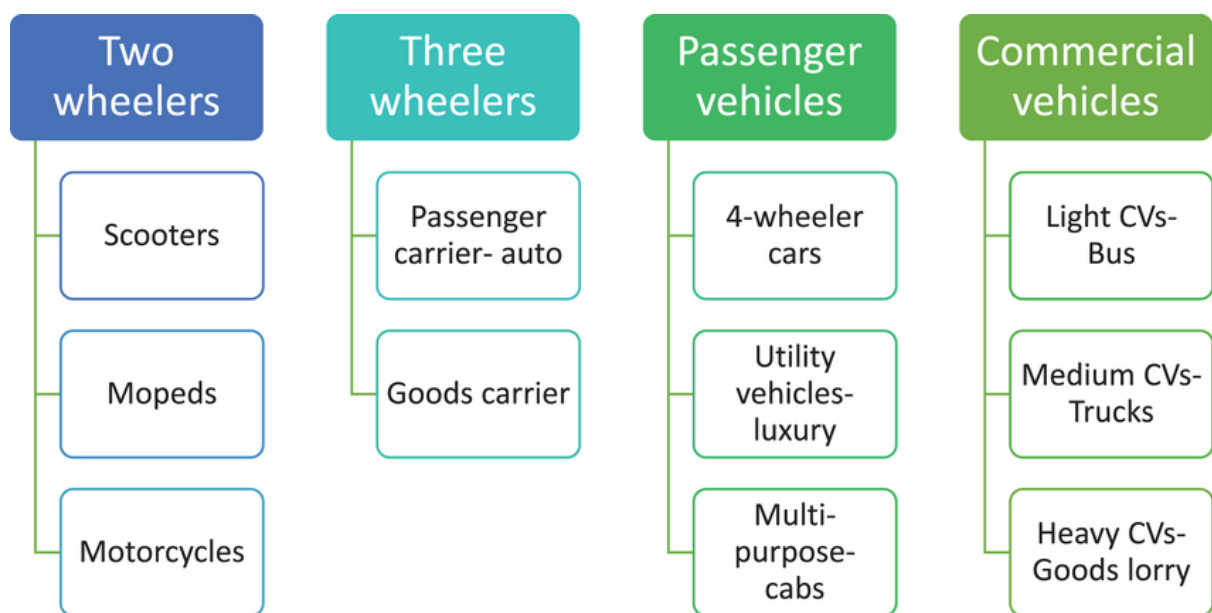
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➤ Vehicle Type Analysis

By vehicle type market is classified into **passenger cars and commercial vehicles**.

Passenger cars accounted highest India electric vehicle market share in 2023. It is also dominant in the market and the fastest-growing segment. Passenger cars are in greater demand due to the availability of varied options, comfort, and luxury they provide with clean emissions. Considering the increasing trend of buying passenger EVs.

On the **commercial** side, the electric commercial vehicle (e-CV) segment has experienced an even more dramatic surge. In FY24, India sold over 107,000 electric commercial vehicles—almost three times the number from the previous year. This includes a significant uptick in electric three-wheelers (e-3Ws), light commercial vehicles (e-LCVs), and electric buses. E-3Ws are expected to dominate the commercial EV space, growing fivefold by FY2030. E-LCVs and electric buses are also gaining traction, with projections suggesting they will each account for about 30% of e-CV sales by 2030. Commercial vehicles also do a prominent rise during 2024 – 2032.



➤ Propulsion Type Analysis

India, electric vehicles (EVs) are broadly classified into four main types: Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles (HEVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Fuel Cell Electric Vehicles (FCEVs). These categories differ primarily in their power source and how they utilize electricity and internal combustion engines

1. **Battery Electric Vehicle (BEV):** Fully powered by electricity. These are more efficient compared to hybrid and plug-in hybrids.

BEVs are also known as All-Electric Vehicles (AEV). Electric Vehicles using BEV technology run entirely on a battery-powered electric drivetrain. The electricity used to drive the vehicle is stored in a large battery pack which can be charged by plugging into the electricity grid. The charged battery pack then provides power to one or more electric motors to run the electric car.

Main Components of BEV:

Electric motor, Inverter, Battery, Control Module, Drive train

Examples of BEV:

MG ZS, TATA Nexon, TATA Tigor, Mahindra E20 plus, Hyundai Kona, Mahindra Verito

2. **Hybrid Electric Vehicles (HEVs):** HEVs are also known as series hybrid or parallel hybrid. HEVs have both engine and electric motor. The engine gets energy from fuel, and the motor gets electricity from batteries. The transmission is rotated simultaneously by both engine and electric motor. This then drives the wheels.

Main Components of HEV:

Engine, Electric motor, Battery pack with controller & inverter, Fuel tank, Control module

Examples of HEV:

Engine, Electric motor, Battery pack with controller & inverter, Fuel tank, Control module

3. **Plug in Hybrid Electric Vehicles (PHEVs):** The PHEVs are also known as series hybrids. They have both engine and a motor. You can choose among the fuels, conventional fuel (such as petrol) or alternative fuel (such as bio-diesel). It can also be powered by a rechargeable battery pack. The battery can be charged externally.

PHEVs can run in at least 2 modes:

- All-electric Mode, in which the motor and battery provide all the car's energy
- Hybrid Mode, in which both electricity and petrol/diesel are employed

Main Components of PHEV:

Electric motor, Engine, Inverter, Battery, Fuel tank, Control module, Battery Charger (if onboard model)

Examples of PHEV:

Porsche Cayenne S E-Hybrid, BMW 330e, Porsche Panamera S E-hybrid, Chevy Volt, Chrysler Pacifica, Ford C-Max Energi, Mercedes C350e, Mercedes S550e, Mercedes GLE550e, Mini Cooper SE Countryman, Ford Fusion Energi, Audi A3 E-Tron, BMW i8, BMW X5 xdrive40e, Fiat 500e, Hyundai Sonata, Kia Optima, Volvo XC90 T8.

- 4. Fuel Cell Electric Vehicle (FCEVs):** FCEVs are also known as Zero-Emission Vehicles. They employ 'fuel cell technology' to generate the electricity required to run the vehicle. The chemical energy of the fuel is converted directly into electric energy.

Main Components of FCEV:

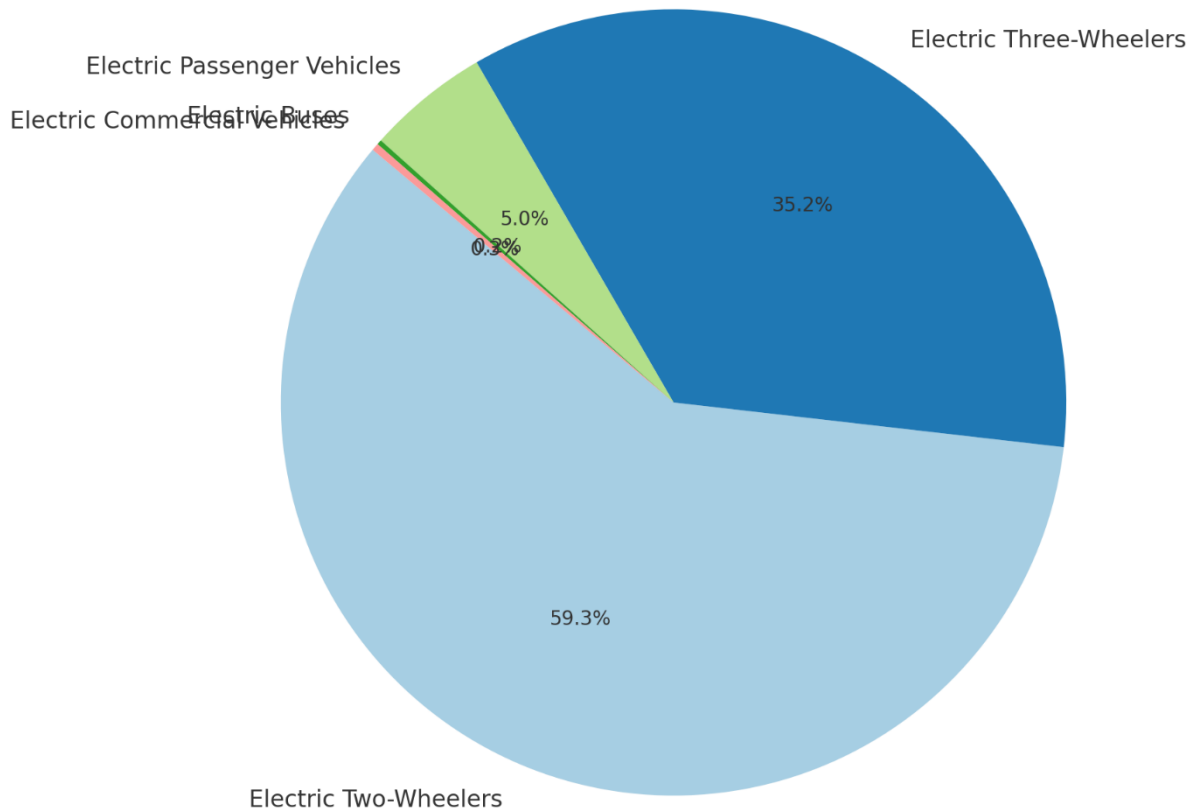
Electric motor, Fuel-cell stack, Hydrogen storage tank, battery with converter and controller

Examples of FCEV:

Toyota Mirai, Riversimple Rasa, Hyundai Tucson FCEV, Honda Clarity Fuel Cell, Hyundai Nexo.

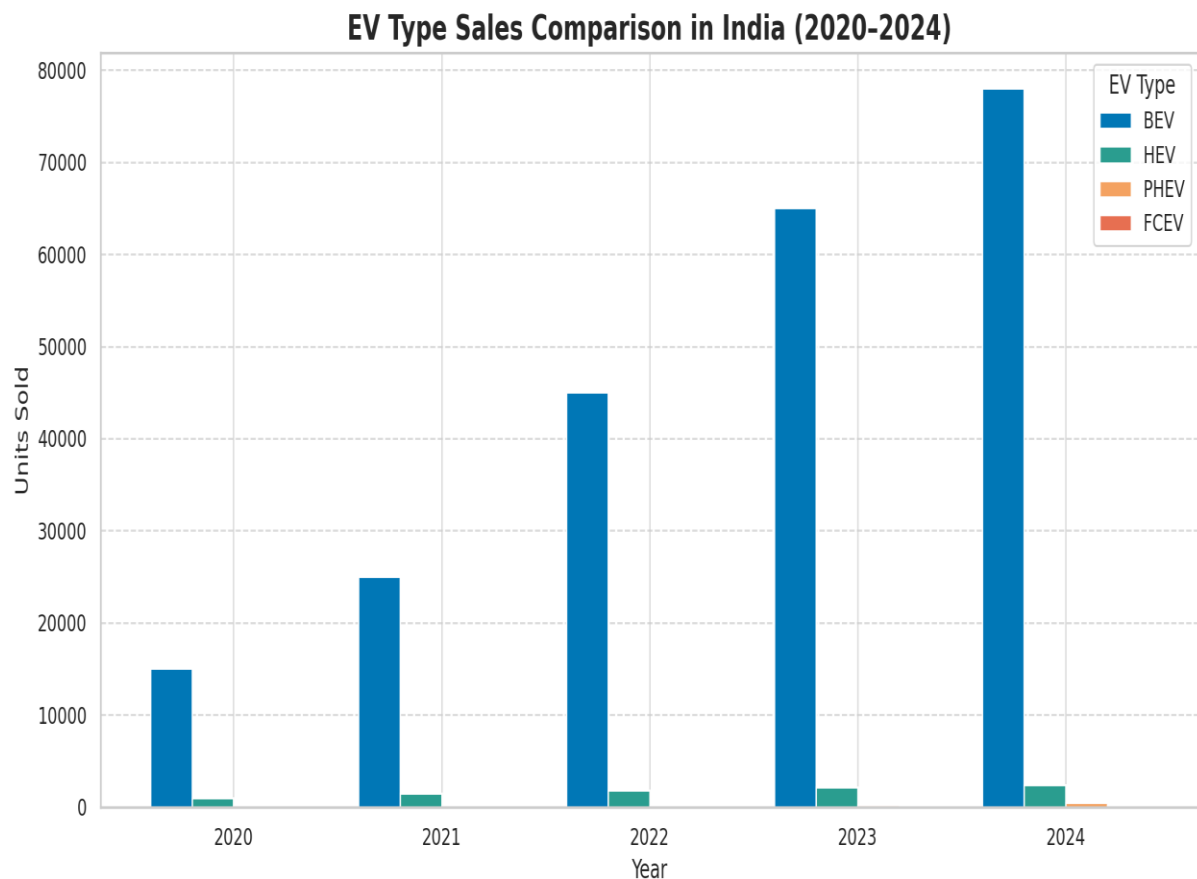
EV SALES IN INDIA BY VEHICLE TYPE

EV Sales Distribution by Category in India (2024)



- **Total EV sales in India** reached approximately 1.94 million units in 2024, which accounted for **7.46% of total vehicle sales** in the country.
- **Electric two-wheelers (e-2Ws)** dominated the EV segment with around **1.15 million units sold**, representing nearly **59% of total EV sales**, and achieved a **5.4% penetration** within the overall two-wheeler market.
- **Electric three-wheelers (e-3Ws)** accounted for about **691,302 units sold**, making up roughly **35% of total EV sales**, with a high **48.9% market penetration** in the three-wheeler segment.
- **Electric passenger vehicles (e-PVs)** recorded **99,068 units sold**, contributing to about **5% of overall EV sales**, with a **2.3% penetration** in the passenger car segment.
- **Electric buses (e-Buses)** saw a significant **85% year-on-year growth**, reaching **3,708 units sold**, though they made up only about **0.2% of total EV sales**.
- **Electric commercial vehicles (e-CVs)**, including light commercial vans and trucks, achieved **6,220 units sold**, marking a **2.5x increase** over the previous year.

EV SALES IN INDIA BY PROPULSION TYPE



From the above graph it can be concluded that that Battery Electric Vehicle dominates the Indian market

- BEVs dominate India's electric car market, commanding approximately 79% market share in 2024
- PHEVs are not popular in India, with no affordable models available.
- HEV sales grew by 30% in the first half of 2024.
- FCEVs are still at a pilot project level in India

In summary, BEVs currently lead the Indian EV market, supported by government incentives and expanding infrastructure. HEVs are gaining traction as a transitional technology. PHEVs and FCEVs have limited presence due to infrastructure and cost challenges.

Battery Electric Vehicles (BEVs): Dominating the passenger vehicle segment, BEVs are favoured due to government incentives, rising fuel prices, and increased environmental awareness. These vehicles are completely electric and have zero gasoline.

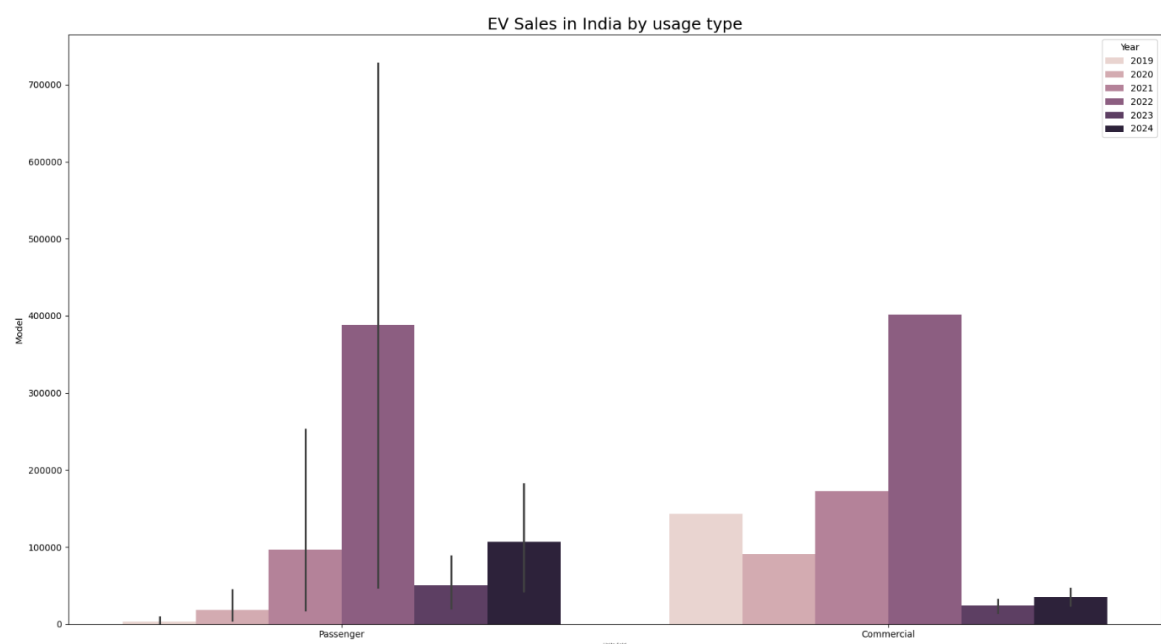
As you can see, the sales of BEVs have been increasing exponentially over the years.

There are a few reasons for this trend. First, BEVs are becoming more affordable. The cost of batteries has been declining, and governments are offering incentives to purchase BEVs. Second, BEVs are becoming more capable. They have longer ranged and faster charging times. Third, consumers are becoming more aware of the environmental benefits of BEVs. As a result of these factors, it is expected that BEVs will become the dominant type of electric vehicle in the future.

Why BEVs are becoming more popular:

- **Lower operating costs:** BEVs have lower fuel costs than gasoline or diesel vehicles. This is because electricity is cheaper than gasoline or diesel, and BEVs are more efficient.
- **Lower emissions:** BEVs produce zero emissions, which helps to improve air quality.
- **Government incentives:** Many governments offer incentives to purchase BEVs, such as tax breaks and rebates.
- **Improved technology:** Battery technology has improved significantly in recent years, which has led to longer ranges and faster charging times for BEVs.
- **Growing consumer awareness:** More and more companies becoming aware of the benefits of BEVs.

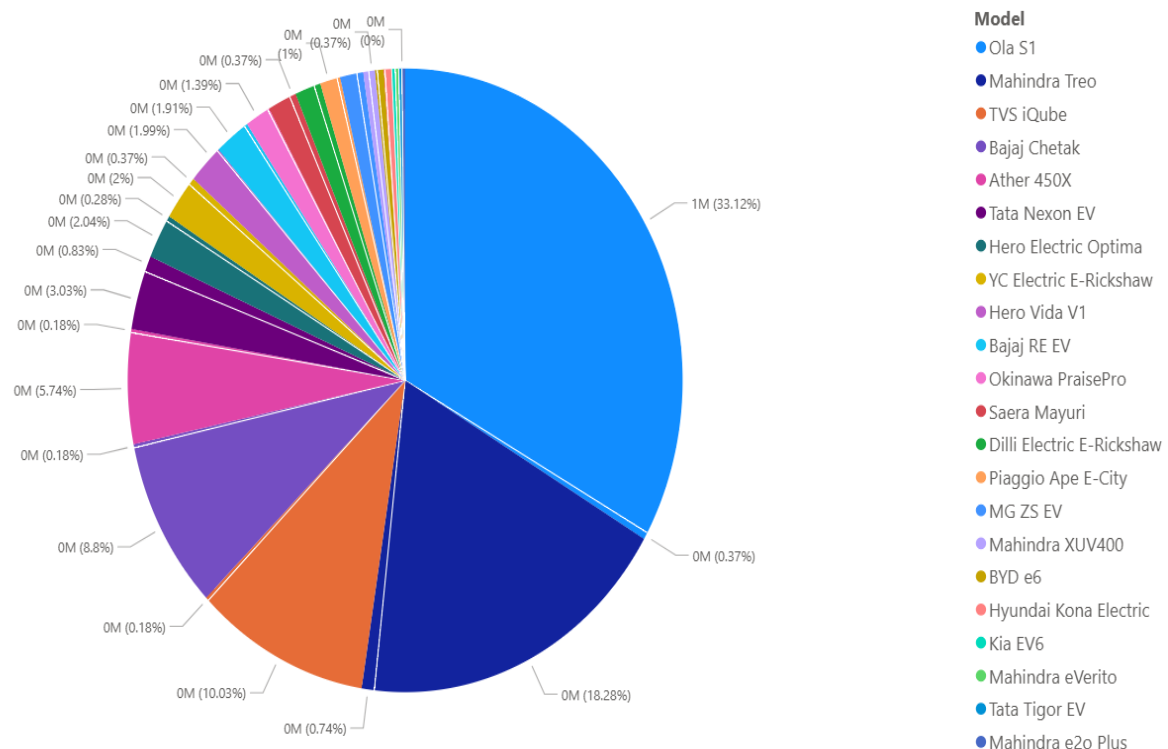
EV SALES IN INDIA BY USAGE TYPE



We can see that from the above graph:

- **Minimal Sales in 2019–2020:** Due to Covid -19 pandemic passenger EV sales were minimum but the Commercial vehicle sales were thriving as more than **100000 units sold in early 2019-2020**. The government was contributing and promoting EV due increased **fuel demands and pollution**.
- **Sharp Growth in 2022:** In 2022 we can see the sharp growth and sales selling around 400000 units of **Passenger and Commercial Vehicles**. It Suggests a breakthrough year, possibly due to new subsidies or better model availability.
- **Moderate Growth in 2021:** We see moderate growth of booth passenger and commercial vehicles in 2021 due to the 2nd wave of covid-19 and Noticeable increase from 2020 to 2021, signalling early momentum.
- **Drop in 2023 & 2024:** As compared to Commercial vehicles we can see that the passenger sales were boosting in recent years in 2023 and 2024.

SALES OF VARIOUS ELECTRIC VEHICLE (EV) MODELS SOLD IN INDIA ACROSS THE YEARS (2019 to 2024).



Following things can be concluded form the above graph:

- **Ola S1** dominates the EV market with the highest share, accounting for **33.12%** of total EV sales across the years.

What makes Ola S1 highest selling?

- **Strong Performance:** The Ola S1 offers rapid acceleration, a top speed of 115 km/h, and a long range of up to 181 km on a single charge.
 - **Smart Tech Features:** It comes with a 7-inch touchscreen, 4G/Wi-Fi/Bluetooth connectivity, navigation, music, voice control, and a keyless digital entry system.
 - **Competitive Pricing:** Priced from ₹99,999 (even lower in subsidized states), it also offers attractive EMI plans starting at ₹2,999 per month.
 - **Practical Design:** The scooter features 36L storage, reverse mode, hill-hold assist, and a sleek, commuter-friendly design.
 - **Wide Market Reach:** Ola uses a direct-to-consumer model with fast-growing service canterers and plans to add 10,000 partners by 2025.
- **TVS iQube (10.03%), Bajaj Chetak (8.8%), Ather 450X (5.74%), and Tata Nexon EV (3.03%)** have established themselves as solid mid-tier performers in EV adoption during this period.

What makes these vehicle unique and mid- tier

- **TVS iQube (10.03%):** The TVS iQube offers a practical electric scooter experience with a range of up to 145 km, 82 km/h top speed, smart connectivity features, reverse mode, and a reliable brand reputation.
- **Bajaj Chetak (8.8%):** The Bajaj Chetak combines retro-modern design with a metal body, 90–108 km range, 63 km/h top speed, and basic smart features like Bluetooth app support and IP67-rated battery protection.
- **Ather 450X (5.74%):** The Ather 450X is a performance-oriented scooter featuring fast acceleration, up to 150 km range, a 7" touchscreen with navigation and OTA updates, multiple riding modes, and a futuristic design.
- **Tata Nexon EV (3.03%):** The Tata Nexon EV delivers an electric SUV experience with a range of up to 465 km (Max variant), fast charging, premium features like a sunroof and connected tech, and strong safety credentials.

All these models combine modern electric drivetrain technology with smart digital features and practical usability, making them appealing choices for daily urban commuting.

- **Multiple models** such as *Mahindra e2o Plus*, *Tata Tigor EV*, and *Mahindra eVerito* have **sales below 1%**, some even near **0%**, indicating minimal market traction.

What makes this a low tier

- **Outdated Design and Tech:** These models lack modern styling and features like touchscreens, app connectivity, and smart controls found in rivals like Ola and Ather.
- **Lower Performance and Range:** With limited top speeds and shorter range, they fall behind higher-performing options like Ola S1 and TVS iQube.
- **Less Value for Money:** They offer fewer features at similar or higher prices compared to more advanced, competitively priced models.
- **Weak Consumer Appeal:** Focused more on fleet or commercial use, they missed out on lifestyle branding and mass-market engagement.
- **Minimal Updates:** Lack of regular upgrades made them feel outdated in a fast-evolving EV market.

2. Geographic Segmentation

- **Urban Areas and Tier 1 Cities:** High concentration in metro cities (e.g., Bengaluru, Delhi, Mumbai) with better EV infrastructure and shorter travel distances. Electric vehicle (EV) sales are higher in urban areas due to better infrastructure, such as an expanding network of charging stations and service canter. Government incentives and policies promoting sustainability also make EVs more appealing. Higher disposable incomes in cities enable consumers to afford EVs, while environmental awareness drives the shift towards greener alternatives. Additionally, shorter commutes in urban areas make EVs more practical, and the trend-conscious, tech-savvy urban population is eager to adopt innovative, cost-effective solutions. Traffic congestion, rising fuel prices, and supportive public transport initiatives further boost EV adoption in cities.

- **Total EV Sales:** India's overall EV sales reached **2,022,873 units** in 2024, marking a 25.4% year-over-year growth.
- **Urban Sales Share:** Approximately **70%** of these sales occurred in urban regions, driven by factors such as better infrastructure, higher disposable incomes, and supportive government policies.

EV Segmentation in Urban Areas

- **Two-Wheelers:** Dominating the market with **1,211,193 units** sold in 2024, reflecting the demand for cost-effective and convenient urban commuting solutions.
- **Passenger Cars:** Sales reached **105,695 units** in 2024, showing a 12.8% increase from the previous year.

- **Three-Wheelers:** E-rickshaws and e-carts accounted for **481,599 units** and **58,957 units**, respectively, indicating strong adoption in last-mile connectivity.
 - **Charging Stations:** The number of public EV charging stations increased to **25,202** nationwide in 2024, facilitating easier adoption in urban areas.
 - **Government Initiatives:** Schemes like the **PM E-DRIVE** have been instrumental in promoting EV adoption through subsidies and incentives
 - **Growth Projections:** The EV market in India is expected to grow from **USD 23.38 billion in 2024** to **USD 117.78 billion by 2032**, at a CAGR of 22.4%.
 - **Urban Focus:** Continued urbanization, coupled with supportive policies and infrastructure development, is anticipated to drive further EV adoption in metropolitan areas.
- **EV Market in Tier 2 Cities:** Tier 2 cities in India are emerging as key players in the EV market, with growing sales and government support. However, challenges such as limited charging infrastructure, high initial costs, and the need for increased consumer awareness must be addressed to accelerate adoption. The shift towards EVs in these regions holds promise for significant environmental benefits, contributing to cleaner air and a reduction in pollution levels.
- **Sales Growth:** In 2024, India's total EV sales reached 2,022,873 units, with electric two-wheelers (e2Ws) accounting for 59.9% of the market share.
 - **Urban Distribution:** While specific data for Tier 2 cities is limited, these regions are experiencing significant growth in EV adoption, driven by factors such as government incentives and increasing environmental awareness.

Challenges faced in Tier 2 Cities

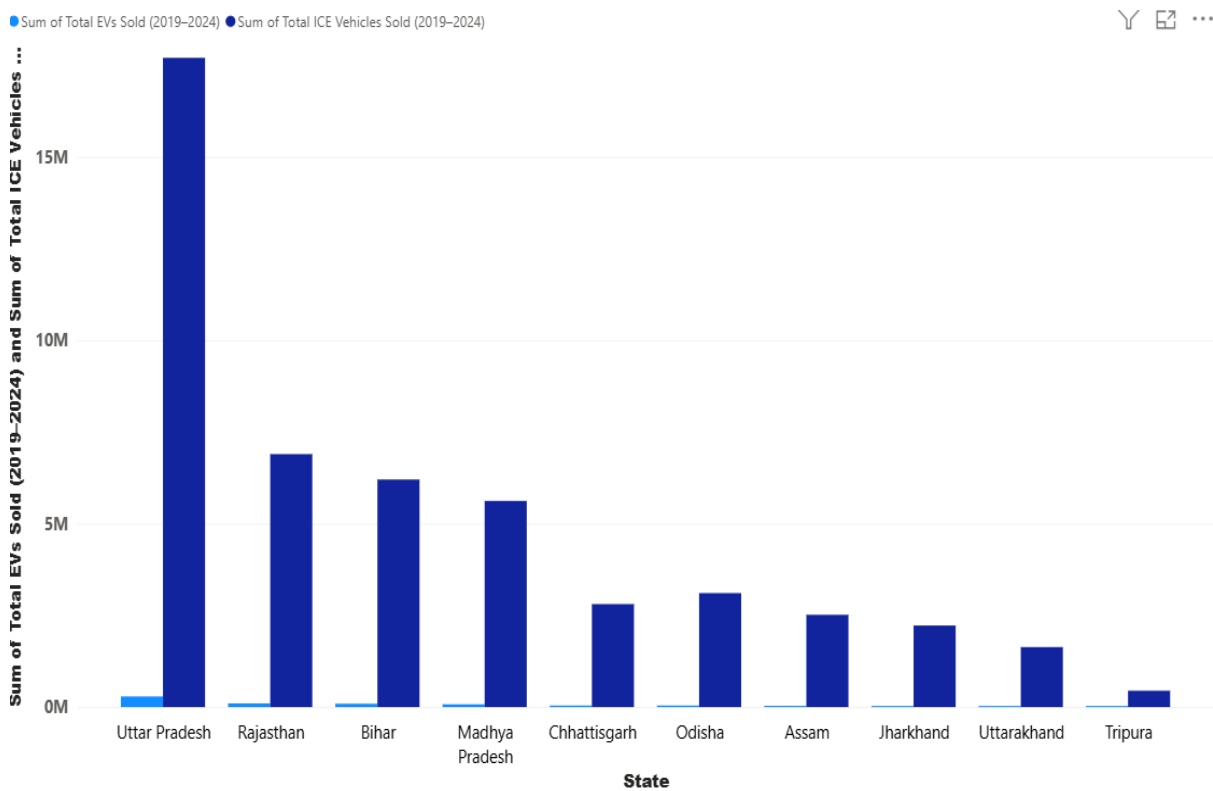
- **Limited Charging Infrastructure:** The availability of EV charging stations is still developing in many Tier 2 cities, posing a barrier to widespread adoption.
- **High Initial Costs:** The upfront cost of EVs remains a significant hurdle for consumers in these regions, despite government subsidies.
- **Consumer Awareness:** There is a need for increased awareness and education about the benefits and availability of EVs to encourage adoption.
- **Battery Disposal Concerns:** The management of used EV batteries poses environmental challenges, including potential pollution if not properly handled.

- **EV Market in Rural India:** While exact figures are scarce, rural EV adoption remains low compared to urban centers. The market is primarily driven by electric two-wheelers and three-wheelers, which are more affordable and suitable for rural terrains.

Challenges faced in Tier 3 Cities

- **Inadequate Charging Infrastructure:** Rural regions often lack sufficient charging stations, leading to range anxiety among potential users.
- **Economic Constraints:** The higher upfront cost of EVs, coupled with limited financing options, makes them less accessible to rural consumers.
- **Limited Awareness:** A lack of understanding about EV benefits and maintenance contributes to hesitancy in adoption.
- **Unreliable Electricity Supply:** Frequent power outages in rural areas can impede regular charging of EVs.

COMPARISON OF ICE AND ELECTRIC VEHICLE SALES IN TIER 2 AND TIER 3 CITIES IN LAST 5 YEAR.

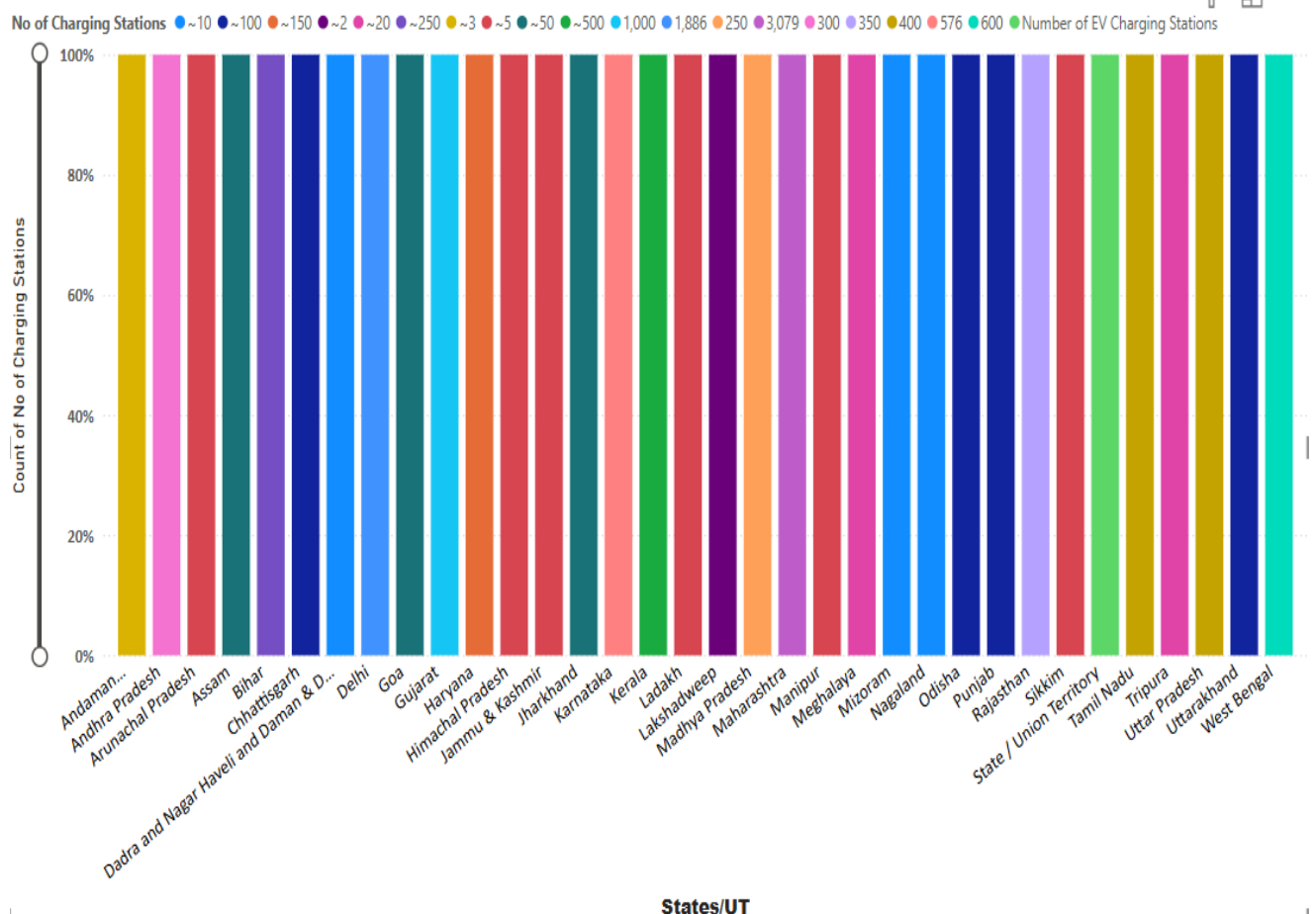


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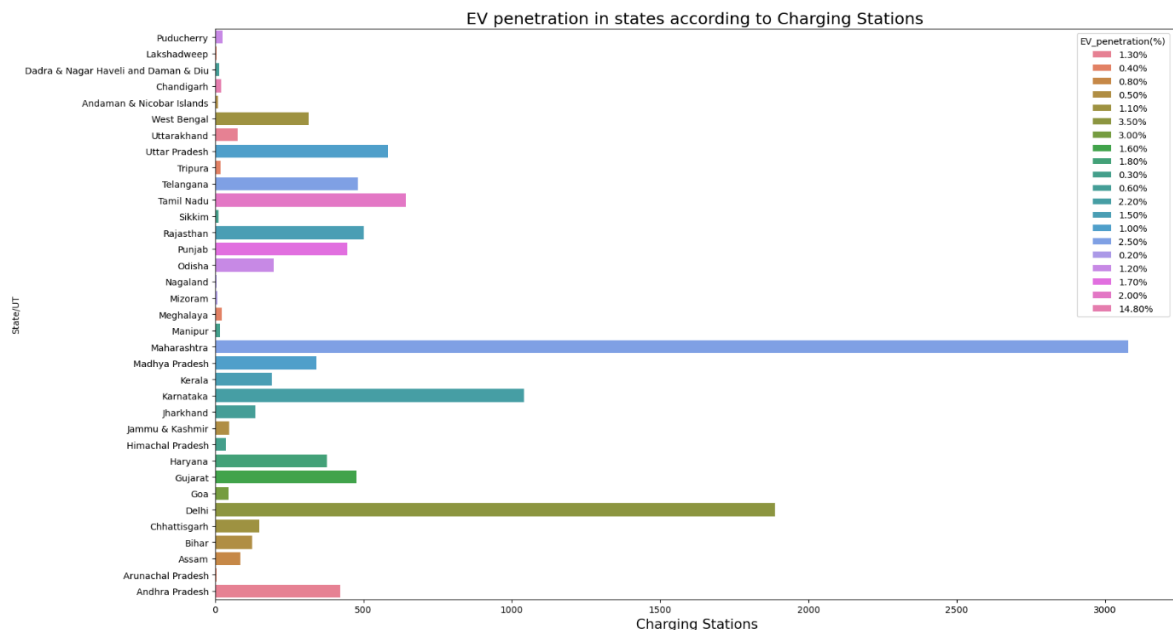
- **Uttar Pradesh** leads in both ICE and EV sales, but EV penetration remains low at **290,000 units** compared to **17.71 million ICE vehicles** sold. This highlights the need for stronger adoption in the face of growing pollution.
- **States like Rajasthan and Odisha** show steady EV growth, with **100,000** and **41,000 EVs** sold respectively, indicating a rising shift towards electric vehicles.
- **Bihar and Assam** show slower EV adoption, with sales of **92,000** and **32,800 EVs**. Challenges like infrastructure gaps and limited incentives could be slowing growth.
- **Tier 2 and 3 states** face common challenges in EV adoption such as limited charging infrastructure, lower awareness, and higher initial costs, but the growing pollution concern is pushing the demand for cleaner alternatives.

NO OF CHARGING STATIONS ACROSS THE STATES AND UNION TERRITORIES AS OF 2024

Count of No of Charging Stations and First No of Charging Stations by States/UTs and No of Charging Stations



NO OF CHARGING STATIONS ACROSS THE STATES AND UNION TERRITORIES AS OF 2024



- **Maharashtra** leads with the highest number of charging stations, followed by **Delhi** and **Gujarat**.
- **Kerala** has made significant strides in EV infrastructure, with approximately 500 charging stations.
- We can see that **Tier 3 states and Union Territories** have limited EV charging infrastructure, with **Assam, Jharkhand, and Goa** each having around 50 stations, while smaller areas like **Tripura, Meghalaya, Mizoram, and Nagaland** have between 10 to 20 stations, and regions such as **Sikkim, Arunachal Pradesh, Manipur, Himachal Pradesh, Jammu & Kashmir, Ladakh, and Lakshadweep** have just 5 or fewer charging stations.

Pollution and Environmental Impact

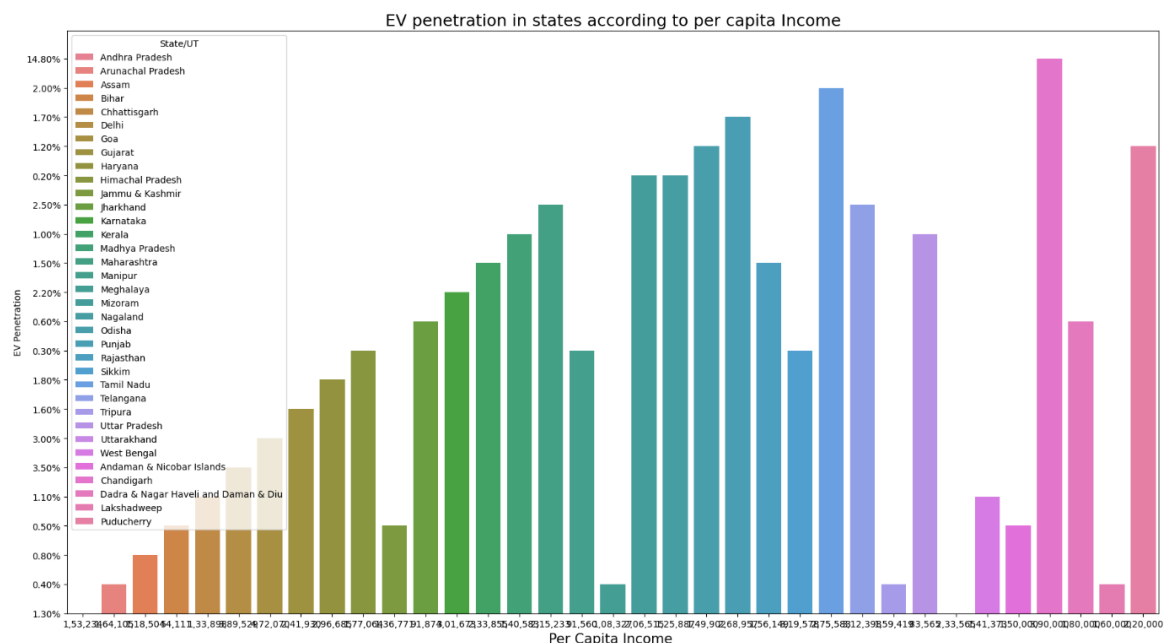
- **Air Quality Improvement:** Transitioning to EVs can significantly reduce air pollution in rural areas, where traditional vehicles contribute to poor air quality.
- **Battery Production Concerns:** The manufacturing of EV batteries involves mining activities that can lead to environmental degradation if not managed responsibly.

3.Demographic Segmentation

The Indian EV market is experiencing growth, and various demographic segments are driving this trend. Generally, younger, educated, and employed individuals with higher incomes are more likely to adopt EVs. Furthermore, larger households and men are also seen as potential EV buyers. However, women's preferences are also evolving, with some studies showing that they are more likely to opt for smaller, more frequent trips.

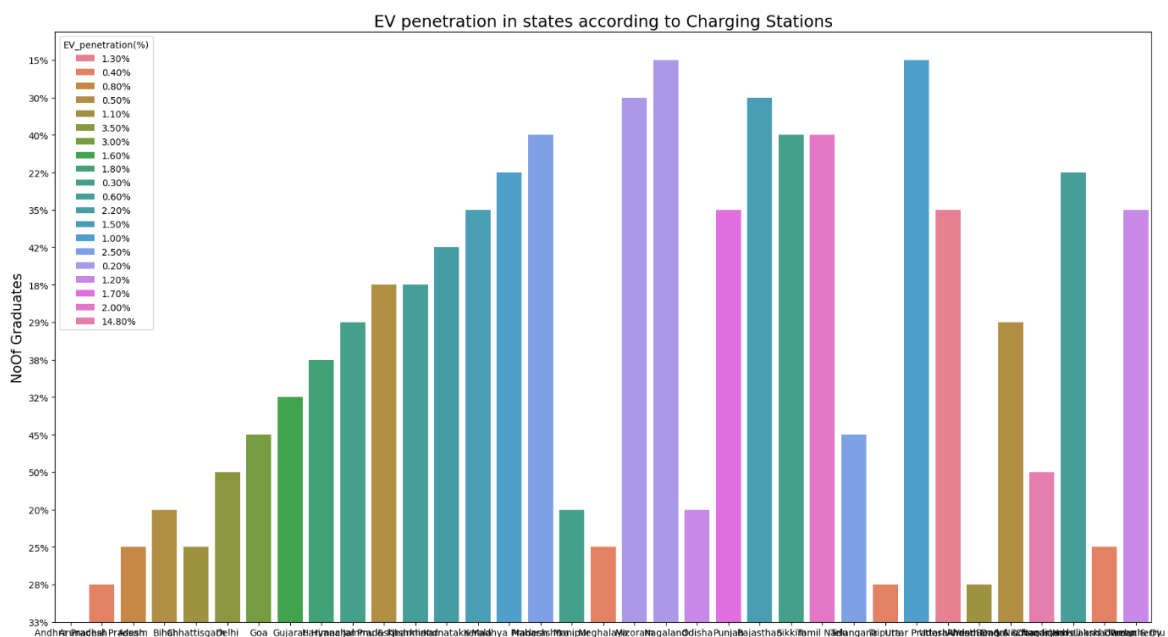
- **Income:** EV adoption in India is driven largely by **middle-aged (30–44 years)**, **well-educated (graduates and postgraduates)** individuals with **stable jobs** and incomes between **₹5–15 lakh**. Electric two-wheelers dominate among the **middle-income group**, while electric four-wheelers are more common among higher-income users.
 - Most EV buyers fall in the **₹5–15 lakh/year** bracket.
 - **E2Ws** are preferred by **mid-income users** in Tier 2/3 cities due to affordability.
 - **E4Ws** are more popular among higher-income urban users due to higher upfront costs.
 - In **rural areas**, lower disposable incomes make **subsidies**, **EMI-based schemes**, and **low-cost models** crucial for adoption.

EV PENETRATION % IN STATES ACCORDING TO PER CAPITA INCOME



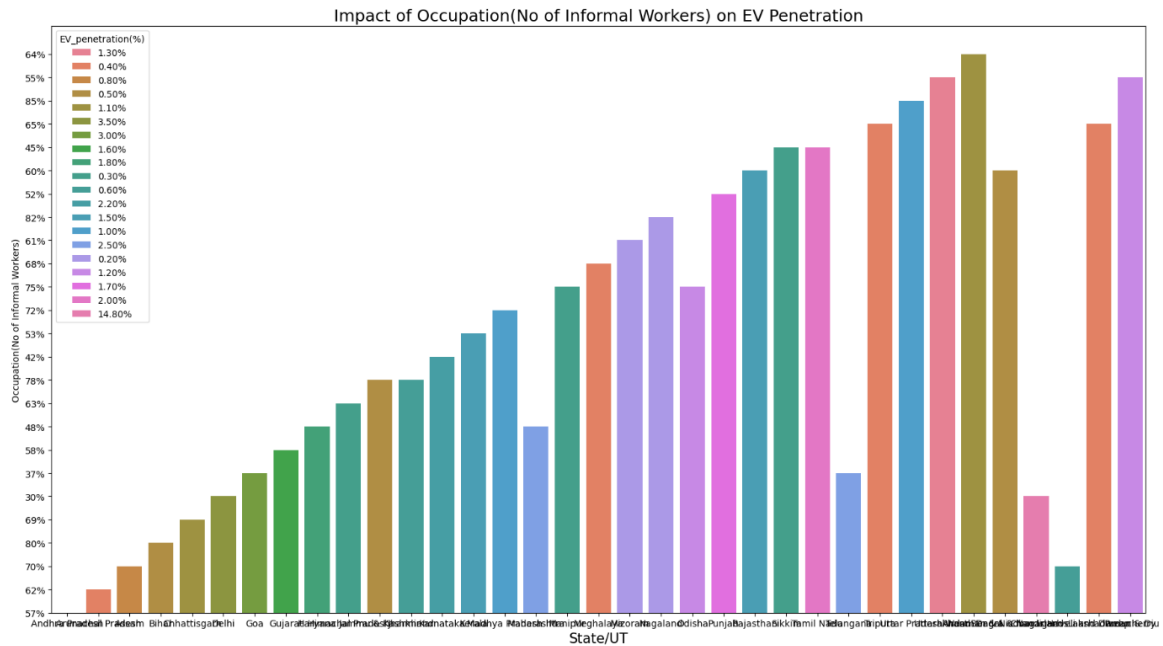
Above graph shows that relationship between per capita income and Ev penetration in Indian States

Top EV Penetration & High-Income States:



- State like Nagaland, Sikkim and Meghalaya shows more than 50% of graduates rate.
 - Arunachal Pradesh shows lowest graduation rate at around 28%.
 - Even though State like Nagaland, Sikkim and Meghalaya has more than 50% of graduates rate it still shows EV penetration below 0.8% due various geographical reasons.
 - Whereas State like Delhi, Andaman & Nicobar and Chandigarh has less than 30% graduation rate but still has high EV penetration rate.
- **Age:** The 30–44 age group leads EV adoption nationwide, including in Tier 2/3 regions, where younger consumers are open to EVs but face limited access and support infrastructure.
- The **30–44 age group** represents the largest EV buyer segment nationally.
 - Younger individuals in Tier 2/3 cities are tech-savvy and environmentally conscious, but need better infrastructure to support adoption.
 - Rural youth show interest in EVs, especially in the **delivery and transport sectors**.
- **Occupation:** Secure employment strongly correlates with EV ownership; rural populations engaged in informal work need financing options and practical EV models like e-rickshaws or electric tractors. As most of Indian states rely on Informal occupation or jobs like Agriculture and natural resource-based activities like farming, fishing, forestry, and horticulture are commonly part of the informal sector—especially in developing countries—because they often operate on a small scale, are family-run, or are seasonal in nature. As a result, many farmers and agricultural labourers are considered informal workers. Thus, highly impacting the EV penetration in Tier 3 and semi-rural states like Assam, Bihar, Himachal Pradesh etc.
- Cost EV buyers have **formal or salaried jobs**, ensuring financial stability and access to credit.
 - In rural and Tier 3 areas, people in **informal employment** rely more on **low-cost mobility** (e.g., e-rickshaws, electric mopeds).
 - EV solutions tailored to **agricultural or local transport use cases** can increase appeal.

IMPACT OF OCCUPATION (NO OF INFORMAL WORKERS (%)) ON EV PENETRATION



From the above graph it can be said:

- **Higher informal workforce** states like Nagaland, Jharkhand, Chhattisgarh shows **Lower EV penetration** (e.g., ~0.2% to 1.5%) likely due to lower purchasing power, lack of credit access, and weak formal financing structures. Informal workers often rely on used or traditional transport due to affordability.
- **Moderate informal workforce** shows **Moderate EV penetration** (~2%–3.5%) as seen in states like Karnataka and Odisha. These states benefit from partial urban infrastructure and growing EV incentives.
- **Lower informal workforce** states indicate **Higher EV penetration** (notably in Chandigarh at 14.8%) due to Urbanization and better infrastructure, Greater access to credit and government schemes and More awareness and availability of EVs.

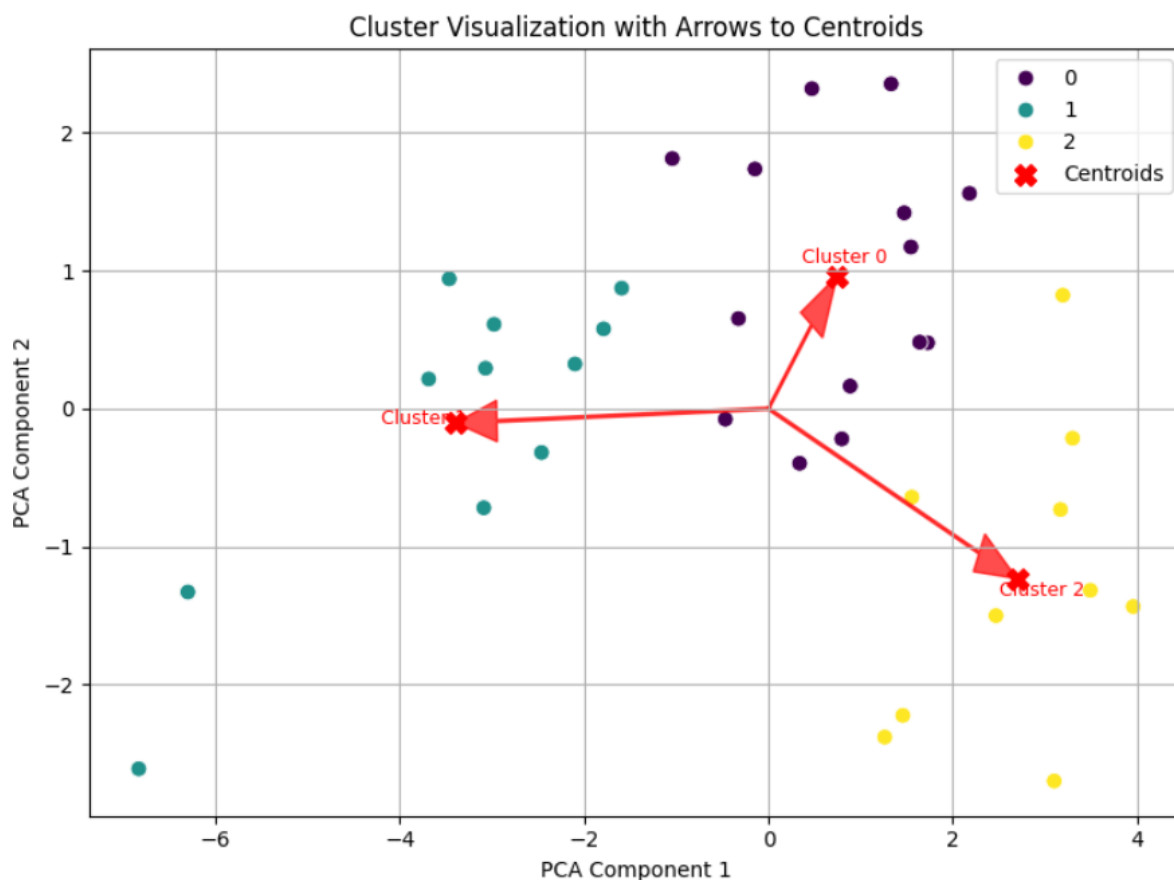
Challenges Faced in Rural Areas

- EVs are often unaffordable for rural households due to low income and limited access to credit or financing.
- Educational awareness is low, leading to poor understanding of EV benefits, usage, and available subsidies.
- Older populations are hesitant to adopt new technology, while younger users face cost and accessibility barriers.
- Most rural occupations are informal or agricultural, making it hard to invest in EVs or find suitable vehicle types.
- Charging infrastructure is scarce, and electricity supply is unreliable in many villages.

- There is limited presence of dealerships, service centers, and opportunities for test rides.
- Low exposure and lack of trust in EVs hinder adoption, with few awareness initiatives in place.

SEGMENTATION USING CLUSTERING

States with high urban populations like Delhi, Chandigarh, Telangana, and Maharashtra exhibit strong EV penetration, highlighting the dependency on urban infrastructure for adoption. Conversely, rural-heavy states such as Bihar, Jharkhand, and Manipur struggle with low EV penetration due to infrastructural and economic constraints. Despite having more charging stations, Maharashtra and Karnataka show similar EV penetration rates, indicating that factors like population size, vehicle ownership, and policy initiatives also play significant roles. High EV penetration in UTs like Chandigarh, despite limited infrastructure, reflects efficient policy and urban usage. Additionally, regions with higher education levels, like Delhi and Chandigarh, see greater EV adoption, potentially due to tech-savvy youth. States with higher 4W ownership, such as Goa and Maharashtra, align with better EV adoption, while 2W-dominant states like Uttar Pradesh may benefit from policies targeting two-wheeler EVs.



- **Cluster 1** (leftmost group, consist of Tier 3 states like Bihar, Jharkhand, Nagaland) showing **low per capita income** and **high informal workforce percentages** (often >70%), indicating lower affordability and infrastructure support for EV adoption.
- **Cluster 0** (upper centre) includes a mix of **developing Tier 2 states** such as Karnataka and Telangana, showing **moderate to high EV penetration** (2–3.5%) and good **education and urbanization levels**, signifying a transition phase toward stronger EV ecosystems.
- **Cluster 2** (bottom right), with **Delhi, Goa, Chandigarh**, etc., represents **highly developed, urbanized regions** with **per capita income exceeding ₹3–4 lakhs**, **strong EV penetration (up to 14.8%)**, and **high postgraduate percentages (up to 20%)**. These regions are clear **leaders in EV readiness**.

CONCLUSION

India's electric vehicle (EV) industry is clearly in a high-growth phase, driven by increasing awareness, government support, and improving technology. EV sales crossed **1.94 million units in 2024**, which is still a small portion of the total market (about **7.5%**), but it is growing rapidly and is expected to keep expanding in the years ahead.

Best Vehicle Type to Produce in India

1. **Battery Electric Vehicles (BEVs) Are Dominant:** Based on the analysis BEVs account for around 79% of EV sales in 2024 and are set to remain dominant due to following reasons:
 - BEVs are becoming more affordable and efficient, which is helping more people make the switch.
 - The rising fuel prices, better charging infrastructure, and government incentives. Lower running costs
 - In contrast, Plug-in hybrids and fuel cell vehicles still have very limited adoption due to cost and infrastructure challenges.
2. **Two-Wheelers is the future trend:** Electric 2-wheelers (e-2Ws) account for nearly 60% of total EV sales, making them the largest and fastest-growing segment.
 - They are popular for daily commutes, especially in cities where traffic is a big issue.
 - **Ola S1** has emerged as the top-selling EV model with over **33% share**, followed by models like **TVS iQube** and **Bajaj Chetak**, which are also gaining good traction.

3. **3-Wheelers See Fast Growth in the Commercial Space:** Electric 3-wheelers have grown very quickly, especially for commercial use.
 - They make up about **35% of all EV sales**, and almost **half of the total 3-wheeler market** is now electric.
 - This is largely because of their lower operating costs and suitability for public transport and last-mile delivery, especially in semi-urban and rural areas.
4. **Avoid Four-Wheelers or Advanced EV Types (PHEVs, FCEVs):** Dominance is expected in the long term due to better battery space, range, and increasing urban adoption.
 - **Four-wheelers** face challenges such as high **upfront costs**, **slow charging infrastructure**, and longer R&D cycles—not ideal for a capital-constrained startup.
 - **PHEVs and FCEVs** are niche markets in India, with **very limited consumer adoption** and **almost no affordable models**.
 - **HEVs** are dominated by global players and are seen as transitional solutions.
5. **Commercial Truck Business in Tier 3 States:** The tier 3 states rely on informal jobs like farming, fishing, horticulture etc. These jobs heavily rely on transportation.
 - The commercial trucking industry in these states is **smaller in scale**, primarily **local or regional** in operation, and focused on **agriculture, construction, and essential goods transport**.
 - **Hybrid or Electric Trucks** will help the local business thrive. With government schemes and subsidies, it can become a large market in upcoming years.
 - Trucks are often used for **intra-state transport** due to difficult terrain and limited highway connectivity.
 - **Small fleet operators and owner-drivers** dominate the market, often operating with 1–3 vehicles per business.

To increase EV consumption considering the India's Geographic section (Tier 2 and Tier 3 cities and states) and Demographic section manufacturers should focus on:

- **Affordable Pricing:** Offer budget-friendly models with local manufacturing and government incentives.

- **Charging Infrastructure:** Build more charging stations and offer home charging solutions.
- **Awareness Campaigns:** Educate consumers on the benefits of EVs through promotions and test drives.
- **Customization:** Tailor EVs for local needs, focusing on durability and range for short city commutes.
- **Financing Options:** Provide easy EMI schemes and financing through local banks.

According to the data Nagaland and north eastern states has the highest percentage of informal workers thus showing lower EV penetration rate likely due to lower purchasing power, lack of credit access, and weak formal financing structures. This could be due to Nagaland is predominantly rural and has agrarian economy. other reasons can be Limited presence of formal industries or private sector jobs and Heavy reliance on self-employment and traditional livelihoods.

Can Hybrid EVs be Useful in tier 3 states like Tripura, Meghalaya, Mizoram, and Nagaland Sikkim, Arunachal Pradesh, and Panjab?

Yes, **Hybrid Electric Vehicles (HEVs)** can be a viable option for Tier 2 and Tier 3 cities. Here's why:

- **Flexibility:** HEVs run on both petrol and electricity, offering flexibility in regions where EV infrastructure (especially charging stations) is not fully developed. Users can switch to petrol when charging options are limited.
- **Range Anxiety:** Hybrid EVs can alleviate range anxiety in these regions, where long-distance travel may be more common due to the lack of widespread charging infrastructure.
- **Cost-Effective:** Hybrid vehicles offer better fuel efficiency than conventional petrol/diesel vehicles, making them more cost-effective for consumers in areas where fuel prices are a concern.
- **Environmental Impact:** Although not fully electric, HEVs are still more environmentally friendly compared to traditional petrol and diesel vehicles. They help reduce emissions in cities with high pollution levels.

Opportunities and Solutions

- **Government Initiatives:** Programs like the PM E-DRIVE scheme aim to promote EV adoption through subsidies and infrastructure development.
- **Community Engagement:** Educational campaigns can raise awareness about the benefits of EVs, addressing misconceptions and building trust.
- **Innovative Models:** Battery-swapping stations and mobile charging units can offer flexible solutions to charging infrastructure challenges

To Increase the EV sales all over India startup should target the demographics features

- **Income:** EV adoption in India is driven largely by middle-aged (30–44 years), well-educated (graduates and postgraduates) individuals with stable jobs and incomes between ₹5–15 lakh. Electric two-wheelers dominate among the middle-income group, especially in Tier 2/3 cities, due to affordability and practicality. Electric four-wheelers are more common among higher-income users in metro cities who can afford the higher upfront costs and have better access to infrastructure and financing.
- **Education:** A high level of education correlates strongly with EV adoption, with over 90% of EV owners being graduates or postgraduates. Educated consumers are more aware of environmental concerns, government schemes, and the economic advantages of EVs. However, states with high graduate rates but low EV penetration (e.g., Nagaland, Sikkim) highlight that education alone is insufficient—factors like geography, income, and infrastructure also play crucial roles.
- **Occupation:** Secure, formal employment significantly enhances the likelihood of EV ownership due to better access to loans, EMI plans, and financial stability. In contrast, informal workers, prevalent in rural areas and Tier 3 states, struggle with affordability and credit access. Tailored EV solutions like e-rickshaws and electric tractors can help bridge this gap in semi-urban and agricultural communities.
- **Policy and Government Support:** Government incentives under schemes like PM E-DRIVE and state-level EV policies play a pivotal role in enabling adoption, especially in urban regions. UTs like Chandigarh have shown exemplary outcomes with strong policy backing despite limited area and population.

Final Insight

EV adoption in India is influenced by a complex interplay of income, education, urbanization, occupation, and infrastructure. To unlock full market potential, especially in Tier 2/3 and rural regions, strategic interventions are needed: expanding charging networks, offering low-

cost models, financing schemes for informal workers, and sustained awareness campaigns. Urban hubs will continue leading the transition, but inclusive, region-specific policy implementation is key to accelerating nationwide EV adoption.