EV Vehicle Market Segment

Introduction:

The electric vehicle (EV) market in India has been witnessing significant growth in recent years, driven by an increasing emphasis on sustainable transportation. Many transportation services are adopting EVs as a step toward reducing environmental impact and addressing the limitations of traditional fuels. Embracing this shift presents a promising opportunity to not only contribute to environmental conservation but also position your business at the forefront of a rapidly expanding industry.

Problem Statement:

You are part of a team working under an Electric Vehicle (EV) Startup. The startup is in the process of determining the ideal vehicle and customer segments to target for developing its EV offerings. Your task is to analyze the Electric Vehicle market in India through segmentation analysis and propose a feasible strategy for market entry. The goal is to identify and prioritize segments most likely to adopt Electric Vehicles, whether they fall under customer categories, vehicle types, or B2B usage.

In addition to traditional segmentation approaches such as Geographic, Demographic, Psychographic, and Behavioral segments, teams are encouraged to explore other relevant segmentation criteria based on the available data. Since market segmentation offers a wide range of possibilities, the chosen segmentation criteria may vary depending on the dataset being analyzed.

For this analysis, the focus is on **vehicle categories** and the corresponding **EV fuel types** they are registered under. The objective is to identify which EV fuel types are most commonly associated with specific vehicle categories, helping to pinpoint high-potential areas for EV adoption. This will guide the startup in selecting its target segments effectively.

Data Sources:

For this segmentation analysis, I have collected two datasets from the **E-VAHAN** website, which are current and up-to-date as of **17th November 2024**.

1. **Dataset 1:** Provides information about the **vehicle categories** and the corresponding **EV fuel types** they are registered under.
2. **Dataset 2:** Offers a more detailed breakdown, focusing on the **vehicle classes** along with the specific **EV fuel types** they are registered under.

Both datasets cover data across all states in India, offering comprehensive insights into the electric vehicle market nationwide.

Data Preprocessing:

The data, being sourced directly from the **E-VAHAN** website, was largely clean with no significant missing or null values. However, minor formatting adjustments were made in Excel to ensure consistency. These included correcting values to proper numeric formats where required. After these adjustments, the data was ready for further analysis.

	S No	Vehicle Category	Fuel							TOTAL
	Unnamed: 0_level_1	Unnamed: 1_level_1	ELECTRIC(BOV)	FUEL CELL HYDROGEN	PLUG-IN HYBRID EV	PURE EV	SOLAR	STRONG HYBRID EV	Unnamed: 8_level_1
0	1	FOUR WHEELER (INVALID CARRIAGE)	102	0	0	2	1	18	123
1	2	HEAVY GOODS VEHICLE	767	0	0	8	59	0	834
2	3	HEAVY MOTOR VEHICLE	180	0	0	0	4	0	184
3	4	HEAVY PASSENGER VEHICLE	9009	14	0	321	11	0	9355
4	5	LIGHT GOODS VEHICLE	14765	1	0	125	97	0	14988
5	6	LIGHT MOTOR VEHICLE	195505	2	29	14192	274	45417	255419
6	7	LIGHT PASSENGER VEHICLE	24231	2	0	2417	65	984	27699
7	8	MEDIUM GOODS VEHICLE	45	0	0	0	25	0	70
8	9	MEDIUM MOTOR VEHICLE	64	0	0	0	4	0	68
9	10	MEDIUM PASSENGER VEHICLE	806	0	0	0	4	0	810

Fig 1: data2:Vehicle category with fuel types

	S No	Vehicle Class	Fuel							TOTAL
	Unnamed: 0_level_1	Unnamed: 1_level_1	ELECTRIC(BOV)	FUEL CELL HYDROGEN	PLUG-IN HYBRID EV	PURE EV	SOLAR	STRONG HYBRID EV	Unnamed: 8_level_1
0	1	ADAPTED VEHICLE	243	0	0	3	1	18	265
1	2	AGRICULTURAL TRACTOR	803	0	0	0	85	0	888
2	3	AMBULANCE	11	0	0	0	1	0	12
3	4	ANIMAL AMBULANCE	1	0	0	0	0	0	1
4	5	ARTICULATED VEHICLE	114	0	0	0	1	0	115
5	6	BULLDOZER	0	0	0	0	2	0	2
6	7	BUS	9518	15	0	321	23	0	9877
7	8	CAMPER VAN / TRAILER	1	0	0	0	0	0	1
8	9	CAMPER VAN / TRAILER (PRIVATE USE)	329	0	0	0	0	0	329
9	10	CASH VAN	3	0	0	0	0	0	3

Fig 2: data2:Vehicle class with fuel types

Segmentation & Visualization:

The first graph presents the number of vehicles registered under each EV fuel type, providing insights into the demand and preferences for different types of EV fuels.
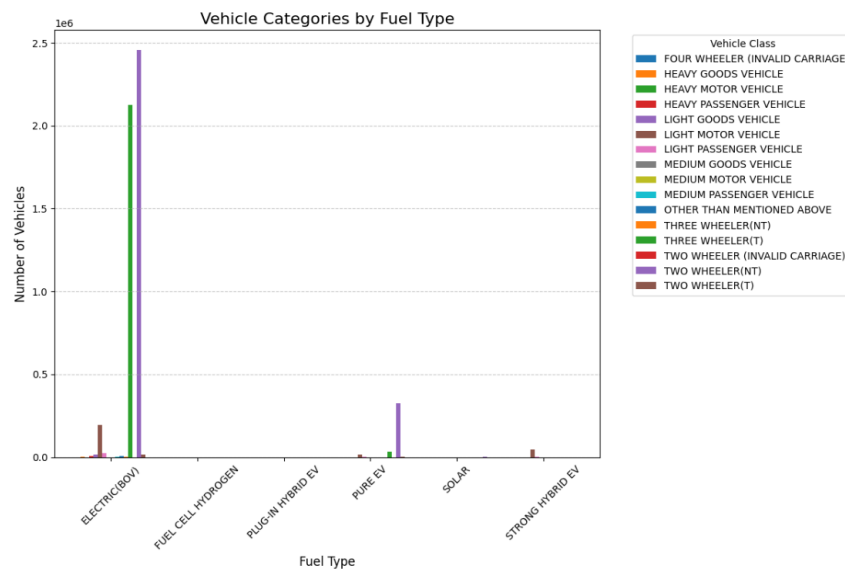

Fig3: Vehicle category registered with EV fuel Types

To gain a clearer understanding, the data was further filtered to focus on the **top 5 vehicle categories** based on their usage of these fuel types.
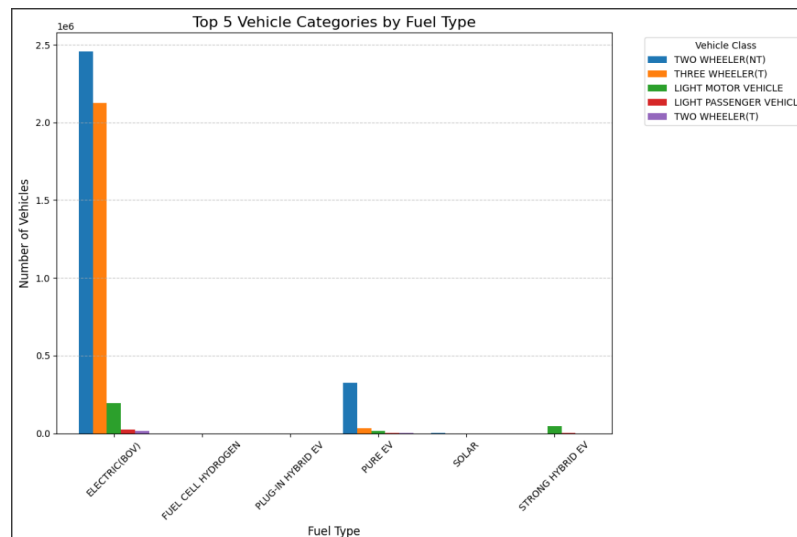

Fig4: Top 5 Vehicle category registered with EV fuel Types

From the graph, we observe that **2-Wheelers (NT)** and **3-Wheelers (T)** are the most registered categories under the Electric BOV (Battery Operated Vehicle) fuel type. Non-Transport (NT) vehicles, such as motorcycles and scooters, are primarily used for personal purposes and are widely preferred for their affordability, ease of navigation in urban traffic, and low maintenance costs. These **eco-friendly and cost-effective** alternatives to traditional petrol-powered vehicles have made 2-wheelers increasingly popular among individual consumers. On the other hand, Transport (T) vehicles like rickshaws and goods carriers are used for commercial purposes. Electric 3-wheelers are gaining traction in urban and last-mile connectivity solutions due to their cost efficiency, low maintenance, and zero emissions. They are especially favored by small-scale businesses and ride-hailing services, offering an affordable and sustainable alternative to conventional fuel-based 3-wheelers. Overall, Battery Operated Vehicles (BOV) powered entirely by rechargeable batteries play a significant role in reducing air pollution and fossil fuel dependency, supported by advancements in battery technology like Lithium-ion batteries, which have enhanced their range and performance.

To gain deeper insights, we further analyze which fuel type is associated with the highest registrations across different vehicle categories.
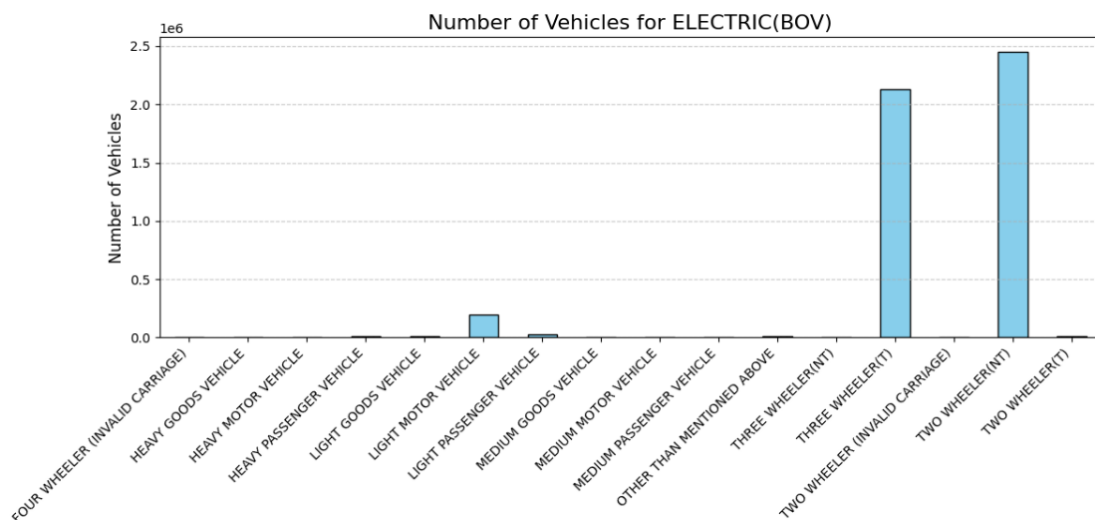

Fig5. No. of vehicles registered for Electric BOV

From the graph, we observe that **3-Wheelers (T)**, **2-Wheelers (NT)**, and some **Light Motor Vehicles (LMVs)** dominate the Electric BOV (Battery Operated Vehicle) registrations.

Three-Wheelers (T), widely used for commercial purposes like public transport and goods delivery, are favored for their low operating costs and zero emissions. **Two-Wheelers (NT)**, used primarily for personal purposes, are popular for their affordability, ease of use in traffic, and eco-friendliness. **Light Motor Vehicles**, though fewer, also leverage Electric BOVs for both personal and small-scale commercial use, reflecting the growing adoption of electric mobility across categories.
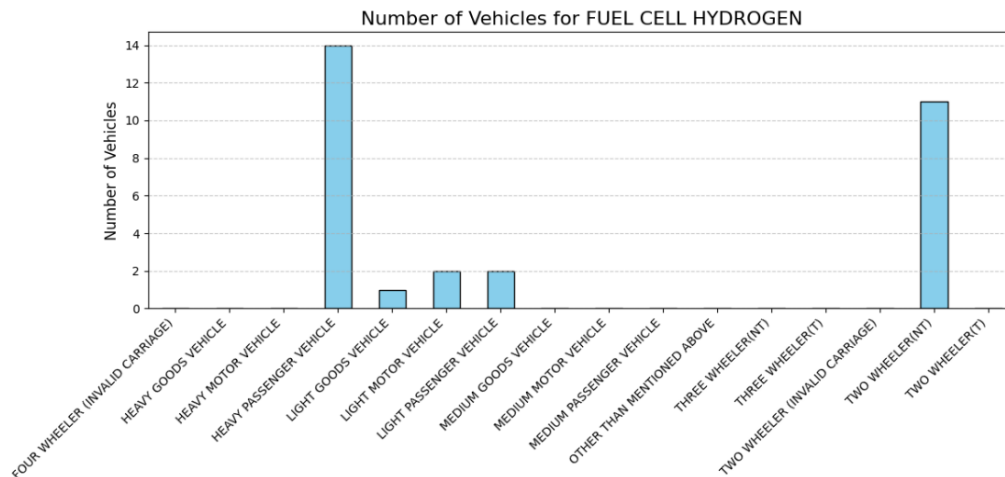
Fig6. No. of vehicles registered for Fuel Cell Hydrogen

We can see that **Two-Wheelers (NT)** and **Heavy Passenger Vehicles** have the highest registrations, followed by some **Light Goods Vehicles**, **Light Motor Vehicles**, and **Light Passenger Vehicles**. This indicates a growing trend in electric mobility across both personal and commercial categories, with particular emphasis on two-wheelers for personal use and heavy passenger vehicles for public transport, while lighter vehicles are being increasingly adopted for goods and passenger transport.
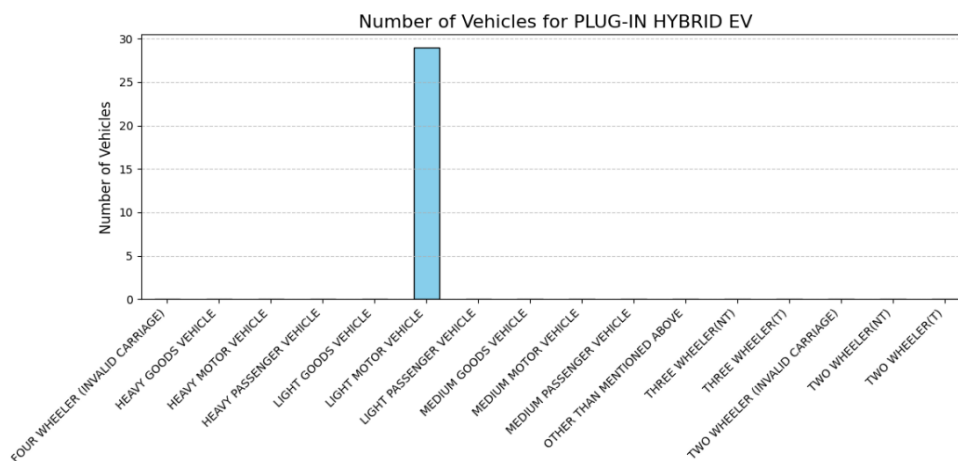
Fig7. No. of vehicles registered for Plug-In Hybrid EV

For the **Plug-in Hybrid EV** fuel type, it is evident that **Light Motor Vehicles** are the most registered. These vehicles are gaining popularity due to their ability to combine both electric power and internal combustion engines, offering enhanced fuel efficiency and extended driving range. This makes them a popular choice for urban commuters and businesses that require a balance between sustainability and performance.
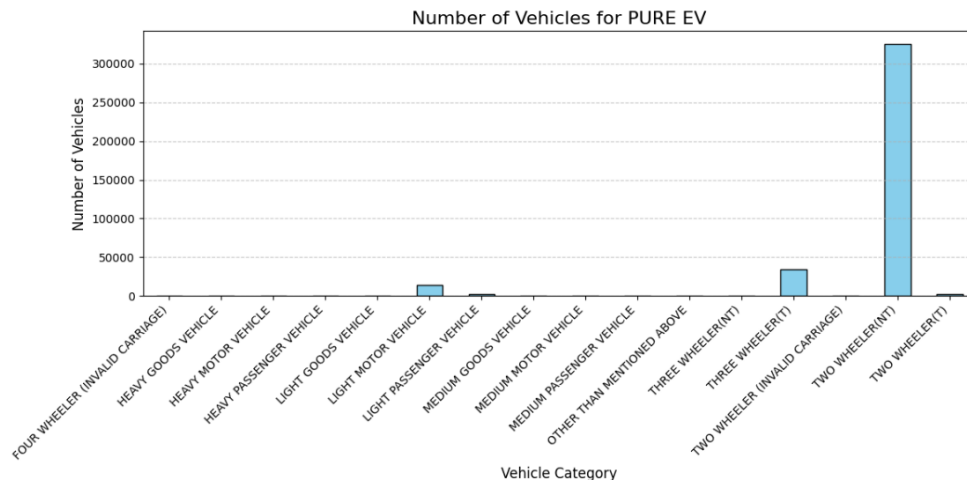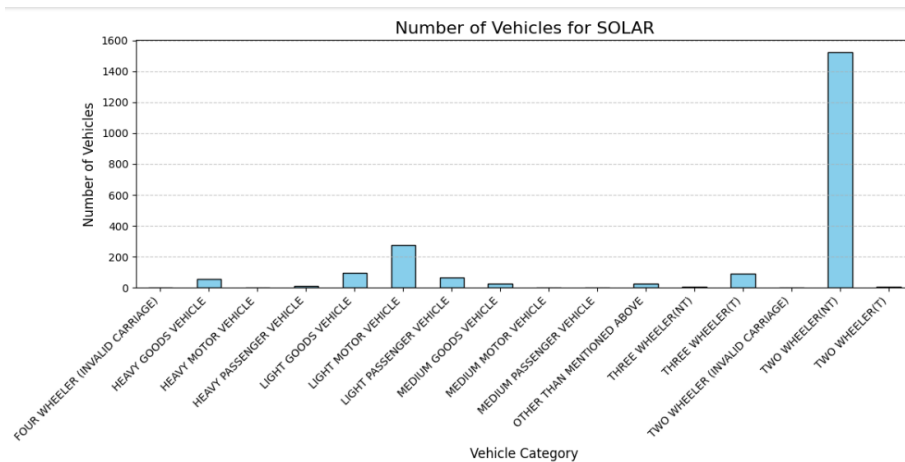
Fig8. No. of vehicles registered for Pure EV

For **Pure EV** fuel type, we observe that **Two-wheelers (NT)** and **Three-wheelers (T)**, along with some **Light Motor Vehicles**, are the most registered. These vehicles are preferred due to their zero-emission nature, cost-effectiveness, and growing infrastructure for electric charging. **Two-wheelers (NT)** are especially popular for personal use, while **Three-wheelers (T)** are favored in commercial transport, especially for goods delivery and public transportation in urban areas.
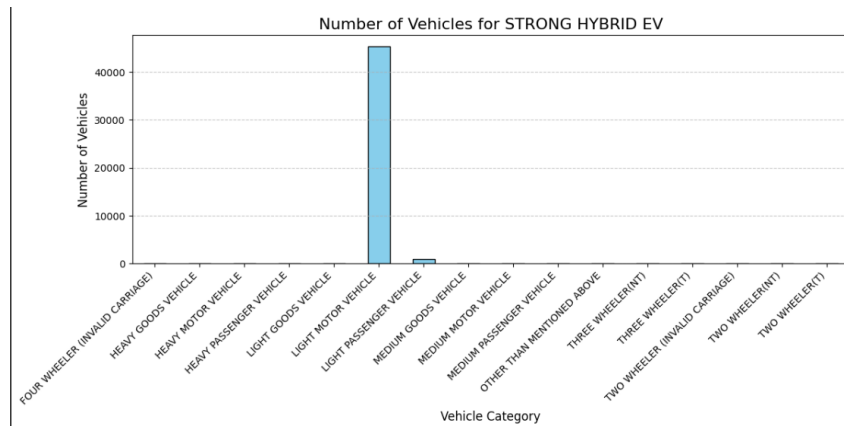

Fig9. No. of vehicles registered for Solar

For **Pure EV** fuel type, we observe that **Two-wheelers (NT)** and **Three-wheelers (T)**, along with some **Light Motor Vehicles**, are the most registered. These vehicles are preferred due to their zero-emission nature, cost-effectiveness, and growing infrastructure for electric charging. **Two-wheelers (NT)** are especially popular for personal use, while **Three-wheelers (T)** are favored in commercial transport, especially for goods delivery and public transportation in urban areas.

Fig10. No. of vehicles registered for Strong Hybrid EV

For **Hybrid EV**, it appears that **Light Motor Vehicles** are the most attracted to this fuel type, with some **Light Passenger Vehicles** also registering. This suggests that hybrid technology, combining both electric and traditional fuel sources, is particularly appealing to smaller, more economical vehicles used for personal transport, as well as some passenger vehicles looking for fuel efficiency and lower emissions.
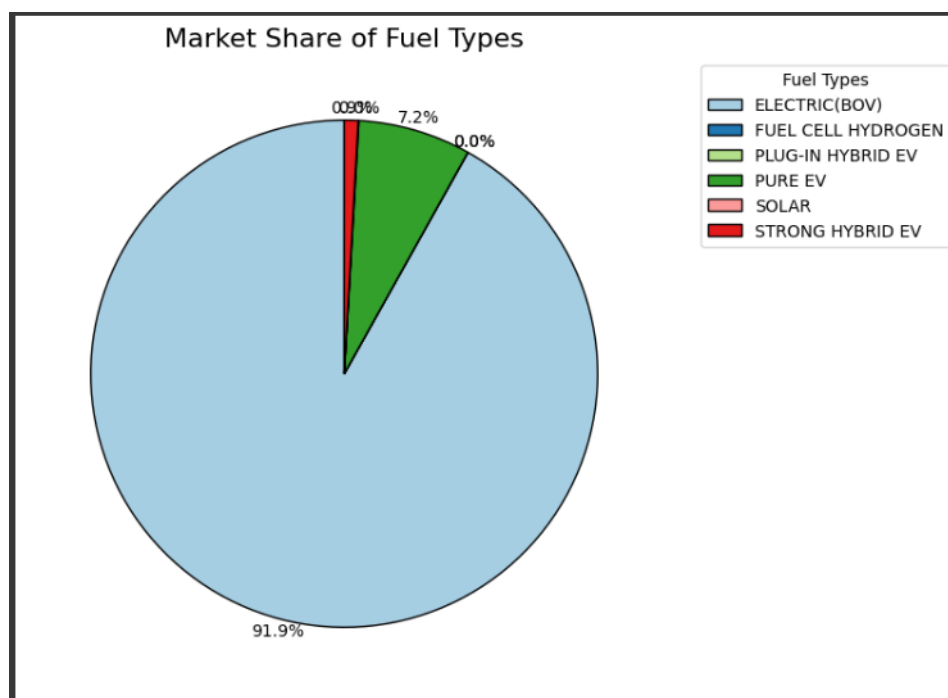

Fig11. Market Share Fuel Types(EV)

The pie chart segmentation illustrates the percentage distribution among the top five vehicle categories, highlighting their respective shares in the EV market.
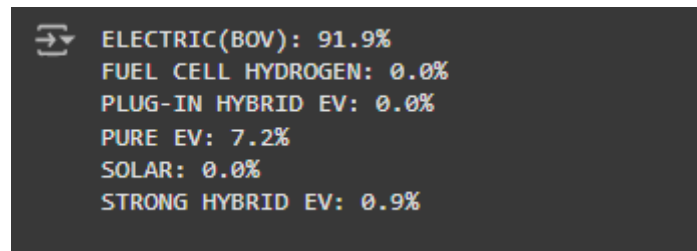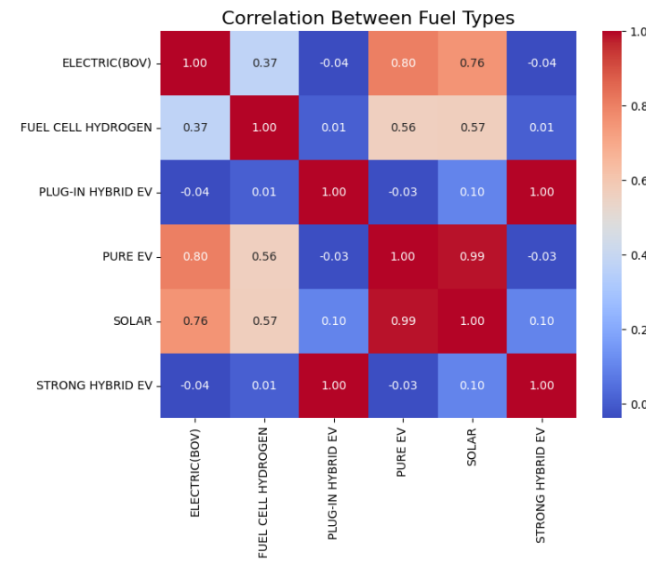
Fig11. Market Share Fuel Types(EV) Percentage

Fig12. Correlation Matrix of Types of Fuels

From the **correlation matrix** for EV fuel types, we can observe that **Electric (BOV)** and **Pure EV** are highly correlated, indicating that both fuel types tend to be used in similar vehicle categories. Additionally, **Solar** and **Electric (BOV)** also show a notable correlation, suggesting that solar-powered vehicles share some characteristics with battery-operated vehicles in terms of usage and preference. This may point to a growing trend where consumers are leaning towards eco-friendly, sustainable alternatives like electric and solar-powered vehicles.

Now, let's dive into the second dataset for deeper insights, focusing on the vehicle classes and their respective fuel types. This analysis aims to provide a clearer understanding of our target segments.
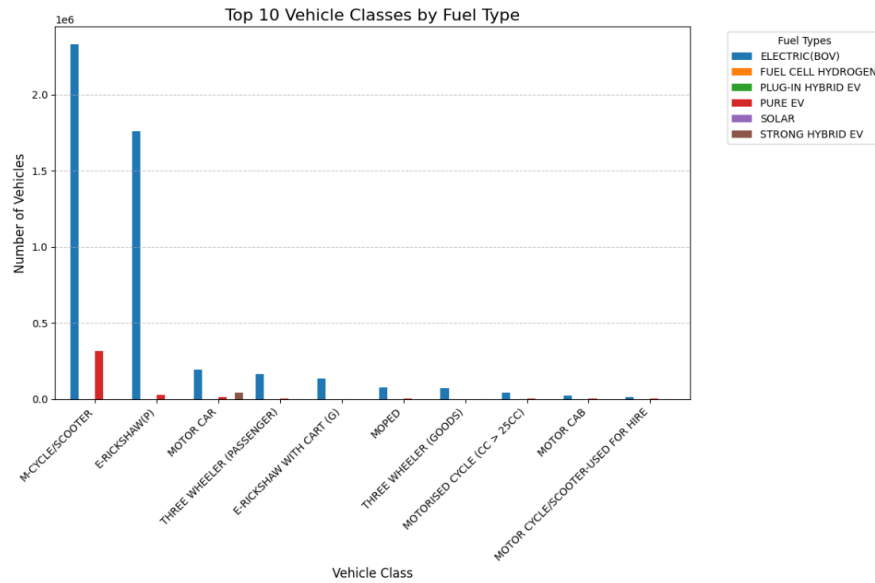
Fig13. Top 10 Vehicle Class by Fuel Type

The above graph shows the top 10 vehicles using EV fuels. We can see that **M-Cycle/Scooter** and **E-Rickshaw (P)** are the most registered vehicles in the EV market. Along with these, **Motor Cars**, **Three-Wheelers (Passenger)**, and other vehicle categories also show notable registrations. This suggests that electric mobility is gaining traction across various vehicle types, with two-wheelers and three-wheelers being the dominant categories, while passenger vehicles and light motor vehicles are also seeing growing adoption of EV technology.

For a more detailed analysis, we zoomed in and visualized three specific vehicle classes to provide a clearer understanding:
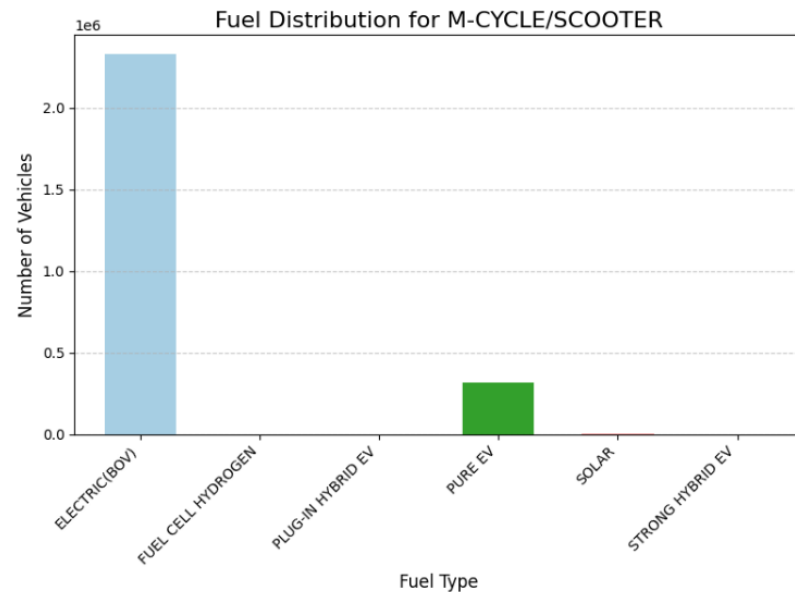

Fig14. Fuel Distribution for M-Cycle/Scooter

We can see that **M-Cycle/Scooter** has been registered for both **Electric (BOV)** and **Pure EV** fuels. This indicates that electric two-wheelers are popular choices among consumers, offering eco-friendly alternatives in both battery-operated and pure electric fuel categories.
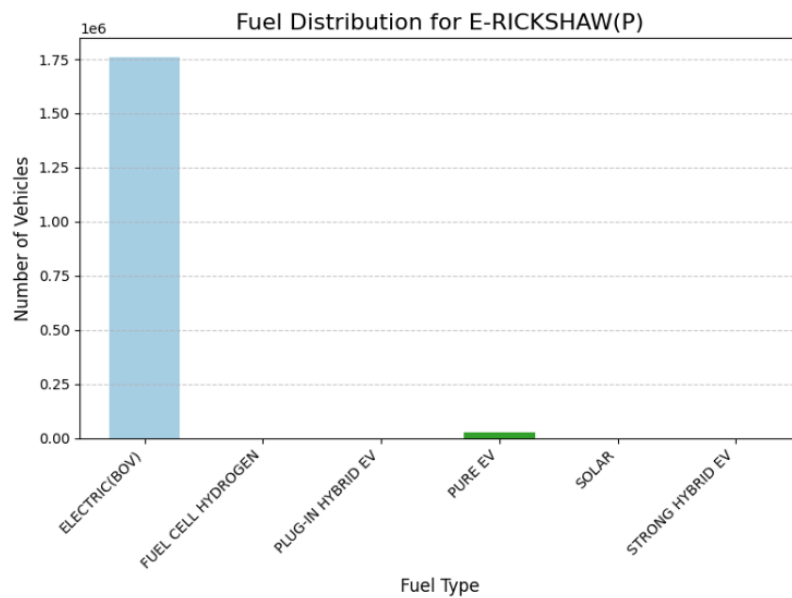

Fig15. Fuel Distribution for E-Rickshaw(P)

Similarly, for **E-Rickshaw**, we can observe that the highest proportion of registrations is in **Electric (BOV)** fuel, followed by **Pure EV**. This shows that E-Rickshaws are primarily adopting battery-operated and pure electric technologies, making them a popular choice for urban and last-mile transportation solutions.
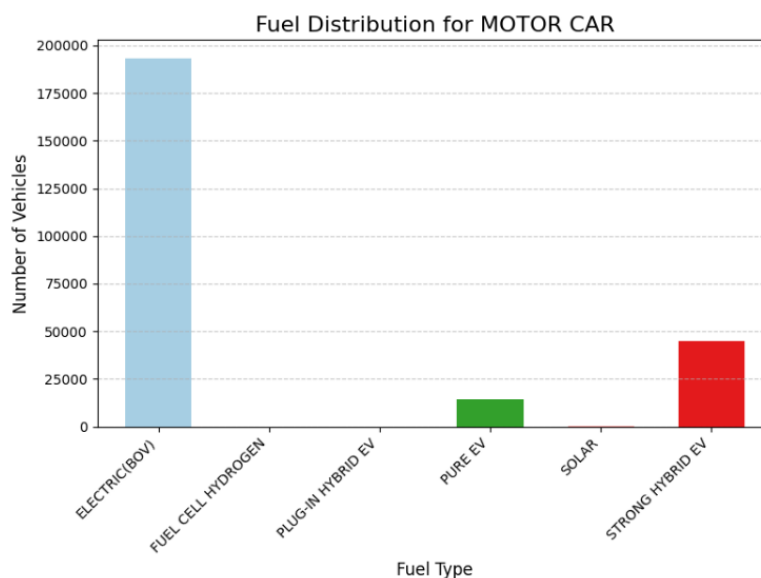

Fig16. Fuel Distribution for Motor Car

In **Motor Cars**, we can see that **Electric (BOV)**, **Pure EV**, and **Strong Hybrid EV** fuel types are the most commonly used. This indicates a growing trend towards more eco-friendly and efficient vehicle options in the motor car category, with consumers opting for fully electric and hybrid vehicles for improved performance and sustainability.
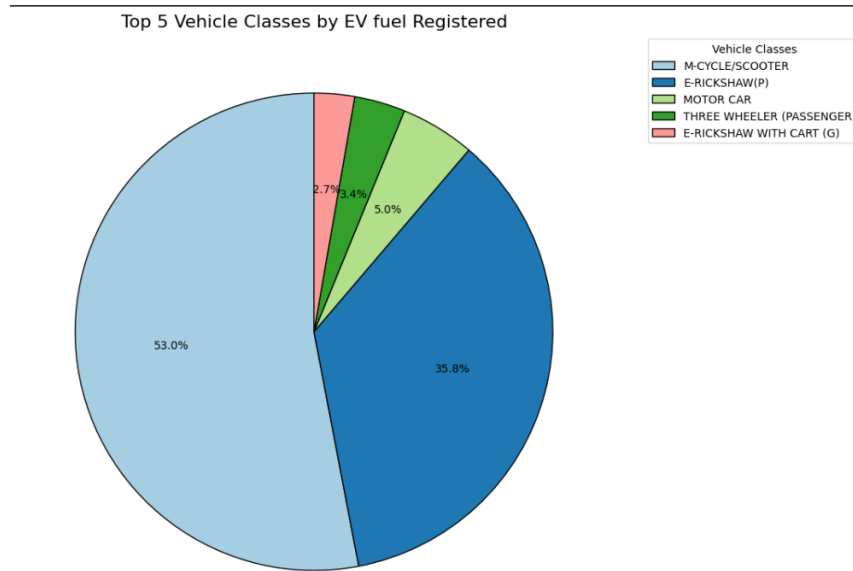

Fig17. Top 5 Vehicle Class by EV Fuel Registered

In the pie chart, we can observe the percentage distribution of EV fuel usage across various vehicle classes:

- **M-Cycle/Scooter**: 53.0%
- **E-Rickshaw**: 35.8%
- **Motor Car**: 5.0%
- **Three Wheeler (Passenger)**: 5.0%
- **E-Rickshaw with Cart**: 2.7%

This highlights that **M-Cycle/Scooter** and **E-Rickshaw** dominate the EV fuel market, with motor cars, three-wheelers, and e-rickshaws with carts accounting for a smaller proportion.

Now, diving deeper into these fuel types, let's analyze the vehicle classes associated with them:
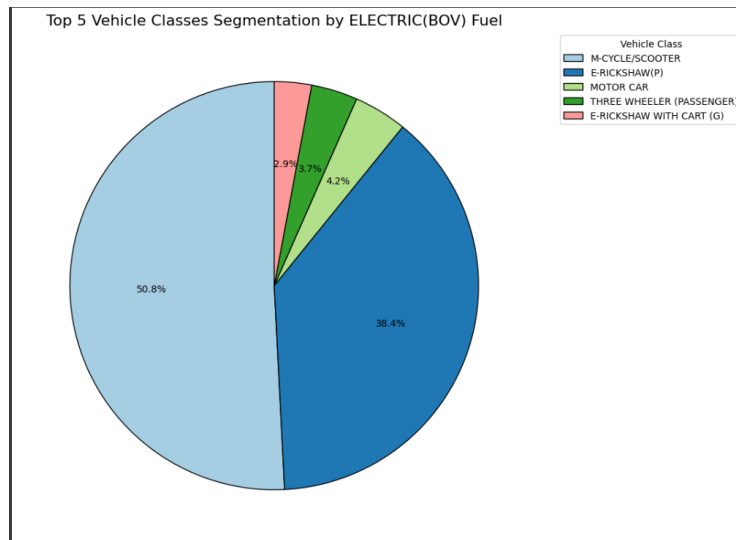
Fig18. Top 5 Vehicle class segment by Electric(BOV)

The percentage distribution of **ELECTRIC (BOV)** fuel usage across the top 5 vehicle classes is as follows:

- **M-Cycle/Scooter**: 50.81%
- **E-Rickshaw (P)**: 38.37%
- **Motor Car**: 4.21%
- **Three Wheeler (Passenger)**: 3.66%
- **E-Rickshaw with Cart (G)**: 2.94%

This indicates that **M-Cycle/Scooter** and **E-Rickshaw (P)** are the primary vehicle types utilizing **ELECTRIC (BOV)** fuel, with the rest having a significantly smaller share.
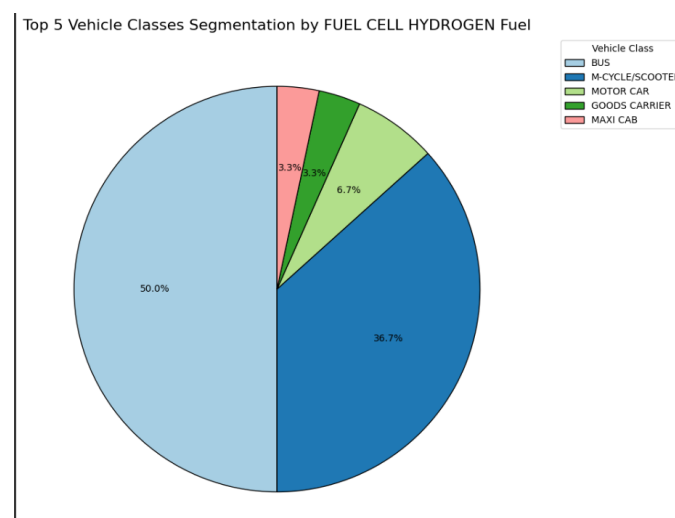

Fig19. Top 5 Vehicle class segment by Fuel Cell Hydrogen

The percentage distribution of **Fuel Cell Hydrogen** fuel usage across the top 5 vehicle classes is as follows:

- **Bus**: 50.00%
- **M-Cycle/Scooter**: 36.67%
- **Motor Car**: 6.67%
- **Goods Carrier**: 3.33%
- **Maxi Cab**: 3.33%

This shows that **Buses** are the largest users of Fuel Cell Hydrogen, with **M-Cycle/Scooter** following as the second largest, while other vehicle types like **Motor Car**, **Goods Carrier**, and **Maxi Cab** make up a smaller portion of the fuel usage.
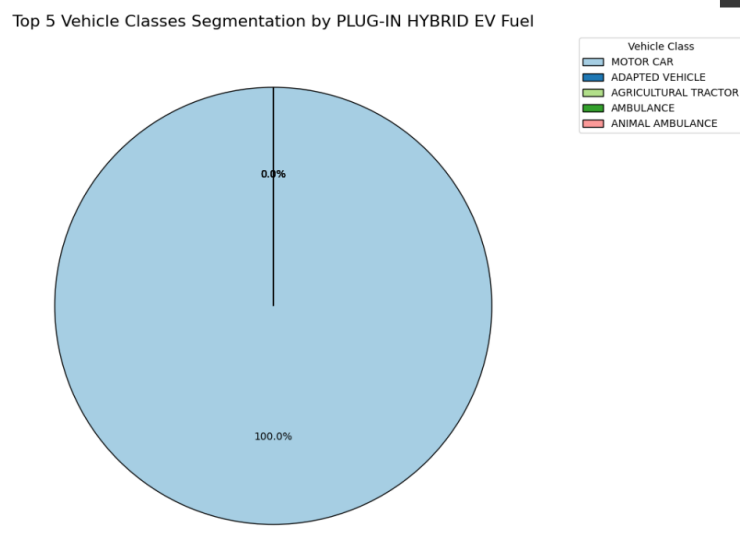

Fig20. Top 5 Vehicle class segment by Plug-In Hybrid EV

The percentage distribution of **PLUG-IN HYBRID EV** fuel usage across the top 5 vehicle classes is as follows:

- **M-Cycle/Scooter**: 0.0%
- **E-Rickshaw (P)**: 0.0%
- **Motor Car**: 100.0%
- **Three Wheeler (Passenger)**: 0.0%
- **E-Rickshaw with Cart (G)**: 0.0%

This shows that **Motor Cars** are the only vehicle class using **PLUG-IN HYBRID EV** fuel in significant proportions, while other vehicle types do not register any usage of this fuel type.
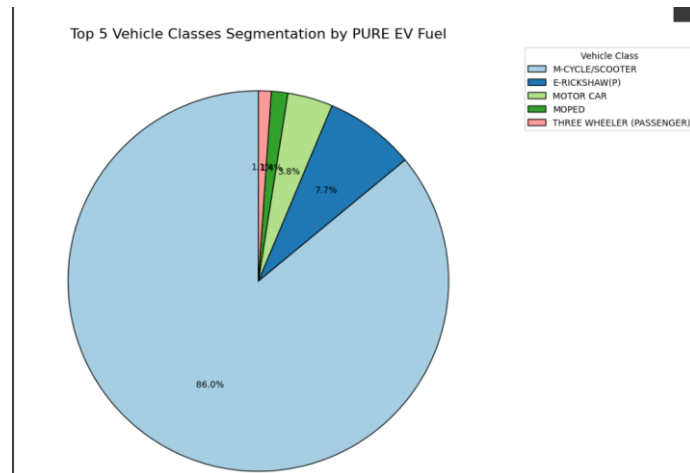
Fig21. Top 5 Vehicle class segment by Pure EV

The percentage distribution of **PURE EV** fuel usage across the top 5 vehicle classes is as follows:

- **M-Cycle/Scooter**: 86.73%
- **E-Rickshaw (P)**: 7.75%
- **Motor Car**: 3.88%
- **Three Wheeler (Passenger)**: 1.10%
- **E-Rickshaw with Cart (G)**: 0.54%

This shows that **M-Cycle/Scooter** takes a dominant share of the **PURE EV** fuel usage, while other vehicle classes like **E-Rickshaw (P)** and **Motor Cars** have a significantly smaller share.
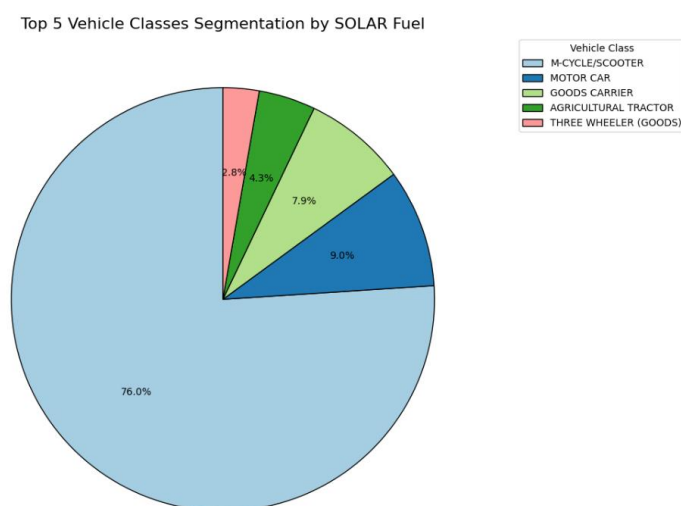

Fig21. Top 5 Vehicle class segment by Solar

The percentage distribution of **Solar** fuel usage across the top 5 vehicle classes is as follows:

- **M-Cycle/Scooter**: 76.03%
- **Motor Car**: 9.03%
- **Goods Carrier**: 7.85%
- **Agricultural Tractor**: 4.33%
- **Three Wheeler (Goods)**: 2.75%

This shows that **M-Cycle/Scooter** dominates the Solar fuel usage, while **Motor Cars** and **Goods Carriers** also contribute, albeit at a smaller share.
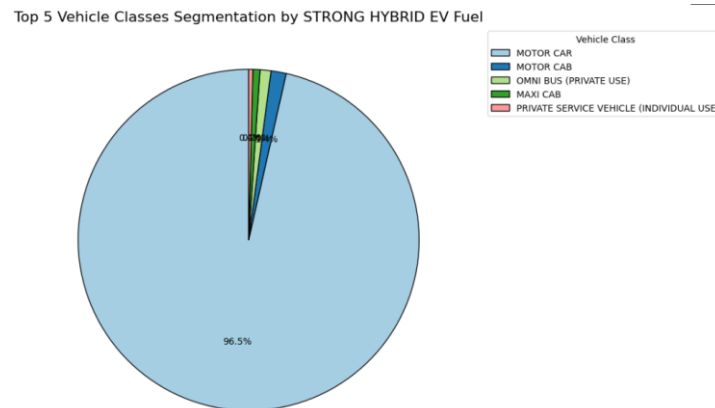

Fig23. Top 5 Vehicle class segment by Strong Hybrid EV

The percentage distribution of **Strong Hybrid EV** fuel usage across the top 5 vehicle classes is as follows:

- **Motor Car**: 96.46%
- **Motor Cab**: 1.44%
- **Omni Bus (Private Use)**: 1.03%
- **Maxi Cab**: 0.67%
- **Private Service Vehicle (Individual Use)**: 0.39%

This shows that **Motor Cars** overwhelmingly dominate the usage of Strong Hybrid EV fuel, with other vehicle classes contributing only a small fraction.

Summary with Insights:

Based on the detailed analysis of EV market segmentation in India, here are the key insights to guide your startup strategy:

1. **Target Vehicle Classes:**
   o **Two-Wheelers (M-Cycle/Scooter)** dominate the Electric BOV, Pure EV, and Solar fuel types, making them a highly attractive segment. Their popularity stems from affordability, ease of use, and growing eco-consciousness among individual users.
   o **Three-Wheelers (E-Rickshaw)** are a strong contender in commercial applications such as urban transportation and last-mile delivery. They show significant adoption in Electric BOV and Pure EV fuels.
   o **Motor Cars** stand out in the Plug-in Hybrid EV and Strong Hybrid EV fuel types. This segment is ideal for urban commuters and environmentally conscious customers seeking longer driving ranges and fuel efficiency.
2. **Fuel Type Prioritization:**
   o **Electric BOV (Battery Operated Vehicles)** lead the market, with wide adoption across both personal and commercial categories. Focusing on this fuel type can ensure broad reach and immediate adoption.
   o **Pure EV** has a growing market share in two-wheelers and three-wheelers, offering opportunities for deeper penetration in urban and semi-urban areas.
   o **Hybrid EVs (Plug-in and Strong)** cater primarily to motor cars, making them ideal for premium and performance-oriented customer segments.
3. **Customer Segments:**
   o **Personal Use:** Two-wheelers (M-Cycle/Scooter) are preferred for affordability, convenience, and environmental benefits.
   o **Commercial Use:** Three-wheelers (E-Rickshaw) and Light Goods Vehicles dominate the last-mile delivery and ride-hailing sectors, offering cost-effective and sustainable solutions.
   o **Premium Market:** Motor Cars with hybrid technology cater to urban professionals and high-income groups focused on performance and sustainability.
4. **Emerging Trends:**
   o **Solar EVs** show promise in the two-wheeler segment, indicating potential for sustainable energy innovations in the personal mobility space.
   o **Fuel Cell Hydrogen** adoption is limited but noteworthy in heavy vehicles such as buses, signaling future opportunities in public transport and logistics.
5. **Regional Focus:**
   o Concentrate efforts in **urban and semi-urban regions**, where infrastructure and awareness for EVs are more developed, ensuring faster adoption.
   o Expand into rural areas with two-wheeler and agricultural applications (e.g., tractors using solar or electric power).
6. **Technology and Infrastructure:**
   o Invest in **charging infrastructure** and partnerships with energy providers to support battery-operated and plug-in EVs.
   o Collaborate with battery manufacturers for cost-efficient and high-performance solutions, focusing on lithium-ion and emerging technologies.

Recommendations for Market Entry:

1. **Start with Two-Wheelers and Three-Wheelers**:
   o Launch affordable and efficient electric scooters and e-rickshaws targeting urban commuters and small businesses.
2. **Explore Hybrid Technology for Motor Cars**:
   o Enter the hybrid car market for urban professionals looking for sustainable yet long-range mobility options.
3. **Invest in Sustainable Energy Solutions**:
   o Develop solar-powered options for rural and niche urban segments, emphasizing cost savings and eco-friendliness.
4. **Leverage Policy Support**:
   o Take advantage of government incentives, subsidies, and support for EV startups to reduce operational costs and encourage adoption.

By focusing on high-potential vehicle classes, understanding fuel-type adoption trends, and tailoring your offerings to specific customer needs, your startup can position itself as a key player in India's rapidly growing EV market.

Code link:

colab link