INDUSTRY ANALYSIS ON

"Electric vehicles"

Submitted to Tumkur University in partial fulfilment of requirements for the award of the degree of

MASTER OF BUSINESS ADMINISTRATION

Submitted By :

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CERTIFICATE

This is to certify that RAKSHITHA S V bearing **Reg.P11MS23M015085** is a Bonafide student of the Master of Business Administration course of the Institute (2023-2024 Batch), Affiliated to Tumkur University. The Industry Analysis Report has been done with special reference to ELECTRIC VEHICLES INDUSTRY and is prepared by his/her under the guidance of Mrs. Smitha S, in partial fulfilment of the requirements for the award of the degree of Master of Business Administration of Sri Siddhartha Institute of Management Studies. Tumkur.

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DECLARATION

I, RAKSHITHA S V hereby declare that the Industry Analysis with reference to **"ELECTRIC VEHICLES INDUSTRY "** prepared by me under the guidance of **Mrs SMITHA S** Assistant Professor, M.B.A Department, Sri Siddhartha Institute of Management Studies, Maralur, Tumkur and

I also declare that this Industry Analysis report is towards the partial fulfilment of the university regulations for the award of the degree of Master of Business Administration by **Tumkur University**, Tumkur

I further declare that this Report is based on the original study undertaken by me and has not been submitted for the award of any degree from any other University Institution.

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Date: Name: RAKSHITHA S V

CONTENTS

EXECUTIVE SUMMARY

An electric vehicle (EV) is a vehicle that runs partially or completely on electricity. Modern EVs typically use lithium-ion batteries, which offer higher energy density and longer life compared to older battery technologies like lead-acid or nickel metal hydride. EVs are more durable and mechanically simpler than gasoline vehicles, and they provide better fuel efficiency since they produce no tailpipe emissions.

Electric vehicles (EVs) represent a significant advancement in automotive technology, utilizing electric motors powered by rechargeable batteries instead of traditional internal combustion engines. This shift to electric propulsion brings numerous benefits, including reduced greenhouse gas emissions, lower operating costs, and decreased reliance on fossil fuels. Modern EVs, primarily powered by lithium-ion batteries, boast impressive energy efficiency and longer ranges. They produce zero tailpipe emissions, which significantly reduces air pollution and contributes to cleaner urban environments. The increasing adoption of EVs is further supported by advancements in charging infrastructure, making it more convenient for users to recharge their vehicles at home, workplaces, and public stations. Additionally, governmental policies and incentives worldwide are accelerating the transition to electric mobility by promoting manufacturing and sales, and developing EV-friendly infrastructure. Despite challenges such as battery disposal and the need for extensive charging networks, ongoing research and development are continuously enhancing EV technologies. The future of EVs looks promising, with ongoing innovations aimed at improving battery technology, driving range, and overall vehicle performance. This transformative shift in the automotive industry not only aligns with global sustainability goals but also promises a future where transportation is cleaner, quieter, and more energy-efficient.

1. **Market Growth:**
    - The global EV market is projected to reach $823.75 billion by 2030.
    - Rapid expansion driven by technological advancements, environmental awareness, and government incentives.
2. **Technological Advancements:**
    - Significant improvements in lithium-ion battery technology, energy density, and cost reduction.
    - Emerging technologies such as solid-state batteries and advanced electric drivetrains.

3. **Environmental Benefits:**
    - EVs produce zero tailpipe emissions, reducing greenhouse gas emissions and air pollution.
    - Contributing to global sustainability and cleaner urban environments.
4. **Government Incentives:**
    - Policies and incentives worldwide, including subsidies, tax rebates, and stringent emission regulations.
    - Examples include India's FAME scheme and the European Union’s ambitious emission targets.
5. **Market Segmentation:**
    - Segmented by vehicle type: passenger cars, commercial vehicles, two-wheelers.
    - Propulsion types include battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).
6. **Challenges:**
    - High initial costs of EVs.
    - Limited charging infrastructure.
    - Ethical sourcing of raw materials like cobalt and lithium for batteries.
7. **Future Trends:**
    - Continued reduction in battery costs and increased vehicle range.
    - Expansion of charging infrastructure, including fast-charging and wireless charging.
    - Growth in the second-hand EV market and integration of renewable energy sources.
8. **Economic and Social Impact**:
    - Creation of new job opportunities in manufacturing, R&D, and infrastructure development.
    - Potential economic displacement in traditional automotive and fossil fuel industries.

CHAPTER 1

INTRODUCTION

1. Industry Identified for The Study:

Electric vehicles (EVs) are transforming the way we think about transportation. Unlike traditional vehicles that rely on internal combustion engines powered by gasoline or diesel, EVs use electric motors powered by rechargeable batteries. Electric vehicles (EVs) represent a significant shift in the automotive industry by using electric motors powered by rechargeable batteries instead of traditional internal combustion engines. This change brings numerous benefits, including reduced greenhouse gas emissions, lower operating costs, and improved energy efficiency. EVs are known for their instant torque, providing a smooth and responsive driving experience, while also operating more quietly than their gasoline counterparts. Advances in battery technology, particularly lithium-ion batteries, have extended the range and performance of EVs, making them suitable for both daily commutes and long-distance travel. With increasing governmental support and growing charging infrastructure, the adoption of electric vehicles is on the rise, paving the way for a more sustainable and eco-friendly future in transportation.

2. Economical contribution:

Electric vehicles (EVs) have significantly impacted the global economy, contributing to various sectors and driving substantial changes in the automotive industry. Here's a brief abstract on their economic contribution and industry analysis.

The rise of electric vehicles (EVs) has marked a transformative shift in the global automotive industry, driven by advancements in technology, environmental concerns, and supportive government policies. In 2023, nearly one in five cars sold globally was electric, with sales reaching approximately 14 million units. This surge in EV adoption has been predominantly concentrated in major markets such as China, Europe, and the United States, which together accounted for 95% of global sales.

Economically, the EV industry has outperformed traditional automotive sectors, with significant returns on investment for companies involved in vehicle manufacturing, battery production, and the extraction of battery metals. The market capitalization of pure-play EV manufacturers soared from USD 100 billion in 2020 to USD 1 trillion by the end of 2023. However, the industry faces challenges such as supply chain disruptions, price volatility of battery metals, and increasing competition, which have introduced market volatility and impacted investor confidence.

The transition to electric mobility has also spurred growth in related sectors, including charging infrastructure, renewable energy integration, and smart grid technologies. Additionally, the environmental benefits of EVs, such as reduced greenhouse gas emissions and lower air pollution, contribute to their economic appeal by aligning with global sustainability goals.

Overall, the economic contribution of EVs extends beyond the automotive industry, influencing energy markets, environmental policies, and technological innovation. As the market matures, continued investment and strategic partnerships will be crucial in addressing challenges and sustaining growth.

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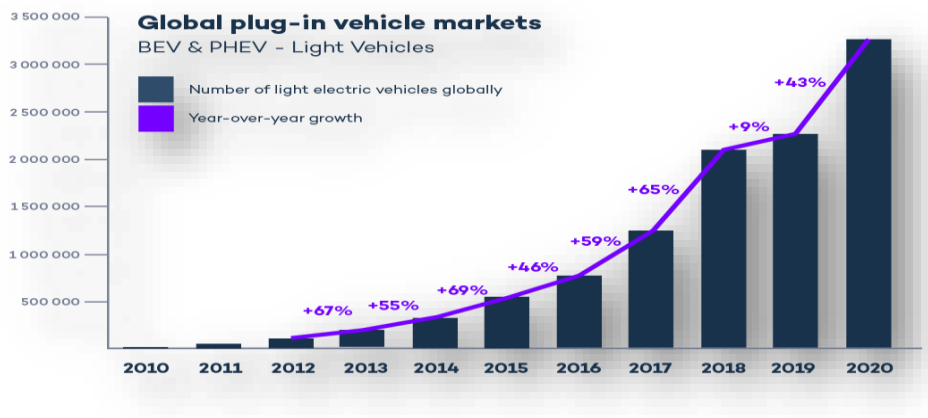


3. Opportunities, Barriers and Challenges:

➢ Opportunities

- **Environmental Benefits:** EVs significantly reduce greenhouse gas emissions compared to traditional internal combustion engine vehicles, contributing to climate change mitigation.
- **Technological Advancements**: Innovations in battery technology, such as solid-state batteries, promise longer ranges and shorter charging times.
- **Government Incentives**: Many governments offer subsidies, tax breaks, and other incentives to promote EV adoption.
- **Market Growth**: The global EV market is expanding, with increasing consumer demand and investment from major automotive manufacturers

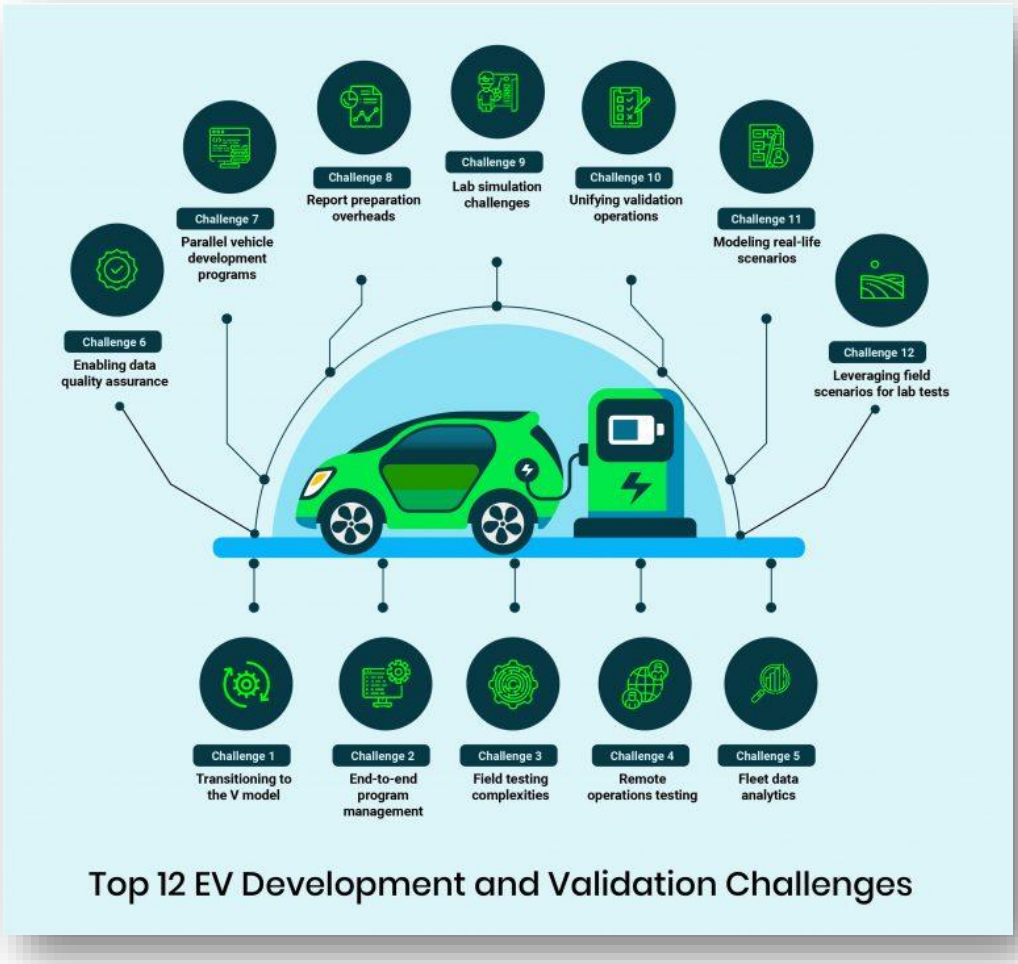
➢ Barriers

- **High Initial Costs:** The upfront cost of EVs is generally higher than that of conventional vehicles, although this gap is narrowing.
- **Charging Infrastructure**: Limited availability of charging stations, especially in rural areas, remains a significant hurdle.
- **Range Anxiety**: Concerns about the distance EVs can travel on a single charge deter some potential buyers.
- **Battery Technology**: Current battery technologies face challenges such as limited lifespan, high costs, and environmental concerns related to mining and disposal**.**

➢ Challenges

- **Consumer Awareness:** There is a need for greater public awareness and education about the benefits and capabilities of EVs.
- **Supply Chain Issues:** The production of EVs requires a stable supply of critical materials like lithium, cobalt, and nickel, which can be subject to geopolitical and environmental issues.

- **Policy and Regulation**: Inconsistent policies and regulations across different regions can complicate the adoption and integration of EVs.
- **Technological Integration**: Integrating EVs with renewable energy sources and smart grid technologies is essential for maximizing their environmental benefits



4. Purpose of Study (Why Industry Chosen and Goals of the Analysis):

The electric vehicle (EV) industry was selected for this study due to its significant potential to transform the global transportation sector. This transformation is driven by several key factors.

Electric Vehicle is chosen in this study for industry analysis, to understand the overall market size and growth potential industry. To and analysis the profitability trends of the electric vehicle

Electric Vehicle, to evaluate the industry supply chain and distribution network. To evaluate the industries overall financial health and stability. To evaluate the industries overall risk factor and challenges.

5. Need and Significance of the Study:

The industry analysis on electric vehicle industry need & importance to know the identify the major players of the electric vehicle. To identify the potential opportunities for innovation and growth of the EV industry to understand the overall market size and growth potential of the electric vehicle industry to understand the competitive dynamic with the industry. To evaluate the industry overall financial health and stability.

6. Objectives:

- To understand the overall market size and growth potential of the EV industry.
- To study the impact of technological advancement on EV industry.
- To identify the major players of EV industry.
- To understand the impact of global market trends on the Ev industry.
- To evaluate the industry supply chain and distribution network.

7. Methodology:

Type research : descriptive in Nature

"Descriptive nature," it means it's focused on providing detailed descriptions and information about a particular subject. This could involve explaining characteristics, features, or attributes in a way that gives a clear and vivid picture of the topic. In a more general sense, "descriptive"

is used to convey information in detail, often using sensory details to paint a picture in the mind of the reader or listener.

Methods of Data collection

Primary Data: Primary data is the data that is collected for the first time through personal experiences or evidence, particularly for research. It is also described as raw data or first - hand information

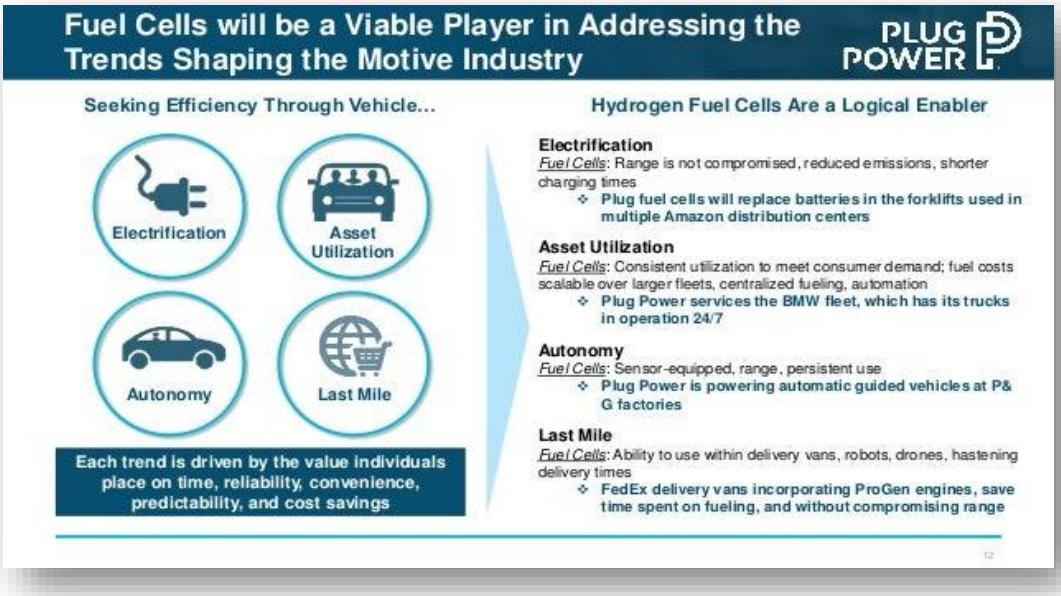
Secondary Data: secondary data means data that are already available they refer to data which have already been collected and analysis by someone else. When the researcher utilizes secondary data, then he has look into various sources from where he can obtain them.

In this industry analysis I am adopting secondary data collection method collecting the data through website, articles journal and newspaper. In this industry analysis descriptive method for analysis

8. Analysis-method used for analysis:

The analysis methods adopted by the industry are:

- PEST analysis.
- Porters five forces model.



CHAPTER 2

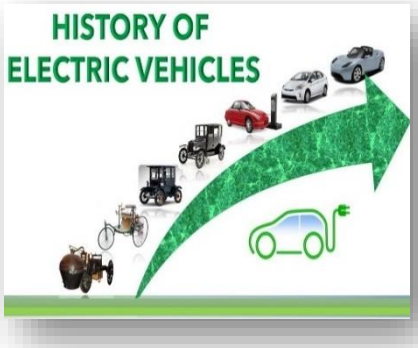
INDUSTRY OVERVIEW

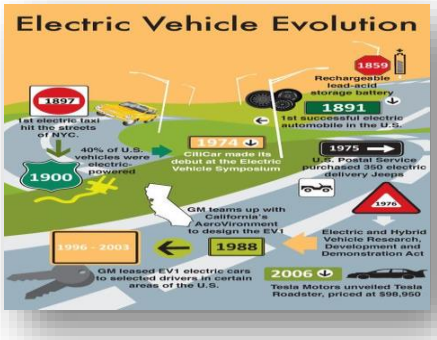
1. History And Background of The Industry:

Crude electric carriages were first invented in the late 1820s and 1830s. Practical, commercially available electric vehicles appeared during the 1890s. An electric vehicle held the vehicular land speed record until around 1900. In the early 20th century, the high cost, low top speed, and short-range of battery electric vehicles, compared to internal combustion engine vehicles, led to a worldwide decline in their use as private motor vehicles. Electric vehicles have continued to be used for loading and freight equipment and for public transport especially rail vehicles.

At the beginning of the 21st century, interest in electric and alternative fuel vehicles in private motor vehicles increased due to: growing concern over the problems associated with hydrocarbon-fueled vehicles, including damage to the environment caused by their emissions; the sustainability of the current hydrocarbon-based transportation infrastructure; and improvements in electric vehicle technology.

Since 2010, combined sales of all-electric cars and utility vans achieved 1 million units delivered globally in September 2016, 4.8 million electric cars in use at the end of 2019, and cumulative sales of light-duty plug-in electric cars reached the 10 million unit milestone by the end of 2020. The global ratio between annual sales of battery electric cars and plug-in hybrids went from 56:44 in 2012 to 74:26 in 2019, and fell to 69:31 in 2020. As of August 2020, the fully electric Tesla Model 3 is the world's all-time best selling plug-in electric passenger car, with around 645,000 units.





1920s–1950s: Dark age of Electric Vehicles

After enjoying success at the beginning of the 20th century, the electric car began to lose its position in the automobile market. A number of developments contributed to this situation. By the 1920s an improved road infrastructure improved travel times, creating a need for vehicles with a greater range than that offered by electric cars. Worldwide discoveries of large petroleum reserves led to the wide availability of affordable petrol, making petrol-powered cars cheaper to operate over long distances. Electric cars were limited to urban use by their slow speed (no more than 24–32 km/h or 15–20 mph and low range (50–65 km or 30–40 miles, and gasoline cars were now able to travel farther and faster than equivalent electrics.

Gasoline cars also overcame much of their negatives compared to electrics, in several areas. Whereas ICE cars originally had to be hand-cranked to start – a difficult and sometimes dangerous activity – the invention of the electric starter by Charles Kettering in 1912 eliminated the need of a hand starting crank. Further, while gasoline engines are inherently noisier than electric motors, the invention of the muffler by Milton O. Reeves and Marshall T. Reeves in 1897 significantly reduced the noise to tolerable levels. Finally, the initiation of mass production of gas-powered vehicles by Henry Ford brought their price down. By contrast, the price of similar electric vehicles continued to rise; by 1912, an electric car sold for almost double the price of a gasoline car.

Most electric car makers stopped production at some point in the 1910s. Electric vehicles became popular for certain applications where their limited range did not pose major problems. Forklift trucks were electrically powered when they were introduced by Yale in 1923. In Europe, especially the United Kingdom, milk floats were powered by electricity, and for most of the 20th century the majority of the world's battery electric road vehicles were British milk floats. Electric golf carts were produced by Lektro as early as 1954. By the 1920s, the early heyday of electric cars had passed, and a decade later, the electric automobile industry had effectively disappeared.

Years passed without a major revival in the use of electric cars. Fuel-starved European countries fighting in World War II experimented with electric cars such as the British milk floats and the French Bréguet Aviation car, but overall, while ICE development progressed at a brisk pace, electric vehicle technology stagnated. In the late 1950s, Henney Coachworks and the National Union Electric Company, makers of Exide batteries, formed a joint venture to produce a new electric car, the Henney Kilowatt, based on the French Renault Dauphine. The car was

produced in 36-volt and 72-volt configurations. The 72-volt models had a top speed approaching 96 km/h (60 mph) and could travel for nearly an hour on a single charge. Despite Kilowatt's improved performance with respect to previous electric cars, it was about double the cost of a regular gasoline-powered Dauphine, and production ended in 1961.

- Electric vehicle TAMA, produced by Tachikawa Aircraft Company in 1947. Mechanical Engineering Heritage (Japan) No. 40

- East German electric vans of the Deutsche Post in 1953

- The Henney Kilowatt, a 1961 production electric car

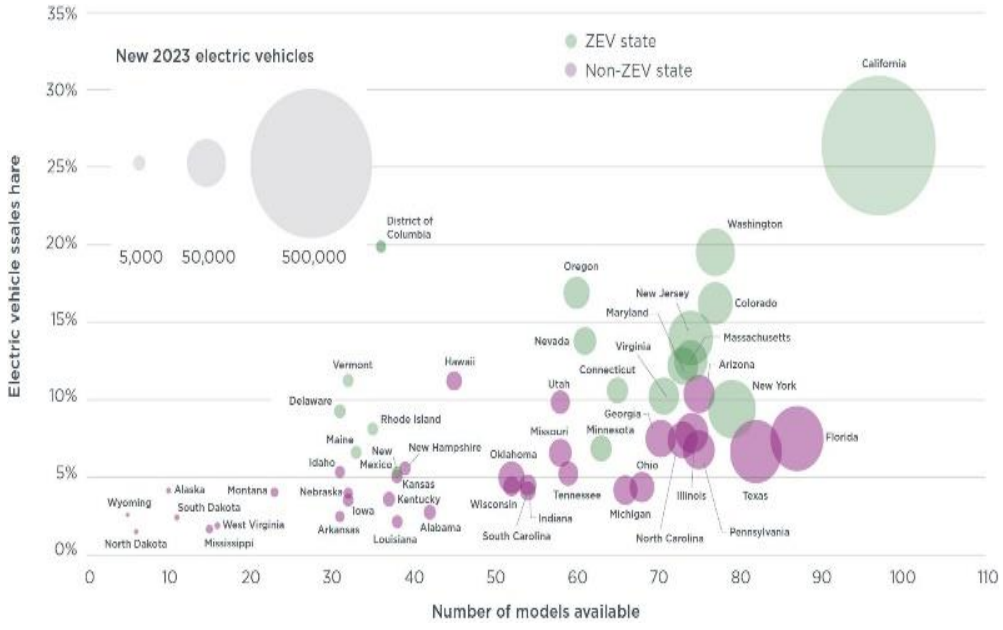
2. Current State of Industry:

In 2023, sales of new electric light-duty vehicles in the United States reached about 1.4 million, up from nearly 1 million in 2022, resulting in a sales share of about 9%. Across the country, the electric vehicle market has grown at different rates in different states. This market spotlight summarizes key metrics related to electric vehicle market growth at the state level through 2023, including annual sales and sales shares, charging infrastructure deployment, state purchase incentives, and model availability.

Figure 1 summarizes electric vehicle (EV) uptake (both battery-electric and plug-in hybrid), charging infrastructure deployment, battery-electric vehicle (BEV) purchase incentives, and EV model availability in 2023 in the 50 U.S. states and the District of Columbia, ordered from highest to lowest EV sales share. Markets categorized as "ZEV states" (solid bars) have adopted California's zero-emission vehicle (ZEV) regulations, while those marked as "non-ZEV states" (hashed bars) have not. As of the end of 2023, 17 states and the District of Columbia had adopted California's ZEV regulations. As shown in the figure, 15 of the 20 markets with the highest electric vehicle sales shares in 2023 were all ZEV states. The top 10 markets (nine states and the District of Columbia) also had EV sales shares greater than 11% and are all ZEV states.

Electric vehicle sales share, charging infrastructure deployment, purchase incentives, and model availability in U.S. states and the District of Columbia, 2023

Areas with high EV sales shares tended to have a high concentration of public and workplace chargers. The 10 markets with the highest EV sales share had close to 980 public and workplace chargers per million residents, on average. All ZEV states had close to 780 chargers per million residents on average, while non-ZEV states had around 320. The top 10 markets with the highest number of chargers per million residents in 2023—California, the District of Columbia, Washington, Oregon, Colorado, Massachusetts, Maryland, Vermont, Rhode Island, and Maine—have all implemented ZEV regulations. These markets also had more than 2 times as many chargers per million residents compared to the non-ZEV state.



The electric vehicle (EV) industry has seen significant growth and development in recent years

Market Growth: In 2023, nearly one in five cars sold globally was electric, with sales reaching almost 14 million units. This represents a 35% increase from 2022. The majority of these sales were concentrated in China, Europe, and the United States**.**

- **Technological Advances:** Research has highlighted advancements in battery technology, charging methods, and energy management systems. Lithium-ion batteries remain the dominant technology, but there are ongoing efforts to improve their efficiency and reduce costs.

- **Challenges and Opportunities:** The industry faces several challenges, including the need for more efficient charging infrastructure, better battery performance, and the integration of EVs into existing power grids. However, these challenges also present opportunities for innovation and growth**.**
- **Environmental Impact:** EVs are seen as a crucial component in reducing greenhouse gas emissions from the transportation sector. Studies have shown that EVs can significantly lower emissions compared to traditional internal combustion engine vehicles**.**
- **Future Prospects:** The future of the EV industry looks promising, with continued growth expected in both sales and technological advancements. There is also a focus on expanding the market beyond light-duty vehicles to include buses, trucks, and other forms of transportation

3. Size of the Industry:

An Electric Vehicle Battery is a rechargeable energy storage device used to power the electric motors and auxiliary systems in electric vehicles. EV batteries are lithium-ion batteries known for their high energy density and rechargeability. They store electrical energy generated from regenerative braking or external sources such as charging stations. EV batteries play an important role in determining the vehicle's range, performance, and overall efficiency, which makes them a key component of electric mobility.

- EV batteries are larger and have higher energy density.
- They handle high current demands and frequent charge-discharge cycles.
- Advanced thermal management systems maintain optimal temperatures.
- Designed specifically for electric vehicle propulsion.
- Specialised design and technology cater to unique EV requirements.
- Battery Capacity.
- Battery Size and Weight.
- Battery Power.
- C-Rate.

Battery Capacity:

Battery capacity, also known as energy capacity, refers to the amount of energy a battery can deliver over a specific period. It's measured in kilowatt-hours (kWh) and calculated by multiplying the battery's voltage by its ampere-hours (Ah).

For example, if a battery has a voltage of 12 volts and an ampere-hour rating of 50 Ah, its capacity would be 600 watt-hours (Wh) or 0.6 kWh (12V x 50Ah = 600Wh = 0.6 kWh). This capacity determines the energy available to power electric motors and other components in devices like electric vehicles.

Weight of EV Battery:

The weight of an EV battery significantly contributes to the overall vehicle weight. Typically, passenger EVs range from 600kg to 2600kg in gross weight, with battery weights varying from 100kg to 550kg. A more powerful battery correlates with a greater weight, as it contains more energy. As vehicle weight increases, more energy is needed to move it. Energy density, measured in Watthours per kilogram (Wh/kg), signifies the amount of energy a battery holds relative to its weight.

Size of EV Battery:

The size of an electric vehicle's battery holds significant importance. Volumetric energy density refers to the amount of energy stored within a specific volume, measured in Wh/litre. Higher volumetric energy density allows for better range without significantly increasing the battery's

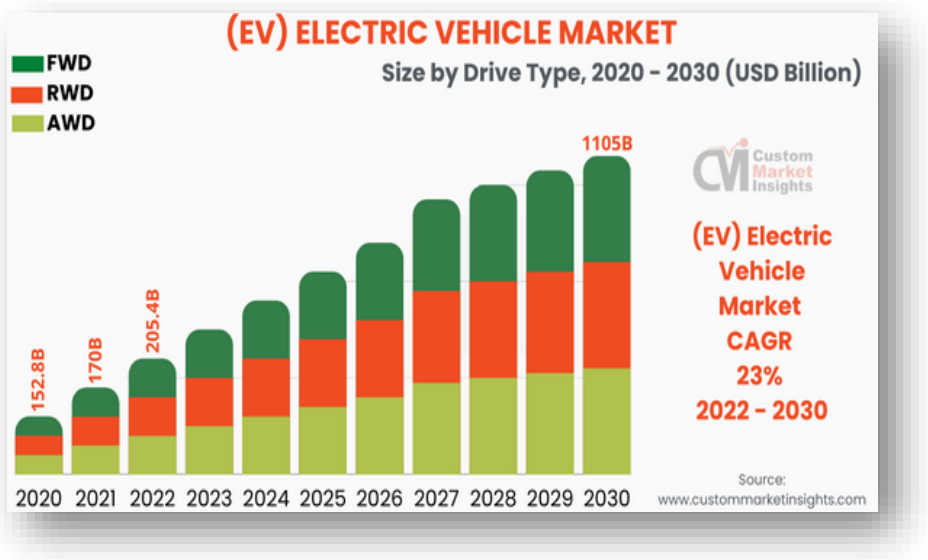
size. This improvement enables savings in space, weight, and manufacturing costs for the vehicle. In essence, batteries with higher volumetric density contribute to building more compact and efficient electric vehicles.

C-Rate:

The C-rating indicates the rate at which a battery can be charged or discharged relative to its capacity. For instance, consider a battery with a capacity of 50 kWh. If it's charged at a 1C rate, it's charged at a rate that fills the battery's full capacity in one hour, so 50 kW. Charging at a higher rate, like 2C, would mean it charges in half the time, i.e., 30 minutes, with a power output of 100 kW. Conversely, a lower rate, say C/2, would mean it takes two hours to charge, with a power output of 25 kW.

Power:

Power in an electric vehicle plays a crucial role in providing acceleration and maintaining speed. While mechanically, power is the result of torque and rpm, in the electrical domain, it's determined by voltage and current. Think of it as the fuel flowing from the tank to the engine in a traditional vehicle. Power is measured in watts (W) or kilowatts (kW), representing the instant power flowing through the electrical circuit.



4. Major Players:

The electric vehicle (EV) market has several major players leading the industry. Here are some of the key companies:

- **BYD**: A Chinese conglomerate, BYD is the largest EV manufacturer, producing over 3 million EVs in 2023.
- **Tesla**: Known for its innovation and market influence, Tesla manufactured around 1.8 million EVs in 2023
- **Volkswagen Group**: This German automaker is also a significant player in the EV market.
- **General Motors** (GM): An American company with a strong presence in the EV sector.
- **Stellantis:** A multinational automotive manufacturing corporation formed from the merger of Fiat Chrysler Automobiles and PSA Group[1].Other notable companies include Toyota, BMW, Hyun

5. Key Trends:

- **Increased Sales and Market Share:** EV sales have been growing significantly. In 2023, nearly one in five cars sold globally was electric, with sales reaching almost 14 million[1]. This represents a 35% increase from the previous year.
- **Geographical Concentration:** The majority of EV sales are concentrated in China, Europe, and the United States, which together account for about 95% of global sales[1]. China alone saw 8.1 million new electric car registrations in 2023**.**

- **Technological Advancements:** There have been continuous improvements in battery technology, leading to longer ranges and faster charging times. Innovations in autonomous driving and connectivity features are also becoming more prevalent**.**
- **Consumer Preferences:** More consumers are considering EVs for their next vehicle purchase. Factors such as sustainability, lower operating costs, and government incentives are driving this shift**.**
- **Policy Support:** Governments worldwide are implementing policies to promote EV adoption, including tax incentives, subsidies, and investments in charging infrastructure.
- **Sustainability and Climate Goals:** The transition to electric mobility is seen as crucial for reducing greenhouse gas emissions and combating climate change. This has led to increased support from both public and private sectors.

As a result of increasing investor appetite and growing EV markets, the valuation of critical mineral companies has increased significantly in the last few years. Over the 2015-2022 period, the market capitalisation of companies involved in the extraction and processing of lithium increased sixfold. The margins for lithium, nickel and copper companies typically outperformed those of the top 100 mining companies over the same period, including relative to gold or iron ore.

However, the picture in 2023 and the first quarter of 2024 is changing. The volatile metal prices seen in the past few years, the increasing competition and pressure to drive down EV and battery prices, and the current overcapacity for several critical minerals (see earlier section on batteries), mean that major mining companies are revisiting growth and performance forecasts.

After several years of important cash flows as a result of high prices and increasing volumes, many companies are now starting to struggle to finance both existing and new projects with their own revenues, suggesting external sources will be needed for large-scale capital expenditure.

In Australia, for example, Albemarle, Core Lithium, Liontown Resources and Pilbara Minerals announced project spending reductions, lower dividends, and job cuts in 2024. Albermarle expects capital expenditures to drop by around USD 500 million from USD 2.1 billion in 2023 to USD 1.6-1.8 billion in 2024, and plans to reduce annual costs by nearly USD 100 million. Pilbara Minerals expects annual exploration spending to be cut by up to AUD 100 million (USD 66 million). Nickel and cobalt projects in Australia have also been delayed or halted, involving companies like BHP, First Quantum Minerals and Wyloo Metals. First Quantum Minerals expects a 30% staff cut as a result of reduced operations. In the United States, Piedmont Lithium Inc. is letting go of 25% of staff. Over the 2024-2026 period, we could see progressive consolidation of critical mineral extraction and refining projects and businesses around lowest-cost producers.

Road transport electrification is reshuffling cards in global markets, as carmakers compete fiercely to capture their share of a growing pie. BYD and Tesla remain far ahead of the curve, together accounting for 35% of all electric car sales in 2023. This is more than all the major carmakers outside China combined (just above 30%), and more than all the other Chinese carmakers (just under 30%). BYD and Tesla's rise as global front-runners has primarily dented the market share of major incumbents, which accounted for 55% of global electric car sales in 2015 but have been falling behind ever since.

In 2022, BYD had already overtaken Tesla as the world's best-selling EV company when accounting for plug-in hybrid cars. In the second half of 2023, BYD also became the world's best-selling battery electric car company. Counting both BEV and PHEV models, BYD's share of global electric car markets was just over 20%. In China, BYD also became the top-selling car company with over 2.4 million new registrations or 11% of the domestic market, ahead of Volkswagen, which had been China's best-selling brand for over 15 years. BYD's worldwide sales exceeded 3 million, making it one of the world's top 10 car sellers.

6. Analysis Through Pest:

➢ Political Factors

- **Government Regulations:** Many governments are implementing strict emissions standards and offering incentives for EV adoption to combat climate change. For example, countries like China and members of the European Union have set ambitious targets for reducing greenhouse gas emissions.
- **Subsidies and Incentives:** Government subsidies and tax incentives for both manufacturers and consumers are crucial in promoting EV adoption. However, the availability and extent of these incentives can vary significantly between countries.

➢ Economic Factors

- **Cost of EVs**: The high initial cost of EVs compared to conventional vehicles is a significant barrier. However, as technology advances and production scales up, the cost is expected to decrease.
- **Fuel Prices:** Fluctuating oil prices can influence the demand for fuel-efficient vehicles, including EVs. Higher fuel prices generally make EVs more attractive to consumers.

➢ Social Factors

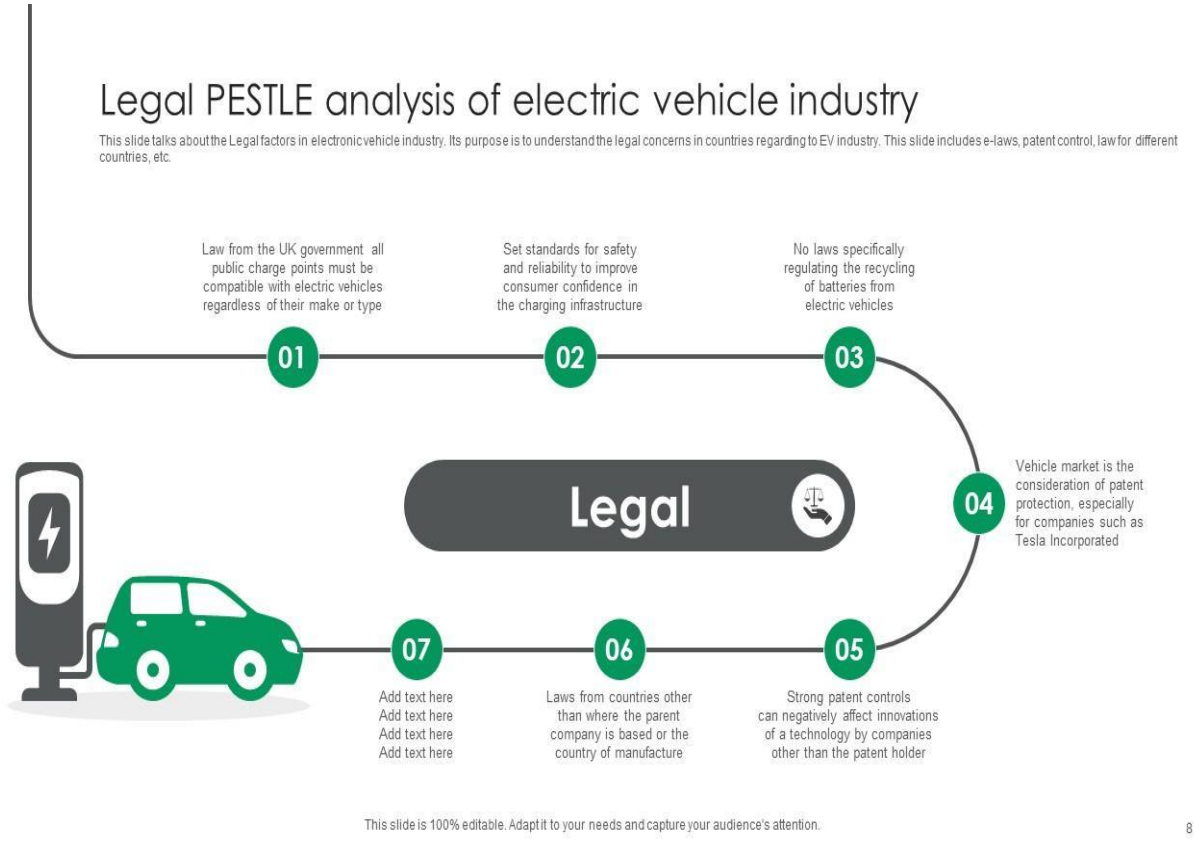
- **Environmental Awareness:** Increasing awareness of environmental issues and the desire to reduce carbon footprints are driving consumer interest in EVs. People are becoming more conscious of the impact of their transportation choices on the environment.
- **Changing Preferences:** There is a growing preference for sustainable and eco-friendly products, which is boosting the demand for EVs.

➢ Technological Factors

- **Advancements in Battery Technology**: Improvements in battery technology are crucial for the EV industry. Better batteries mean longer ranges and shorter charging times, making EVs more practical for everyday use[2].

- **Charging Infrastructure:** The development of widespread and efficient charging infrastructure is essential for the growth of the EV market[2]. Governments and private companies are investing heavily in expanding charging networks.

P	E	S	T
Political	Economic	Social	Technological
• Government incentives of up to US$10,000 for private purchase of new battery electric vehicles or plug-in hybrids • Government goal to raise the annual production capacity to 2,500,000 plug-in hybrid by the end of 2020 • Road Space Rationing scheme (New energy vehicles are exempted) • Vehicle quota system that inhibits the purchasing of new conventional autos	• Increasing inflation rate • Increasing labor cost • The city's economic outlook is healthy according to the key economic indicators • Stable foreign currency exchange rate • September is the traditional peak season of automobile • Rapidly increasing lithium-ion battery price	• Younger consumers are open to new technologies • 75% of citizens need to travel an average of up to 35 km on weekdays • Consumers prefer a lower maintenance cost • Environmental protection is a key consideration to most consumers • Most consumers found the government subsidies very attractive • To recharge vehicles at home or workspace is impractical to most people due to the residential design • Most drivers regard new energy vehicle technology as unsafe and immature • Serious traffic jam de-motivates people's desired to buy new vehicles	• Comparing to internal combustion engines, electric vehicles are more environmental friendly • Slow charging • Battery range is a concern • Lack charging stations



7. Innovations:

The electric vehicle (EV) industry is witnessing rapid innovation, driven by advancements in technology aimed at enhancing efficiency, convenience, and sustainability. According to BIS Research, in 2023, the electric vehicle battery formation and testing market in Europe, excluding the U.K. was valued at $227.6 million. It is anticipated to expand at a CAGR of 16.76%, reaching $917.7 million by 2032.

- **Cargo-Carrying E-Tricycles:**

Cargo-carrying electric tricycles provide an efficient, eco-friendly solution for urban logistics. Able to transport up to 500 kg, they navigate congested city streets with ease. These e-tricycles are ideal for last-mile deliveries, reducing traffic congestion and emissions compared to traditional vans. With features like pedal assist and electric drive, they offer a sustainable alternative for businesses needing effective goods transport.

- **Smaller EV Chargers:**

Smaller EV chargers boost convenience by fitting into urban spaces like residential areas, parking lots, and street furniture. This innovation expands charging accessibility, addressing a key barrier to EV adoption.

Explore the Electric Vehicle (EV) battery market and related technologies, where advancements like VUI technology enhance user experience, safety, and vehicle efficiency.

- **Voice-User-Interface Technology:**

Voice-user-interface (VUI) technology is becoming increasingly prevalent in electric vehicles, allowing drivers to interact with their vehicle using natural language. This innovation enhances safety by enabling hands-free control of navigation, climate settings, and entertainment systems. VUI technology can also provide real-time information about battery status, charging locations, and vehicle diagnostics.

- **Ultra-Fast Charging Technology:**

Ultra-fast charging technology significantly reduces the time required to charge electric vehicles, making EV ownership more convenient. These chargers can deliver power levels exceeding 350 kW, enabling drivers to charge their vehicles to 80% in as little as 15-30 minutes. The expansion of ultra-fast charging networks is vital for the widespread acceptance of EVs as a practical alternative to traditional gasoline-powered cars.

- **Battery Swapping Technology:**

Battery swapping technology offers a novel solution to the challenges of EV charging. Instead of waiting for their vehicle to charge, drivers can exchange their depleted battery for a fully charged one at designated swapping stations. This process can take as little as three minutes, significantly reducing downtime for EV users. Battery swapping is particularly advantageous for commercial fleets and ride-hailing services, where minimizing vehicle downtime is critical.

- **Autonomous Driving:**

Autonomous driving technology is transforming the automotive industry, including electric vehicles (EVs). By using advanced sensors, machine learning, and AI, EVs can operate independently, enhancing road safety, reducing congestion, and optimizing energy use. Autonomous EVs can improve fuel efficiency and manage regenerative braking, and as regulations develop, they may significantly reshape urban mobility.

- **Wireless Charging:**

Wireless charging technology eliminates the need for physical connectors, allowing electric vehicles to charge simply by parking over a charging pad. Wireless charging systems can be installed in parking lots, homes, and even roadways, enabling dynamic charging while driving. As this technology matures, it could significantly improve the practicality of electric vehicle ownership.

- **Bidirectional EV Charging:**

Bidirectional EV charging technology allows electric vehicles to not only draw power from the grid but also return energy back to it. This capability enables EVs to act as mobile energy storage units, providing power to homes during outages or feeding energy back into the grid during peak demand periods. Bidirectional charging can help stabilize the grid and promote renewable energy usage, making it a valuable innovation for both consumers and energy providers.

- **Dynamic Wireless Power Transfer (DWPT) Technology:**

Dynamic Wireless Power Transfer (DWPT) technology enables electric vehicles to charge while in motion, using embedded charging infrastructure in roadways. This innovation could revolutionize public transportation and long-haul trucking by eliminating the need for frequent

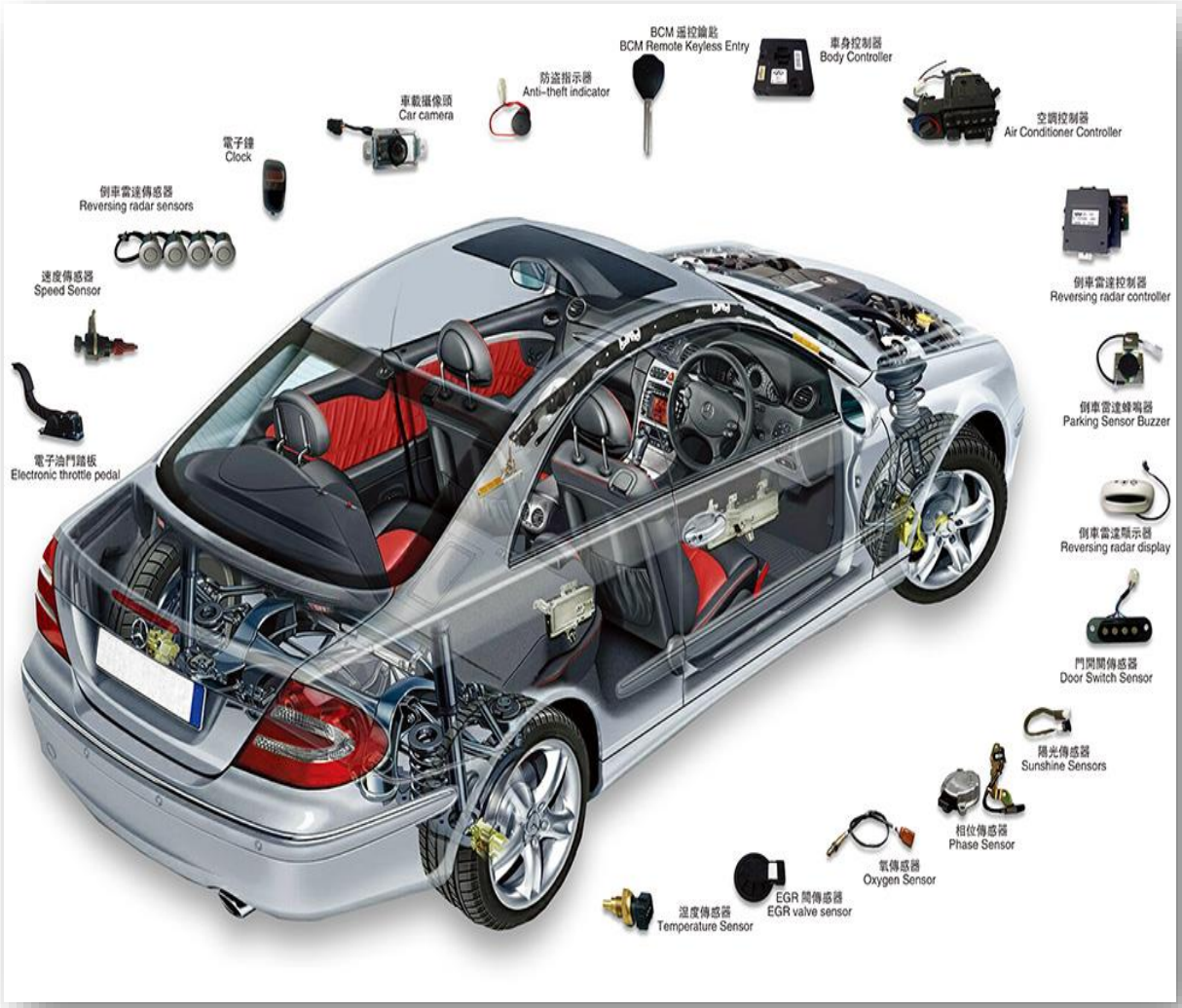
stops to recharge. DWPT systems can provide continuous power to vehicles, extending their range and reducing the overall energy consumption of the transportation system.

- **Air Taxi:**

Air taxis represent the next frontier in urban transportation, leveraging electric vertical take off and landing (eVTOL) technology to provide on-demand aerial mobility. These electric aircraft can reduce travel time significantly in congested urban areas, offering a sustainable alternative to traditional ground transportation. Air taxis are being developed to operate in urban air mobility networks, providing efficient and eco-friendly transportation solutions.

8. Products:

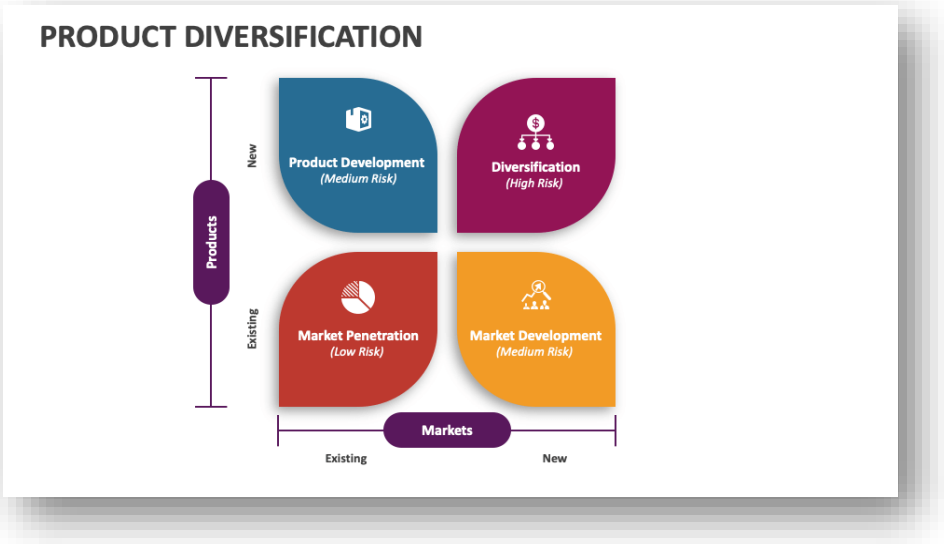
- **Wiring and Cables**: Essential for connecting different electrical components in a vehicle.
- **Battery Cables and Terminals**: Used for connecting the battery to the vehicle's electrical system.
- **Fuse Holders and Fuses**: Protect electrical circuits from overcurrent.
- **Relays and Solenoids**: Control high-power circuits with low-power signals.
- **Switches**: Used for controlling various electrical functions like lights, wipers etc.
- **Connectors and Terminals**: Ensure secure and reliable electrical connections.
- **Lighting**: Includes headlights, taillights, interior lights, and more.
- **Ignition Components**: Such as spark plugs, ignition coils, and distributors.



9. Product Diversification:

- **Expanding Vehicle Types**: Companies are not just focusing on electric cars but also on electric trucks, buses, motorcycles, and even bicycles. This helps cater to a broader market.
- **Battery Technology**: Innovations in battery technology, such as solid-state batteries, are crucial. These batteries offer higher energy density, faster charging times, and longer lifespans.
- **Autonomous Driving**: Integrating autonomous driving features can differentiate products. This includes advanced driver-assistance systems (ADAS) and fully autonomous driving capabilities.

- **Connectivity and Smart Features:** Offering vehicles with advanced connectivity features, such as over-the-air updates, smart navigation, and integration with smart home devices, can attract tech-savvy consumers.
- **Sustainability:** Emphasizing the use of sustainable materials and manufacturing processes can appeal to environmentally conscious consumers.
- **Affordable Models:** Developing more affordable EV models can help capture a larger market share, especially in developing countries.
- **Commercial and Fleet Vehicles:** Targeting commercial fleets with electric vans and trucks can be a lucrative market, especially as companies look to reduce their carbon footprints.
- **Energy Solutions:** Offering complementary products like home charging stations, solar panels, and energy storage solutions can create a comprehensive ecosystem for consumers



10. Geographical Coverage:

1. **Global Trends:** As of 2023, around 1 in 4 new cars sold globally were electric. Norway leads with over 90% of new car sales being electric, followed by China at nearly 40%.

2. **Regional Highlights:**

    - Europe: Countries like Norway, Germany, and the United Kingdom have extensive EV adoption, supported by strong government policies and incentives.
    - Asia: China is a major player, with substantial investments in EV infrastructure and manufacturing.
    - North America: The United States and Canada are also seeing increased EV adoption, particularly in states and provinces with supportive policies.

3. **Infrastructure:** The availability of charging stations is crucial for EV adoption. Leading regions have developed extensive networks of public and private charging stations to support the growing number of EVs

    Electric vehicles (EVs) are gaining traction globally, with significant adoption in several key regions:

    - **China:** Leading the charge, China accounted for nearly 60% of new electric car registrations in 2023. The country registered 8.1 million new electric cars in 2023 alone.
    - **Europe:** Europe follows closely, with around 25% of global EV sales. Countries like Norway, Iceland, and Sweden are at the forefront, with Norway having over 90% of new car sales being electric.
    - **United States:** The U.S. saw about 10% of global EV sales in 2023. The market is growing steadily, with increasing support for EV infrastructure and incentives.
    - **Other Regions:** While the adoption rate is slower in other parts of the world, countries like Japan and India are gradually increasing their EV presence.

    Overall, the global EV market is expanding rapidly, with nearly one in five cars sold in 2023 being electric. This trend is expected to continue as more countries implement policies to support EV adoption and infrastructure development.

11. Key Competitors:

The electric vehicle (EV) market is highly competitive, with several key players vying for dominance. Here are some of the major competitors:

- **Tesla:** Known for its innovative technology and strong brand recognition, Tesla remains a leader in the EV market.

- **Ford:** With models like the Mustang Mach-E, Ford is making significant strides in the EV space.
- **General Motors (GM):** GM has committed to an all-electric future with its Chevrolet Bolt and upcoming models.
- **Nio:** A Chinese EV manufacturer, Nio is gaining traction with its premium electric SUVs.
- **Rivian:** Focused on electric trucks and SUVs, Rivian is another strong contender.
- **Lucid Motors:** Known for its luxury electric sedans, Lucid Motors is targeting the high-end market.
- **Volkswagen:** With its ID series, Volkswagen is expanding its EV lineup.
- **BMW:** BMW continues to innovate with its i series of electric vehicles.

These companies are pushing the boundaries of electric vehicle technology and offering consumers a variety of options. Are you interested in any specific EV brand or model.

12. Analysis Through Porter's Five Force Model:

Porter's Five Forces model is a strategic tool used to analyze the competitive environment of an industry. Here's how it applies to the electric vehicle (EV) industry:

1. **Threat of New Entrants:**
    - Barriers to Entry: High due to significant capital investment required for research, development, and manufacturing. However, government incentives for EV production can lower these barriers.
    - New Players: Established automakers and startups are entering the EV market, increasing competition.
2. **Bargaining Power of Suppliers:**
    - Key Components: EV manufacturers rely heavily on specific components like batteries and electric drivetrains. Suppliers of these components, such as battery manufacturers, hold significant power.

- Strategic Partnerships: Companies like Tesla have formed strategic partnerships with suppliers (e.g., Panasonic) to secure a steady supply of high-quality batteries.

3. **Bargaining Power of Buyers:**

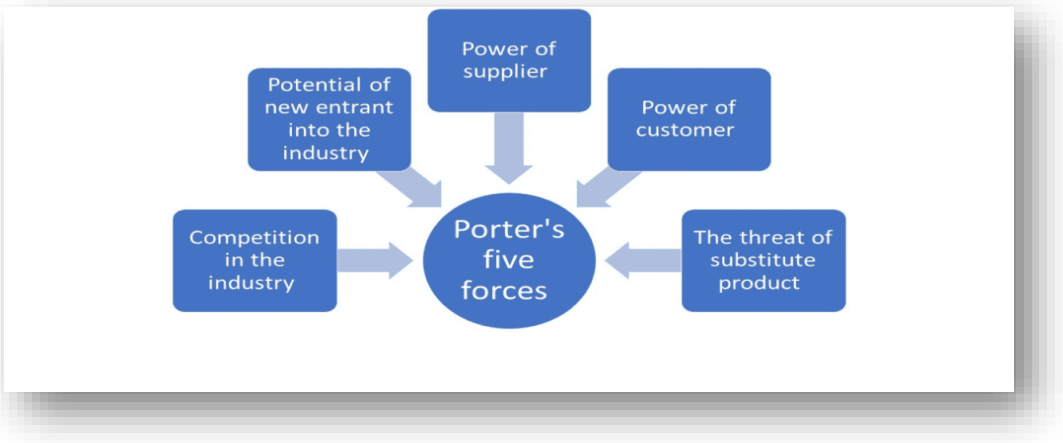
   - Consumer Choices: With more EV options available, consumers have greater bargaining power. They can choose based on price, features, and brand reputation.
   - Direct Sales Models: Some companies, like Tesla, use direct-to-consumer sales models, which can empower buyers by eliminating dealer markups[2].

4. **Threat of Substitutes:**

   - Alternative Technologies: Traditional internal combustion engine vehicles and emerging technologies like hydrogen fuel cells pose a threat to EVs.
   - Consumer Preferences: Shifts in consumer preferences towards sustainable and eco-friendly options can mitigate this threat[2].

5. **Competitive Rivalry:**

   - Market Players: The EV market is highly competitive with major players like Tesla, Nissan, and new entrants from traditional automakers.
   - Innovation and Differentiation: Companies compete on innovation, technology, and brand differentiation to capture market share.



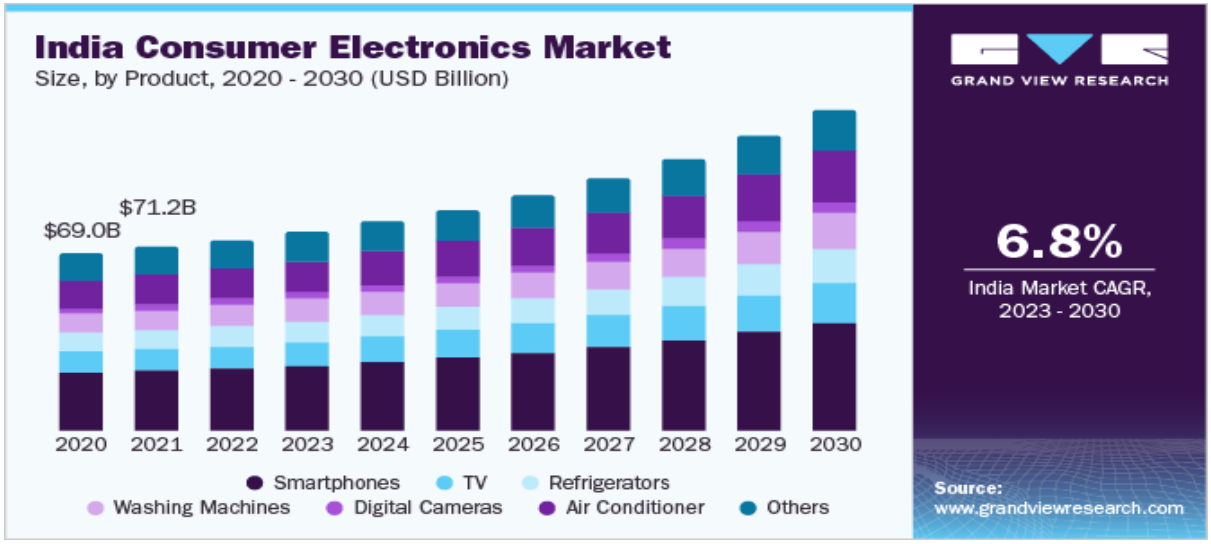
CHAPTER 3

FUNCTIONAL ANALSIS OF MARKET AND FINANCE

1. Marketing:

1. Market Size:

India consumer electronics market size was valued at USD 73.73 billion in 2022 and is expected to grow at a compound annual growth rate (CAGR) of 6.8% from 2023 to 2030. India provides a worldwide opportunity for short to medium-term growth in consumer electronics spending. Minimal penetration rates, as against other upcoming markets, portray a better prospect to sell to first-time buying households, along with replacement devices to the middle class.



Due to the COVID-19 pandemic, the demand for consumer electronics has been significantly impacted. Manufacturing plant shutdown and supply chain disruptions resulted in substantial component shortages. Increased counterfeiting, shipping delays, customer behaviour and environmental concerns had a significant impact on the market growth. Due to the pandemic, manufacturers of consumer electronics have witnessed component shipment delays of at least five weeks from suppliers.

Growth in the Indian market for consumer electronics can be attributed to an increase in demand from households, changing lifestyles of individuals, easier access to credit, and rising disposable incomes. Intentional reduction by the Government in the import bill, coupled with

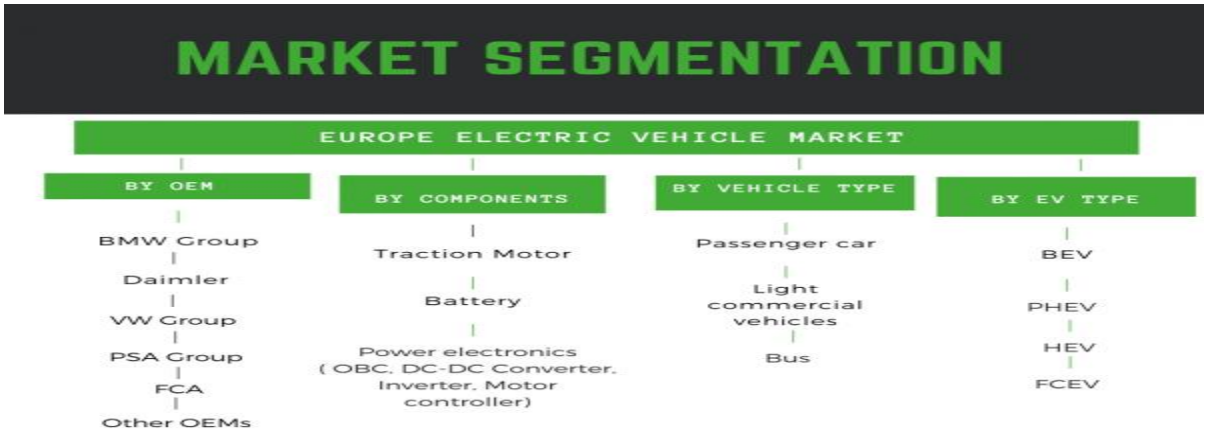
government and corporate spending, is anticipated to complement the positive demand in this market. The India consumer electronics sector has attracted several strong investments in the form of merger & acquisition policies practiced by key participants of the global market and other FDI inflows.

- Competitive benchmarking
- Historical data & forecasts
- Regional opportunities

2. Market Segmentation:

The electric vehicle (EV) market is segmented based on several factors to better understand consumer needs and market trends1. Here are some key segments:

- Vehicle Type: This includes passenger cars, commercial vehicles, two-wheelers (scooters and motorcycles), and three-wheelers2.
- Propulsion Type: EVs can be categorized by their propulsion systems, such as batter electric vehicles (BEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs)3.
- Charging Type: This segment includes slow charging (Level 1 and Level 2) and fast charging (DC fast charging)3.
- Battery Capacity: EVs are also segmented by their battery capacity, which affects their range and performance1.
- Price Range: The market is divided into different price ranges to cater to various consumer segments, from budget-friendly to luxury models1.
- Geographic Region: The EV market is analysed by regions such as North America, Europe, Asia-Pacific, and others to understand regional areas.



3. Target Market and Niche:

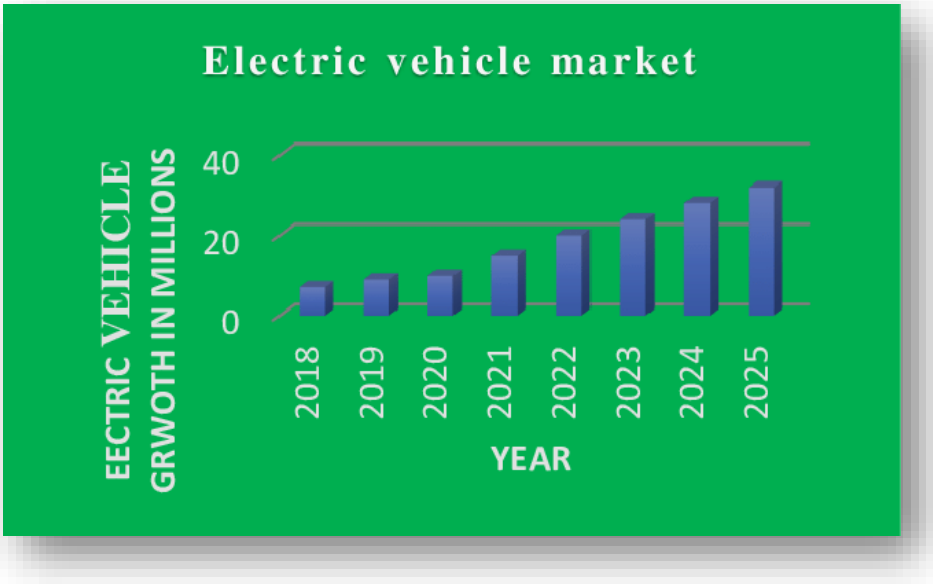
When it comes to electric vehicles (EVs), identifying the target market and niche segments is crucial for manufacturers and marketers. Here's a breakdown:

1. **Target Market for Electric Vehicles**
   - Environmentally Conscious Consumers: Individuals who prioritize sustainability and reducing their carbon footprint.
   - Tech-Savvy Individuals: Those who are early adopters of new technology and appreciate the latest innovations.
   - Urban Dwellers: People living in cities where EV infrastructure, like charging stations, is more readily available.
   - Cost-Conscious Consumers: Those looking to save on fuel and maintenance costs in the long run.
   - Fleet Operators: Companies and organizations that operate vehicle fleets and are looking to reduce operational costs and environmental impact.
2. **Niche Segments for Electric Vehicles**
   - Luxury EVs: High-end electric vehicles that offer premium features and performance.
   - Micro-Mobility EVs: Small electric vehicles like scooters and compact cars designed for short-distance travel.
   - Commercial EVs: Electric trucks, vans, and buses used for commercial purposes. Performance EVs: High-performance electric sports cars and super car
   - Road EVs: Electric vehicles designed for off-road

4. **Market Growth:**

The electric vehicle (EV) market is on a remarkable growth trajectory1! Here are some key highlights:

- Global Market Size: The global EV market was valued at $163.01 billion in 2020 and is projected to reach $823.75 billion by 2030, with a CAGR of 18.2% from 2021 to 2030.
- Revenue Projections: In 2024, the market is expected to reach around $786.2 billion, growing to $1,084 billion by 2029, with a CAGR of 6.63%.
- Regional Growth: Different regions are experiencing varying growth rates. For instance, in the U.S., EV sales accounted for nearly one in 10 new light-duty vehicle sales in Q2 2024, up from 9.05% in Q2 2023.
- Two-Wheeler Segment: The electric two-wheeler market has seen a 40.45% year-on-year sales growth, with total sales reaching 90,007 units recently.



5. **Marketing Strategies:**

Marketing electric vehicles (EVs) requires a strategic approach to address unique challenges and leverage opportunities. Here are some effective strategies**:**

- **Targeting Valuable Markets**

Focusing on regions with strong government support and high customer awareness, such as China, Europe, and North America, is essential1. These markets offer significant opportunities due to subsidies, incentives, and a growing customer base interested in sustainable travel1.

- **Emphasizing Environmental Benefits**

Highlighting the environmental advantages of EVs, such as zero tailpipe emissions and reduced carbon footprint, can appeal to eco-conscious consumers2. Marketing campaigns should emphasize the positive impact of EVs on the environment and public health.

- **Addressing Range Anxiety**

Educating consumers about the advancements in battery technology and the expanding charging infrastructure can help alleviate concerns about range anxiety2. Providing information on the availability of fast-charging stations and the increasing range of EVs can boost consumer confidence.

- **Leveraging Digital Marketing**

Utilizing digital marketing tools, such as search engine optimization (SEO), pay-per-click (PPC) advertising, and social media campaigns, can increase visibility and engagement3. Creating engaging content that resonates with the target audience and highlights the benefits of EVs is crucial.

- **Offering Incentives and Promotions**

Providing incentives, such as discounts, rebates, and financing options, can make EVs more affordable and attractive to potential buyers2. Collaborating with governments and utility companies to offer special deals and promotions can further drive sales.

- **Showcasing Technological Innovations**

Highlighting the latest technological advancements in EVs, such as autonomous driving features, connectivity, and smart charging solutions, can attract tech-savvy consumers. Demonstrating how these innovations enhance the driving experience can differentiate EVs from traditional vehicles.

- **Building Brand Loyalty**

Creating a strong brand identity and fostering customer loyalty through excellent customer service, warranties, and after-sales support can help retain customers and encourage word-of-mouth referrals. Engaging with customers through loyalty programs and exclusive events can strengthen the brand's reputation.

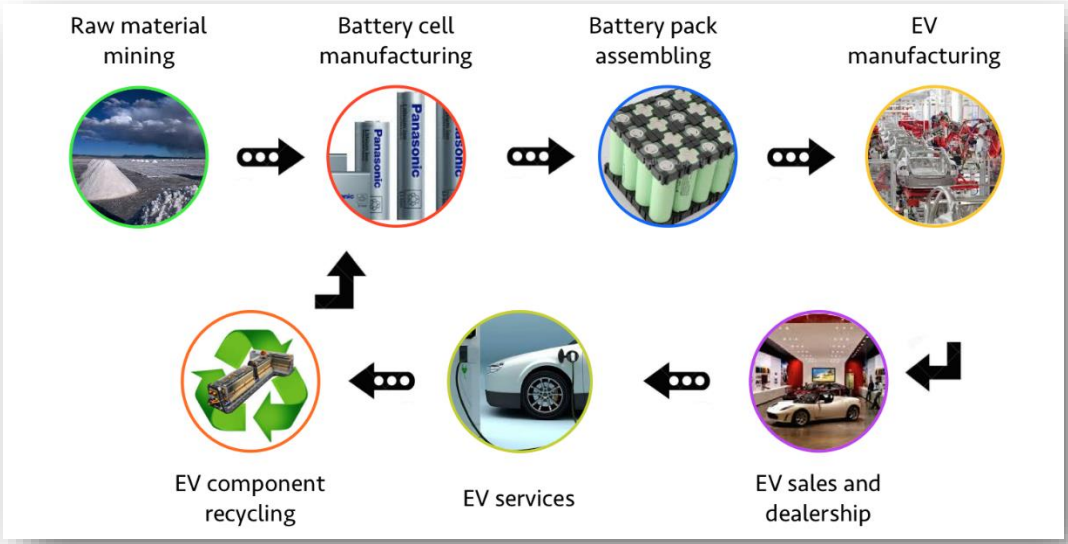
- **Collaborating with Influencers and Partners**

Partnering with influencers, environmental organizations, and other stakeholders can amplify the reach of marketing campaigns. Collaborations with celebrities, industry experts, and sustainability advocates can help build credibility and attract a wider audience .

6. Supply Chain:

The supply chain for electric vehicles (EVs) is quite complex and involves multiple stages1. Here's a breakdown:

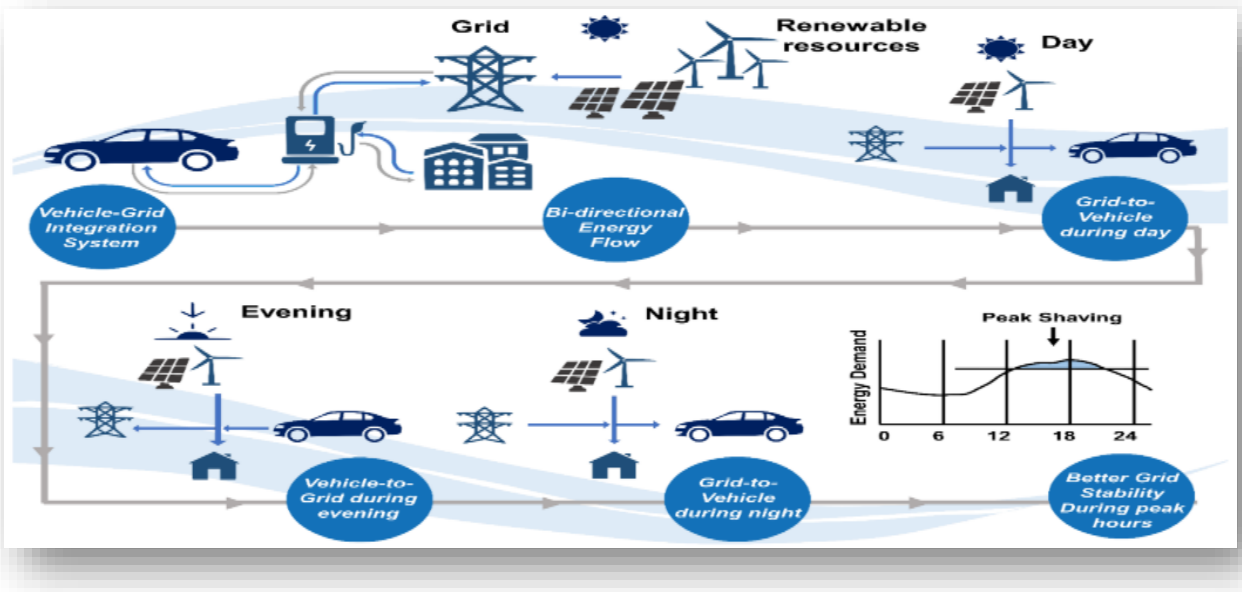
- Raw Material Sourcing: This includes mining and refining critical minerals like lithium, cobalt, nickel, and manganese, which are essential for EV batteries.
- Battery Manufacturing: The production of batteries is a crucial step, as they account for 30-40% of the vehicle's value. This involves assembling cells into battery packs.
- Component Manufacturing: Other key components like electric motors, power electronics, and wiring systems are produced.
- Vehicle Assembly: The assembly of the vehicle itself, integrating the battery pack and other components.
- Distribution and Sales: Finished EVs are distributed to dealerships and sold to consumers.
- End-of-Life Management: This includes recycling and repurposing of batteries and other components at the end of the vehicle's life.



7. Distribution Channel:

The distribution channels for the electric vehicle (EV) industry are diverse and evolving to meet the growing demand. Here are some key channels:

- Direct Sales: Some EV manufacturers sell directly to consumers through their own showrooms or online platforms, bypassing traditional dealerships.
- Dealerships: Traditional car dealerships are also selling EVs, often alongside internal combustion engine vehicles.
- Online Platforms: Many EV manufacturers and third-party platforms offer online sales, providing convenience and a wider reach.
- Fleet Sales: Companies that operate vehicle fleets, such as delivery services and rental companies, purchase EVs in bulk.
- Government and Institutional Sales: Governments, municipalities, and other institutions may purchase EVs for public transportation, government fleets, and other official uses.
- Aftermarket Services: This includes maintenance, repairs, and upgrades for EVs, often provided by specialized service centers.



2. **Finance:**

    1. **Financial Performance Comparison with Other Industries:**

    The financial performance of the electric vehicle (EV) industry has been quite impressive, especially when compared to traditional automotive industries. Here are some key points.

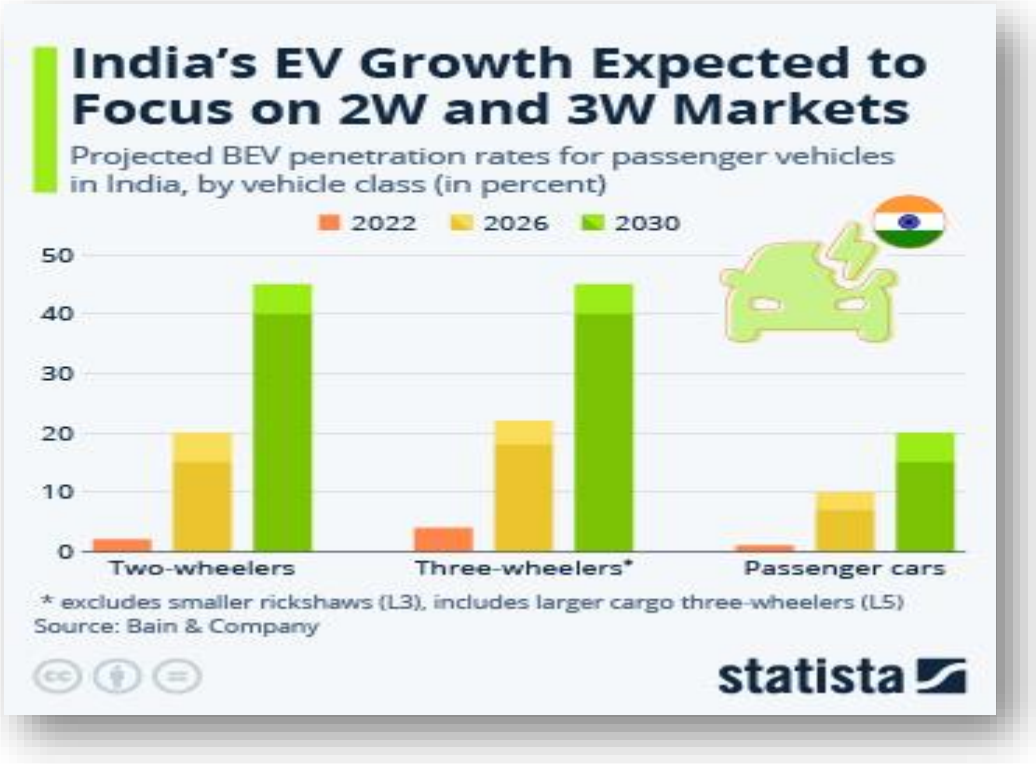
    - Revenue Growth: EV-related companies have shown significant revenue growth1. For example, Tesla, a leading EV manufacturer, has seen substantial increases in revenue over the years.
    - Market Capitalization: Stocks of EV-related companies have outperformed incumbent automakers since 20193. This indicates strong investor confidence in the EV sector.
    - Profitability: While EV companies often have higher revenue growth, their profitability margins can be lower compared to traditional automakers2. This is due to high initial R&D and production costs.
    - Investment and Capital: EV-related companies have had easier access to capital, allowing them to invest more in innovation and expansion.

    2. **Revenue:**

    The electric vehicle (EV) market in India is experiencing rapid growth1. Here are some key points about its revenue:

    - Market Value: The Indian EV market is projected to generate over $100 billion in revenue by 2030.
    - Current Revenue: As of recent reports, the market is valued at $163.01 billion and is expected to reach $823.75 billion by 2030.
    - Two-Wheeler Segment: This segment is particularly strong, with electric two-wheelers accounting for a significant portion of the market

The India electric vehicle (EV) market size was valued at USD 8.03 billion in 2023. The market is projected to grow from USD 23.38 billion in 2024 to USD 117.78 billion by 2032, exhibiting a CAGR of 22.4% during the forecast period.



3. ROI:

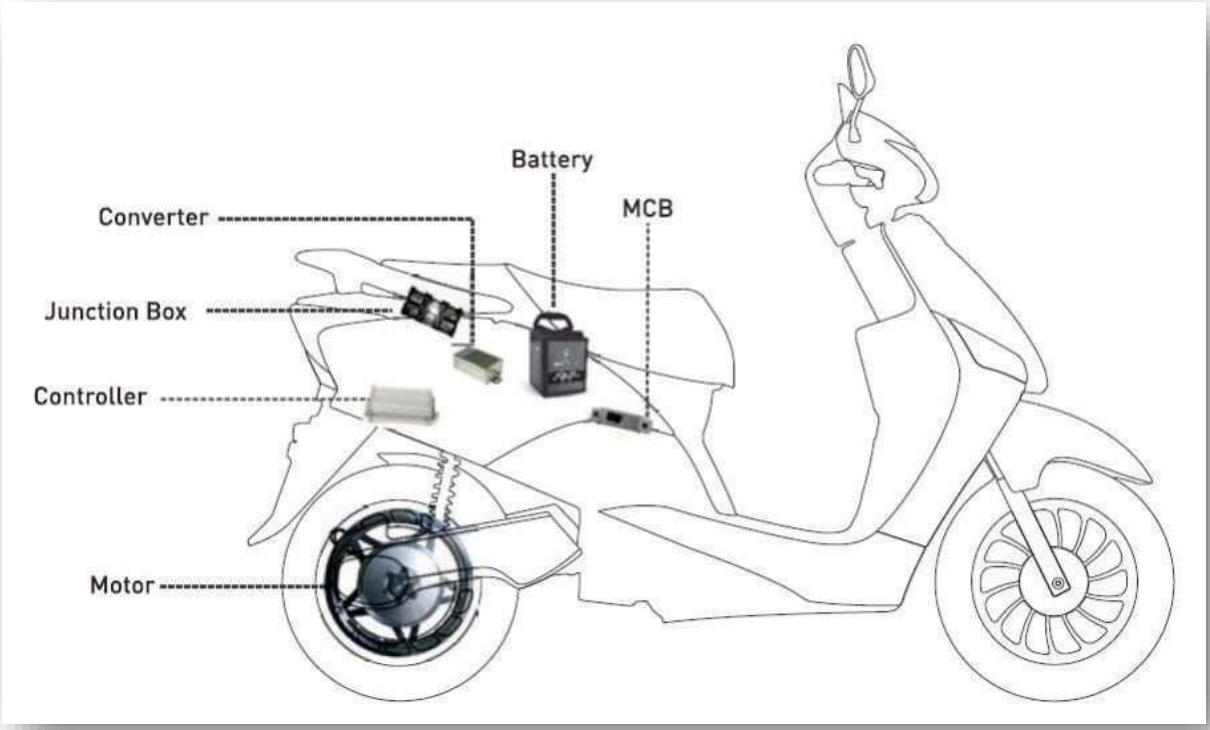
The return on investment (ROI) in India's electric vehicle (EV) industry is promising, driven by rapid market growth and supportive government policies1. Here are some key points:

- Market Growth: The Indian EV market is projected to generate over $100 billion in revenue by 2030.
- CAGR: The domestic EV market is expected to grow at a 49% compound annual growth rate (CAGR) between 2022 and 2030.
- Investment Opportunities: With initiatives like the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme, India aims to significantly increase EV adoption.

4. Indexing:

There are several indices that track the performance of companies in the electric vehicle (EV) industry. Here are a few notable ones:

- S&P Kensho Electric Vehicles Index: This index measures the performance of companies involved in the EV sector and the ecosystems supporting it, including electric road vehicles, powertrains, energy storage systems, and charging infrastructur.
- Nifty EV & New Age Automotive Index: Launched by the National Stock Exchange (NSE) in India, this index tracks companies involved in the EV ecosystem, including electric cars, scooters, batteries, and charging stations.
- McKinsey Electric Vehicle Index: This proprietary index assesses trends in the EV industry across 15 major markets, providing a year-on-year analysis of sales, competitive landscape, and policy implications.



3. **Human Resources:**

1. **Employee size**

The electric vehicle (EV) industry is rapidly growing, and with it, the number of jobs in this s ector is also increasing1. Here are some insights:

- **Global Employment**: Tesla, one of the leading EV manufacturers, employed nearly
    - 40,500 people worldwide as of 2023.
- **India's EV Job Market**: India's ambition to become a top player in the EV market is expected to create 5 million new direct job opportunities by 20301. Between 2020 and 2022, EV jobs saw a 110% compound annual growth rate (CAGR).

The growth in employment is driven by the expansion of manufacturing, R&D, and support roles in the EV ecosystem. Cities like Bengaluru are becoming vital centers for the sectors.

2. **HR Policy**

Human Resources (HR) policies in the electric vehicle (EV) industry are evolving to address the unique challenges and opportunities of this dynamic sector. Here are some key aspects of HR policies in the EV industry:

- Talent Acquisition and Development: The EV industry requires a workforce with specialized skills in areas such as battery technology, electric drivetrains, and software development. HR policies focus on attracting and retaining talent with expertise in these areas through competitive compensation packages, professional development opportunities, and continuous learning programs.
- Diversity and Inclusion: Promoting diversity and inclusion is a priority in the EV industry. HR policies aim to create a diverse workforce by implementing inclusive hiring practices, offering mentorship programs, and fostering a culture of equality and respect.
- Workforce Training and Upskilling: As technology advances, continuous upskilling and training are essential. HR policies include programs for reskilling employees to keep pace with technological innovations, ensuring that the workforce remains competitive and adaptable.

- Employee Well-being: Employee well-being is a critical component of HR policies in the EV industry. Companies invest in health and wellness programs, flexible work arrangements, and mental health support to ensure a healthy and productive workforce.
- Sustainability and Corporate Social Responsibility: HR policies in the EV industry often emphasize sustainability and corporate social responsibility. This includes initiatives to reduce the environmental impact of operations, promote sustainable practices, and engage employees in community and environmental projects.
- Performance Management: Effective performance management systems are in place to evaluate and reward employee performance. HR policies focus on setting clear goals, providing regular feedback, and recognizing achievements to motivate and retain top talent.
- Workforce Planning: Strategic workforce planning is essential to meet the growing demands of the EV industry. HR policies include forecasting future workforce needs, identifying skill gaps, and developing plans to address these challenges through recruitment and training.

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Human Resources (HR) practices in the electric vehicle (EV) industry are evolving to meet the unique demands of this rapidly growing sector. Here are some key HR practices:

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4. Competency Skill Required for The Job:

The electric vehicle (EV) industry requires a diverse set of skills due to its technical and innovative nature. Here are some key competencies and skills needed for various roles in the EV industry:

- Electrical Engineering: Understanding of electrical systems, power electronics, and battery technology.
- Software Development: Skills in embedded systems, firmware, and software for vehicle control and diagnostics.
- Mechanical Engineering: Knowledge of vehicle design, aerodynamics, and mechanical systems.
- Battery Technology: Expertise in battery chemistry, management systems, and energy storage solutions.
- Data Analysis: Ability to analyse and interpret data from vehicle sensors and systems for performance optimization.
- Project Management: Skills in managing projects, timelines, and resources effectively.
- Regulatory Compliance: Understanding of industry standards, safety regulations, and compliance requirements.

- Sustainability Practices: Knowledge of sustainable practices and environmental impact reduction.
- Customer Service: Skills in providing excellent customer support and after-sales service.
- Multidisciplinary Collaboration: Ability to work across different disciplines and collaborate with various teams.

5. Job Opportunities:

The electric vehicle (EV) industry offers a wide range of job opportunities across various role and disciplines. Here are some key positions and their responsibilities**:**

- EV Design Engineer: Responsible for designing key components of electric vehicles, such as the body frame and electric drivetrain.
- Battery Engineer: Focuses on developing and improving battery technology, including energy storage solutions and battery management systems.
- Power Electronics Engineer: Works on designing and developing power electronic systems for EVs, ensuring efficient energy conversion and management.
- Software Developer: Develops software for vehicle control, diagnostics, and connectivity.
- Mechanical Engineer: Involves in designing and testing mechanical systems and components of EVs.
- Quality Assurance Engineer: Ensures that EVs meet quality standards and regulatory requirements through rigorous testing and evaluation.
- Sales and Marketing Specialist: Focuses on promoting and selling EVs, educating customers about the benefits and features of electric vehicles.
- Customer Service Representative: Provides support and assistance to EV owners, addressing their queries and concerns.
- Supply Chain Manager: Manages the supply chain for EV components, ensuring timely delivery and cost-effective procurement.
- Research and Development Specialist: Works on innovative projects to advance EV technology and improve vehicle performance.

Job opportunities in Electric Vehicle Industry

India is expected to switch about 25% of the transportation (cars, motorcycles, other two-wheelers, three-wheelers, buses, trucks) to electric vehicles by 2030.

The Indian Labor Organization report stated that the Renewable Energy industry's job opportunities would rise to 38 lacs by 2030.

1 Research & Development

Challenges: Battery type/design, Battery Management System improvement, Recharging technology

Qualifications: Masters or Bachelors engineer in Chemical, Electronics & Electrical sector

2 Design & Development

Challenges: Battery design, Electronic circuits, softwares & Applications for consumers, Durable & lightweight vehicle body design

Qualifications: Masters or Bachelors engineer in Mechanical, Software, Electronics & Electrical sector

3 EV Manufacturing

Challenges: Machines or robots for manufacturing plant, Quality testing, Human resources, plastic molding etc.

Qualifications: Bachelors/ITI/Diploma degree in Electronics, Mechanical, Electrical sector & MBA in HR

4 Maintenance

Challenges: After sales services includes Battery problems, Motor issues, Digital display or compatibility issues with app/software

Qualifications: Engineers for testing & supervision, Diploma/ITI for fitting & repairing

5 Infrastructure Development

Challenges: Charging station, High power electric wiring, Renewable energy generation (solar, wind etc.)

Qualifications: Masters or Bachelors engineer in Civil, Electrical, Electronics & Architect

CHAPTER 4

REGULATORY ENVIRONMENT

1. **Government Regulation:**
   1. **Government Policies and Incentives for Electric Vehicles in India**
      - FAME-II The FAME India initiative was launched on April 1, 2015, by the Indian government to reduce the usage of petrol and diesel automobiles.
      - PLI SCHEME In June 2021, The Department of Heavy Industry launched the Production Linked Incentive for Advanced Chemistry Cell Battery Storage (PLI-ACC Scheme).
      - Battery Swapping Policy.
      - Duty Reduction on Electric Vehicles.
      - Special E-mobility Zone.

   2. The Indian government has implemented several regulations and policies to promote the adoption of electric vehicles (EVs) and support the growth of the EV industry. Here are some key initiatives:
      - FAME India Scheme: The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme aims to reduce dependency on fossil fuels and address vehicular emissions. The scheme provides subsidies for electric buses, three-wheelers, four-wheelers, and two-wheelers.
      - Production Linked Incentive (PLI) Scheme: This scheme aims to boost domestic manufacturing of EVs and their components, including batteries.
      - GST Reduction: The government has reduced the Goods and Services Tax (GST) on lithium-ion batteries from 28% to 12% to make EVs more affordable.
      - Income Tax Deduction: Buyers of electric vehicles are eligible for income tax deductions under Section 80EEB of the Income Tax Act.
      - Green License Plates: EVs are issued green license plates to distinguish them from conventional vehicles.
      - Charging Infrastructure: The government has issued guidelines for the development of EV charging infrastructure, including the installation of public charging stations.

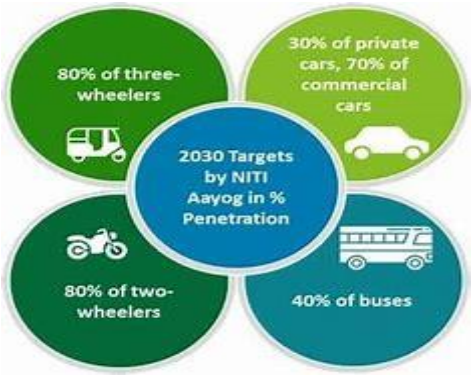
- State Policies: Various state governments have also introduced their own policies to promote EV adoption, such as subsidies, tax exemptions, and support for charging infrastructure.

These policies are part of India's broader goal to achieve net-zero emissions by 2070 and to have 30% of private cars, 70% of commercial cars, 40% of buses, and 80% of two and three-wheelers be electric by 2030.

2. Environment Regulation:

India has implemented several environmental regulations to support the growth of the electric vehicle (EV) industry while ensuring sustainability. Here are some key regulations and laws:

- Battery Waste Management Rules (BWMR): These rules aim to manage the disposal and recycling of batteries, especially lithium-ion batteries, to minimize environmental impact.
- FAME India Scheme: The Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME) scheme provides subsidies for EVs and aims to reduce vehicular emissions.
- Production Linked Incentive (PLI) Scheme: This scheme encourages domestic manufacturing of EVs and their components, promoting sustainable production practices.
- GST Reduction: The Goods and Services Tax (GST) on lithium-ion batteries has been reduced from 28% to 12% to make EVs more affordable and promote their adoption.
- Green License Plates: EVs are issued green license plates to distinguish them from conventional vehicles and promote their use.
- State Policies: Various state governments have introduced their own policies to support EV adoption, including subsidies, tax exemptions, and support for charging infrastructure



3. **Social Issues:**

The social and environmental consequences of electric and hybrid cars include implications on mobility and travel, the functioning of the energy supply system, the use of petroleum and other fuels, air pollution, and traffic noise**.**

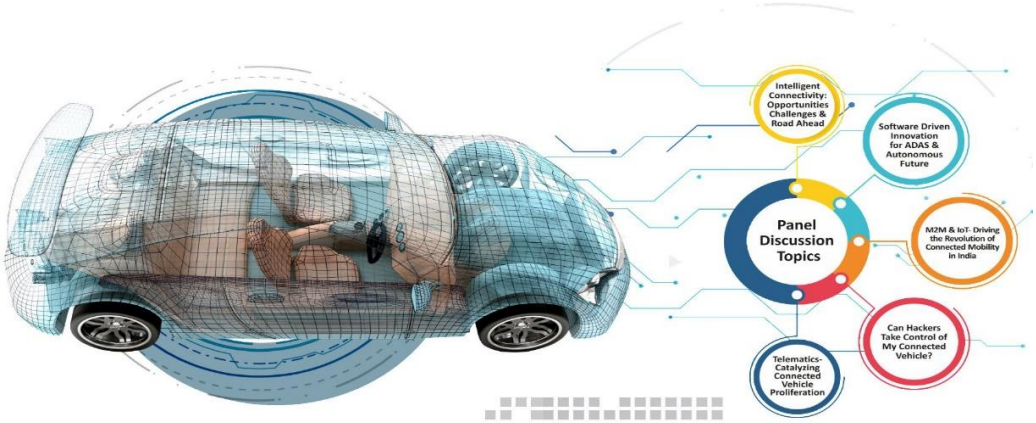
- Human Rights Violations: The extraction of minerals like cobalt and lithium, essential for EV batteries, has been linked to human rights abuses, including child labor and unsafe working conditions, particularly in countries like the Democratic Republic of Congo1.
- Environmental Impact: The rapid expansion of mining operations for battery materials can lead to environmental degradation, including deforestation, water pollution, and habitat destruction1.
- Community Exploitation: Communities near mining sites often face exploitation, health risks, and difficulties accessing clean water due to pollution from mining activities.
- Transparency and Accountability: Many EV manufacturers have been criticized for not adequately demonstrating how they address human rights risks in their supply chains. There is a need for greater transparency and accountability in sourcing practices.
- Economic Displacement: The shift towards EVs can lead to economic displacement for workers in traditional automotive and fossil fuel industries, requiring retraining and support for affected workers.) Technological Innovation.

The electric vehicle (EV) industry is rapidly evolving with both current and emerging technologies driving innovation1. Here are some key highlights:

1. **Current Technologies:**
    - Battery Technology: Advances in lithium-ion batteries have significantly reduced costs and improved energy density, leading to longer driving ranges and shorter charging times.
    - Electric Motors: Modern EVs are equipped with highly efficient electric motors that offer instant torque and quieter operation compared to internal combustion engines.
    - Charging Infrastructure: The development of fast-charging stations and home charging solutions is making EVs more convenient for consumers.
    - Thermal Management Systems: Improved thermal management ensures better performance and longevity of EV batteries, especially in extreme temperatures.

- Software and Connectivity: Over-the-air (OTA) updates and connected vehicle technologies enhance the driving experience and allow for remote diagnostics and updates.

2. **Emerging Technologies:**
   - Wireless Charging: This technology allows EVs to charge without the need for cables, making the charging process more convenient and accessible.
   - Vehicle-to-Home (V2H) and Vehicle-to-Grid (V2G): These systems enable EVs to supply power back to homes or the grid, providing energy storage solutions and supporting grid stability.
   - Autonomous Driving: Integration of advanced sensors, AI, and machine learning is paving the way for fully autonomous EVs, enhancing safety and driving efficiency.
   - Battery Recycling and Reuse: Innovations in battery recycling and second-life applications are addressing environmental concerns and promoting sustainability.
   - Smart Power Distribution: Smart grids and energy management systems optimize the use of renewable energy sources and improve the efficiency of EV charging.

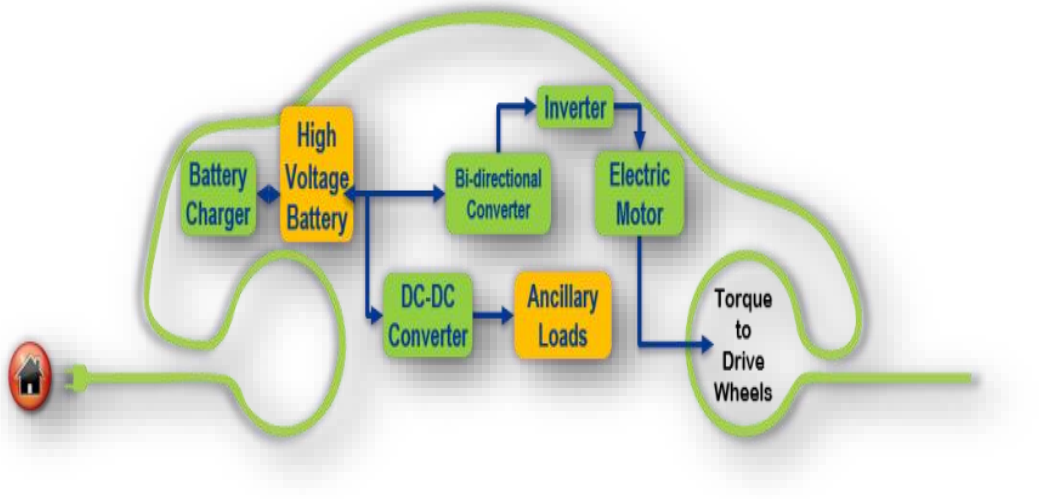


4. **Research and Development:**

Research and Development (R&D) in the electric vehicle (EV) industry is crucial for driving innovation and improving technology. Here are some key areas of focus:

- Battery Technology: Enhancing battery performance, energy density, and reducing costs are major R&D areas. Innovations include solid-state batteries and improved lithium-ion batteries.
- Charging Infrastructure: Developing faster, more efficient charging solutions, including wireless charging and Vehicle-to-Grid (V2G) technology.

- Power Electronics: Improving the efficiency of power electronic components that manage the flow of electricity within EVs.
- Autonomous Driving: Integrating advanced sensors, AI, and machine learning to develop fully autonomous EVs.
- Lightweight Materials: Researching new materials to reduce vehicle weight, thereby increasing efficiency and range.



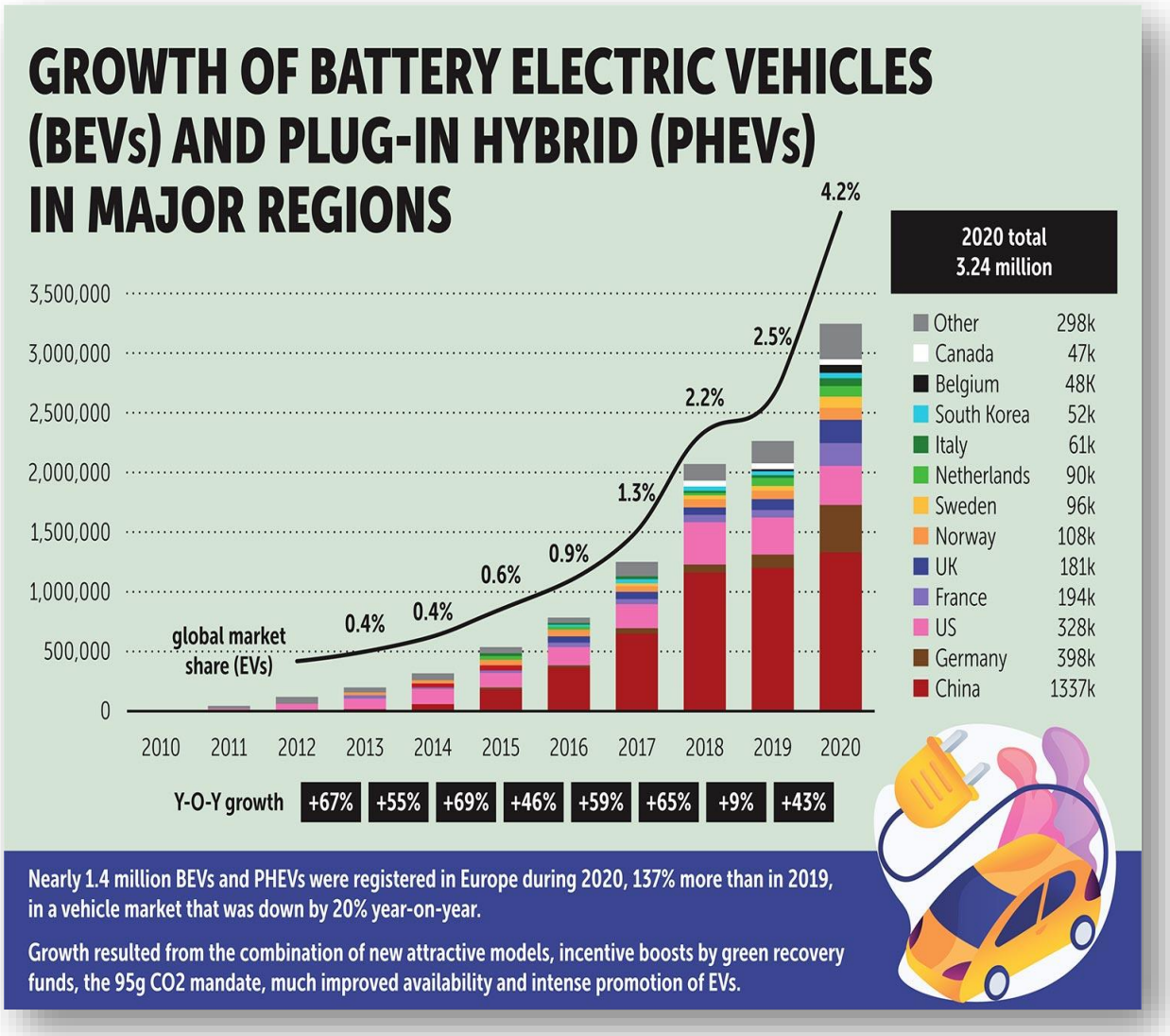
5. Quality Standards and Certificate:

The electric vehicle (EV) industry adheres to various quality standards and certifications to ensure safety, performance, and environmental sustainability. Here are some key standards and certifications:

- ISO 9001: Quality Management System - Ensures consistent quality in production processes.
- ISO 14001: Environmental Management System - Focuses on reducing environmental impact and promoting sustainability.
- ISO 45001: Occupational Health and Safety Management System - Ensures safe working conditions for employees.
- ISO 50001: Energy Management System - Promotes efficient energy use and management.
- Bureau of Indian Standards (BIS): BIS develops standards for EVs and their components, including safety and performance standards.
- IS 18590: 2024 and IS 18606: 2024: These new standards focus on the safety and quality of critical components in EVs, including the powertrain.

These standards and certifications help ensure that EVs meet high quality and safety benchmarks, contributing to the industry's growth and consumer confidence.

6. Forecast of Industry and Future Trends:



1. **Forecast for 2024:**
    - Market Growth: The global EV market is projected to reach $786.2 billion in revenue in 2024, with a steady annual growth rate of 6.63% from 2024 to 20291.
    - Sales Volume: It's forecasted that 25% of all new passenger car registrations will be electric, exceeding 17 million units in sales globally.
    - Battery Prices: Continued reduction in battery costs, making EVs more affordable for consumers.
2. **Future Trends:**
    - Charging Infrastructure: Automakers are focusing on improving the charging experience, including faster and more accessible charging stations.
    - Second- Hand Market Growth in the used EV market, providing more affordable options for consumers.
    - Advanced Connectivity: Integration of advanced connectivity features in EVs for enhanced user experience and vehicle-to-everything (V2X) communication.
    - Shift to LFP Batteries: Increased adoption of lithium iron phosphate (LFP) batteries due to their cost-effectiveness and safety features.
    - Federal Tax Credits: Updates to federal tax credit rules, influencing automakers' pricing strategies and encouraging North American manufacturing.

CHAPTER 5

FINDINGS, SUGGESTION AND CONCLUSION

Findings:

- The study helps to understand the global electric vehicle market and rapid growth, driven by a combination of government incentives, technological advancements, and increasing consumer demand for sustainable alternatives to traditional internal combustion engine (ICE) vehicles.
- The study revels EV sales have surged in several key markets, including Europe, China, and North America. In 2023, global EV sales accounted for over 15% of total vehicle sales, with projections to exceed 30% by 2030.
- The study helps to know that EVs are expected to make up over 40% of global car sales, with some markets like Europe already surpassing 20% in 2030.
- The study understands that the Support of Governments around the world are implementing stringent emissions regulations and offering subsidies for EV adoption. Initiatives like the European Green Deal, China's EV production quotas, and the U.S. Inflation Reduction Act are vital in pushing the EV transition.
- The study help me to know that the Several countries are planning to phase out the sale of new ICE vehicles by 2035, significantly accelerating the EV adoption rate.
- study helps to understand that Affordability & Cost Parity of battery prices continue to drop, EVs are becoming more cost-competitive with ICE vehicles. Additionally, governments and automakers are working together to reduce the price gap through incentives, rebates, and economies of scale.
- EVs are increasingly offering comparable or superior performance to their ICE counterparts, with extended driving ranges and fast acceleration. Range anxiety is gradually being mitigated through better battery technology and improved infrastructure.

Suggestions:

- It can be suggested to make some strategies for expanding EV charging infrastructure to increase its opportunities.
- It can be suggested Improve battery technology to attract more customers.
- Increase consumer incentives.
- To Ensure ethical and sustainable sourcing it can be suggested to Promote transparency and traceability in the supply chain, ensuring materials can be traced back to their origin.
- It can be suggested Establish comprehensive recycling initiatives for EV batteries and components to reduce waste and encourage the reuse of valuable materials..
- Increase in public education and awareness campaigns to inform consumers about the environmental and economic benefits of switching to electric vehicles.
- Emphasize long-term cost savings associated with owning and maintaining electric vehicles, including lower fuel and maintenance expenses.
- Strengthen regulatory frameworks by enforcing stricter emissions standards for both traditional and electric vehicles to further drive the transition to cleaner transportation.
- Encourage closer collaboration between governments, industry stakeholders, and automakers to create policies that support the growth of the electric vehicle market.
- Invest in workforce development programs that equip workers with the skills needed for the expanding electric vehicle industry, from manufacturing to maintenance and charging infrastructure.

Learning Outcomes

Technological innovation is another critical learning outcome. Advancements in battery technology, such as increased energy density and reduced production costs, have been pivotal in enhancing the performance and affordability of EVs. These technological strides are making EVs a more viable option for a broader consumer base, thus accelerating market adoption.

The environmental impact of EVs is a profound learning point. EVs are crucial in reducing greenhouse gas emissions, particularly when the electricity used to charge them comes from renewable sources. This shift not only helps mitigate climate change but also reduces air pollution, leading to healthier urban environments.

Economic implications also emerge as a significant learning outcome. The EV industry is creating numerous job opportunities, particularly in the fields of manufacturing, research and development, and infrastructure development. This job creation is critical for economic growth and for the transition to a more sustainable economy.

Government policy and regulation play a crucial role in the EV industry's growth. Understanding the impact of subsidies, tax incentives, and emission regulations is essential for comprehending how public policy can drive technological adoption and industry growth. These policies are crucial for addressing some of the industry's most significant challenges, such as the development of charging infrastructure and the ethical sourcing of raw materials.

Consumer behavior and adoption patterns also provide valuable insights. Factors influencing consumer decisions, such as environmental concerns, cost, and vehicle performance, are critical for tailoring marketing strategies and product development.

Finally, the sustainability of the EV industry itself is a crucial learning outcome. This includes not only the immediate environmental benefits but also the long-term sustainability practices, such as the recycling of batteries and the integration of EVs with renewable energy sources to ensure a holistic approach to environmental stewardship.

In summary, the study of the EV industry reveals a comprehensive view of how technological innovation, market dynamics, policy frameworks, and socio-economic impacts converge to shape the future of transportation. These insights are invaluable for stakeholders looking to navigate and influence this rapidly evolving industry.

APPENDIX

- https://www.smev.in
- https://evstory.in
- https://evindia.online
- https://powermin.gov.in
- https://www.imarcgroup.com