Innovating for a Sustainable Future: Exploring Business Opportunities in India's Electric Vehicle Sector

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Abstract:

This study assesses the current state of the sustainable vehicle market in India, focusing on key opportunities and challenges for entrepreneurs. India's electric vehicle (EV) market is growing rapidly due to government incentives and increasing consumer awareness. However, there are significant challenges such as limited charging infrastructure, high battery costs, range anxiety, CO2 emissions from EV and battery production, and rising electricity demand. The research identifies business opportunities in EV production, battery technology, charging infrastructure, battery swapping services, electric mobility, retrofitting services, and software development. Government regulations have played a key role in promoting EV adoption, but more efforts are needed to overcome infrastructure barriers, increase consumer interest, and reduce costs. This study is based on secondary data and a literature review. The research provides insights for entrepreneurs, policymakers, investors, and consumers interested in understanding India's sustainable vehicle landscape. The recommendations include continued government support, battery technology advancement, alternative energy solution exploration, and greater customer adoption of sustainable vehicles to foster a thriving EV ecosystem.

Keywords: Electric vehicles, Sustainable vehicle ecosystem, Entrepreneurship, and Government policies and incentives.

1. Introduction

India accomplished a significant milestone, with the sale of 13,25,112 EVs in FY24 (till January 2024). The electric vehicle (EV) market is estimated to reach US$ 7.09 billion (Rs. 50,000 crore) in India by 2025. A study by CEEW Centre for Energy Finance recognised a US$ 206 billion opportunities for electric vehicles in India by 2030. This will necessitate a US$ 180 billion investments in vehicle manufacturing and charging infrastructure **(IEBF 2024).** In 2023, approximately one in four new vehicles sold worldwide were electric, with Norway leading the charge, where electric vehicles (EVs) accounted for over 90% of sales. In China, this figure approached 40% (Ritchie & Roser, 2024). Norway has established itself as the global capital for electric vehicle adoption, while countries such as China, the United States, Germany, Mexico, and the United Kingdom rank among the top five in terms of electric vehicle revenue **(Tomar, 2023).**

India's automotive market, valued at approximately $100 billion in 2021, is projected to expand to $160 billion by 2027, reflecting a compound annual growth rate (CAGR) of 8.1% during the forecast period from 2022 to

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2027. According to the India Electric Vehicle Market Overview Report (2020-2027), EV sales in India reached 380,000 units in 2019-2020, with the EV battery market at 5.4 GWh for the same year. Under a base-case scenario, the Indian EV market is expected to grow at a CAGR of 44% from 2020 to 2027, potentially reaching annual sales of 6.34 million units by 2027. Furthermore, annual battery demand is forecasted to increase at a rate of 32%, reaching 50 GWh by 2027, with over 40 GWh attributed to lithium-ion batteries. The battery market, which was valued at approximately $580 million in 2019, is anticipated to surge to $14.9 billion by 2027.

The International Energy Agency (IEA, 2016) posits that the transportation sector accounts for approximately one-quarter of global greenhouse gas emissions, with projections indicating a 23-50% increase by 2030. The sector's reliance on fossil fuels makes it a significant contributor to both urban and regional air pollution. As the demand for transportation continues to rise, transitioning to more sustainable alternatives is imperative for a cleaner future. Electric vehicles (EVs) offer a viable solution due to their zero-tailpipe emissions. However, the sustainability of EVs hinges on the source of electricity used to power them. If the electricity grid relies heavily on fossil fuels, such as coal, which currently accounts for approximately 70% of electricity generation, the overall environmental impact of EVs may be mitigated. Therefore, a shift towards renewable energy sources like solar and wind for electricity generation is essential to maximize the sustainability benefits of electric vehicles.

This research contributes to the growing body of academic literature on electric vehicles (EVs) in India. By providing an insight of the current market landscape, business opportunities, challenges, and policy implications, the study offers valuable insights for policymakers, entrepreneurs, and stakeholders involved in the EV industry. The outcomes of this research can inform the development of effective policies, support the growth of EV start-ups, and contribute to India's transition towards a sustainable and electrified future.

2. Literature review:

Un-Noor et al., (2017) examines existing data on electric vehicle (EV) configurations, energy sources, machines, charging methods, and optimization strategies. The aim is to present a comprehensive overview of current EV technology and future development pathways to facilitate subsequent research in this field. Bhattacharyya & Thakre, (2020) investigated the determinants affecting the adoption of electric vehicles (EVs) within the Indian context, emphasizing the viewpoints of industry experts and consumers. Through the implementation of semi-structured interviews with 38 specialists, the researchers delineated 11 primary factors that facilitate EV adoption. Notably, the availability of charging infrastructure surfaced as the most significant determinant. The research employed a push-pull-mooring framework to elucidate the dynamics associated with EV adoption.

The study of Tarei et al., (2021) investigates the interrelationships among barriers to EV adoption in India using a hybrid MCDM (multi-criterion decision making) approach. By applying BWM (Best-Worst Method) and ISM (interpretive structural modelling), the research ranks and prioritizes critical barriers, such as performance and range, total cost of ownership, charging infrastructure, and consumer awareness. This analysis provides a framework for decision-makers to allocate resources effectively and address high-priority barriers. The study also establishes the strength of relationships between these barriers, shedding light on their influence on EV adoption. Overall, the research contributes to a deeper understanding of the complex factors hindering EV adoption in India.

Pour et al., (2023) Entrepreneurial opportunities are classified into five main categories, including “smart vehicles”, “business partners/smart transportation supply side”, “supporting services”, “infrastructures”, and “smart transport management and control”. As a new digital technology, the Internet of Things (IoT) has many uses, and the transportation industry is perhaps its most influential. Integrating the IoT into the transportation industry will transform the industry and create many new economic opportunities. By discovering, assessing, and exploiting opportunities, entrepreneurs find unique products or services to penetrate new markets. Though transportation management want to engage in the IoT and research is increasing, little is known about IoT-based entrepreneurship potential in the industry. IoT-based entrepreneurial potential in the transportation industry are the focus of this study. The study (Saxena et al., 2023) reviews methodologies and theories from 2010 to 2022, emphasizing the need for tailored strategies for EV deployment. It highlights EVs' potential to significantly reduce carbon emissions and boost public acceptance, aiming for widespread adoption by 2030. Additionally, the research examines the potential economic benefits and the carbon exchange market linked to EVs. The paper (Singh et al., 2023) examines electric vehicles as eco-friendly alternatives, emphasizing their potential to reduce pollution and the growing need for renewable solutions. While many countries have embraced EV technology, India faces challenges, particularly in developing charging infrastructure and addressing battery material shortages. Government incentives are helping promote EV adoption, but anti-EV activism also poses obstacles. The paper explores both the opportunities and challenges of implementing EVs in India. In this paper, (Tomar, 2023) an analysis utilizing the Strengths, Weaknesses, Opportunities, and Challenges (SWOC) framework was performed concerning the current electric vehicle (EV) deployment in India, in conjunction with the examination of the potential benefits and obstacles present within this sector. This study (Malakhatka et al., 2024) focused on evaluating technological solutions, innovations, or possibly entrepreneurial ventures using specific methodologist. The study seeks to illuminate how innovative management practices and digital entrepreneurship can effectively bridge the gap between the technical potential of smart grid solutions and their practical market applications. This study (Gerwe & Houde, 2024) includes various entrepreneurial opportunities on the path to net zero mobility like charging infrastructure development, advanced battery technologies, renuable energy integration, electric fleet management, sustainable urban planning, data analytics and software development and education and awareness programmes. The paper (Singh et al., 2024) reviews India's electric vehicle (EV) development landscape, highlighting key technological advancements and supportive policy frameworks driving the sector. It assesses market dynamics shaping consumer behavior and discusses challenges hindering the EV transition. The importance of local manufacturing and supply chains is emphasized, along with the need for a robust charging infrastructure to support widespread adoption. Despite these challenges, consumer acceptance of EVs continues to grow. According to (B & M, 2024) explores the current state of electric vehicles in India, emphasizing government efforts to encourage EV adoption. It analyzes the progress in developing EV infrastructure and highlights the challenges within the electric vehicle market. Additionally, it discusses future prospects for EV growth in India and examines the environmental impact of transitioning to electric mobility. Shinde et al., (2024) as per this paper India aims for a 30% shift to electric vehicles (EVs) by 2030, with sales projected to grow nine-fold in the next four years. Government initiatives are driving EV adoption and creating jobs. The market is currently led by electric two-wheelers, while four-wheelers lag behind. However, the COVID-19

pandemic disrupted global EV supply chains. Despite this, the EV transition presents significant investment opportunities and potential for economic recovery.

2.1. Research Gap:

While existing research has extensively explored the current market landscape, opportunities, and challenges within the Indian electric vehicle (EV) industry, there remains a significant gap in understanding the diverse range of business models and entrepreneurial opportunities available across different segments of the EV value chain. This research aims to fill this gap by providing a comprehensive analysis of emerging business models and identifying potential areas for new and existing entrepreneurs to capitalize on. The existing literature primarily focuses on traditional EV business models, such as vehicle manufacturing, battery technology, and charging infrastructure. However, there is a need for more in-depth exploration of innovative business models that can address specific market needs and leverage emerging technologies. This includes areas such as energy storage solutions, shared mobility services, software services, retrofitting services and aftermarket services.

- What is the current state of electric vehicle market in India?
- What are the key opportunities for entrepreneurs in the Indian EV sector?
- What are the potential challenges faced by EV entrepreneurs in India?
- What are the government initiatives for EV entrepreneurs in India?

3. Research Methodology:

This study adopts an exploratory approach, relying on secondary data collection methodologies to review existing academic literature, industry reports, and government publications focused on electric vehicles, sustainable transportation, and entrepreneurship in India. By analyzing information from diverse sources, including scholarly journals, research reports, various News, Websites and publications from institutions such as International Energy Agency (IEA), Society of Manufacturers of Electric Vehicles (SMEV), Ministry of Heavy Industries and Public Enterprises, Government of India as well as insights from key conferences like the UN Climate Summit (COP28), the research aims to identify trends, patterns, and correlations within the Indian electric vehicle market and related government policies.

3.1. Objectives:

- To understand the current market landscape of Electric vehicles in India.
- To explore the various business opportunities for entrepreneurship in Indian EV sector.
- To address the challenges for EV entrepreneurs in India.
- To identify the various government policies and initiatives for promoting EV sector in India.

4. Findings & Discussion:

4.1. Electric Vehicle Market in India:

At present, India ranks fifth in the global automotive market but estimates do show that it could rise to a third rank market by 2030 (IBEF, 2022). At present, there are 399 electric vehicle start-ups in India (e-Amrit portal). As part of a national effort to achieve zero carbon emissions by 2070, NITI Aayog, the premier policy thinks tank of India, targets EV sales penetration at 70% for commercial cars, 30% for private cars, 40% for buses and a massive number of 80% in two and three-wheelers by year-end (2030). The character of the Indian EV market is unique, with two-wheelers holding the largest portion. The increasing demand from this segment has brought many domestic manufacturing companies to serve them. The future course of EV sales, however varies between various factors such as rapid growth in charging infrastructures, energy distribution network building up pace, increasing governmental initiatives on electric vehicle adoption etc. States such as Uttar Pradesh, Maharashtra, Karnataka, Rajasthan, Gujarat, Tamil Nadu and Delhi have become key drivers of EV adoption across other regions (IBEF, 2022).

This will be in addition to a 30 percent EV market share target set by the current government for 2030. Electric two-wheelers have a large penetration of 4.4% in fiscal year 2023, given the sizeable two wheelers market (more than 15 million units sold annually) in the Indian automobile industry. In contrast, just 72,930 fully electric four-wheelers sold last year, nearly double the figure for 2022 (Statista. com, 2024). This illustrates clear consumer interest in electric 2-wheelers, which is still an overall small aspect of the overall market, but one that is growing rapidly. India is the third largest automobile market globally in terms of sales, ahead of Germany and Japan.

Table1: Electric Vehicle Sales in India

Category	Grand Total (Figure in Nos.)	% of total sales
E-2 Wheelers	2026471	52.63%
E-3 Wheelers	1648860	42.82%
E-4 Wheelers	167173	4.34%
E-Buses	7763	0.20%
Grand total	**3850267**	**100.00%**

Source: https://www.smev.in/statistics *This data as on 20th August, 2024. It excludes Telangana and not include Low Speed Sales.

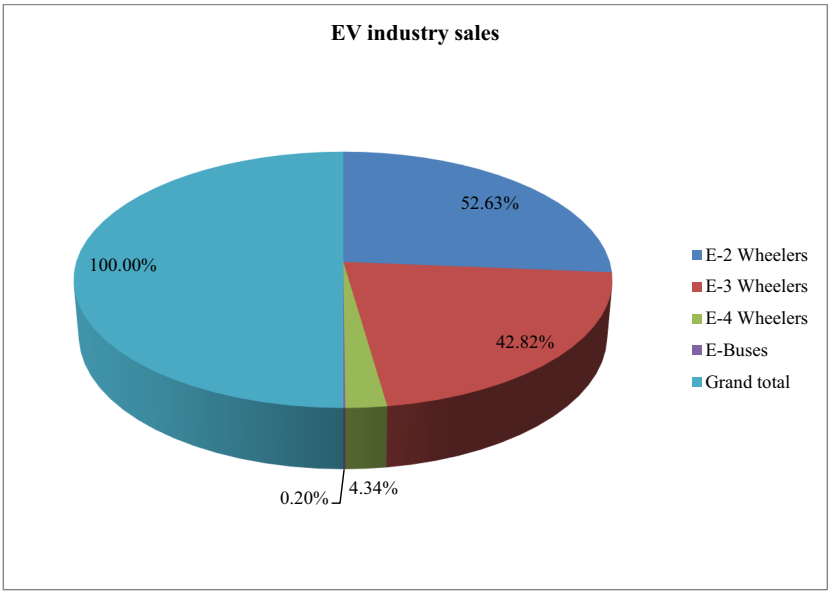


Figure 1Electric Vehicle Sales in India

The pie chart depicts the market share distribution across different electric vehicle (EV) categories in India. E-2 wheelers hold the largest share, followed by E-3 wheelers, while E-4 wheelers and E-buses represent smaller portions of the market. This dominance of two- and three-wheelers shows consumer preference affected by various factors such as affordability, practicality, and their suitability for urban transportation and last-mile delivery services.

4.2. Opportunities in India's Electric Vehicle Industry:

Start-ups in India are transforming the established automotive sector by providing creative solutions along the whole EV value chain, as the country's EV market gets closer to price parity. These entrepreneurs use cutting-edge technologies to provide themselves a competitive edge and increase consumer accessibility to EV adoption, even in the face of challenges from more established businesses. Since EVs may lower carbon emissions and provide affordable transportation, startups in India are actively influencing the changing face of electric mobility. At present, there are 399 electric vehicle start-ups in India. Electric vehicle sector has variety of opportunities for new and existing entrepreneurs throughout its value chain. These opportunities are discussed in following points:

Electric vehicle manufacturing: Till 31st July 2021, there were 380 electric vehicle manufacturers in India. With the increasing adoption of electric vehicles in the landscape, this number is only expected to increase further (e-Amrit).

Two wheeler manufacturing: India's EV market is dominated by Two wheelers. It captures the biggest part of market share. Here are key players of this market:

1. Ola electric (21.23%)
2. Hero electric (12.50%)
3. Okinawa auto tech (12.38%)
4. Ampere vehicles (11.77%)
5. Tvs motors (11.48%)
6. Ather energy (10.77%)
7. Bajaj auto (4.47%)

Source: https://jmkresearch.com/annual-india-ev-report-card-fy2023/

Three wheeler manufacturing: After 2 wheelers, three wheeler electric vehicles market covers a significant amount of market share in Indian electric market. Here are the key players of this segment:

1. Mahindra electric (8.95%)
2. YC electric vehicle (7.34%)
3. Saera electric (5.46%)
4. Dilli electric (4.15%)
5. Champion polyplast (3.45%)
6. Mini metro (2.99%)
7. Unique intl (2.64%)
8. Piaggio vehicles (2.55%)

Source: https://jmkresearch.com/annual-india-ev-report-card-fy2023/

Four wheeler manufacturer: Here is a list of the Top Electric Car Manufacturers in India. Here is the list of Electric Car Manufacturing Companies along with their models:

Table 2: Name of company and model

Sr. No.	Company Name	Models
1.	Tata Motors	3
2.	Mahindra Electric	6
3.	MG Motors	3
4.	Hyundai Motors	3
5.	Maruti Suzuki	1
6.	Jeep	1

7.	Renault	1
8.	Nissan	1
9.	Ford	1
10.	Skoda	1
11.	BMW	2
12.	Citron	1
13.	Mean Metal Motors	1

Source: https://e-vehicleinfo.com/electric-car-manufacturers/

Commercial vehicle manufacturing: Commercial vehicles include electric bus market and electric cargo vehicles and others. Tata motors, Switch mobility, Olectra, Hyundai, PMI Electro Mobility, JBM Group, Ashok Leyland, Evolet, Mellor, Green Power and BYD are the manufacturers in this sector.

Service providers: There are primarily 3 areas where businesses can invest and build offerings around electric mobility. These areas are: Mobility, Infrastructure and energy. Each of these categories are further divided into domains and each domain has several business models.

Electric mobility services: Mobility is the segment where the actual increase of electric vehicles on the road will take place. Firms in mobility will focus on business models that employ electric vehicles to give services to the customers. It will focus on value addition to the customers using electric vehicles. In India, there is a huge population who uses car or bike rental and ridesharing services very often. Some people use it on daily basis to reach their destination. Uber, ola, rapido, Zoomcars are some of the popular examples of these service providers. In India this market still has high scope. Now electric vehicles are gaining popularity due to its zero tail pipe emissions and government is also in support of promoting these EVs for attaining its sustainability goals. In India there are Following Electric mobility services startups are there which provide electric cars and electric bikes for rent:

- **Micro Mobility:** Bounce, Vogo, Yulu, Zyapp
- **Car Sharing**: E-Savari rentals, Lithium Urban, Drivezy
- **Ride Hailing:** Blu Smart, Ola, SmartE
- **Ride Sharing:** Blablacar, sRIDE
- **Car Subscription:** Zoomcar, Myles
- **E-Roaming:** Yet to be explored
- **Digital Payment Service:** Ola money
- **Yulu bikes:** yulu bikes,

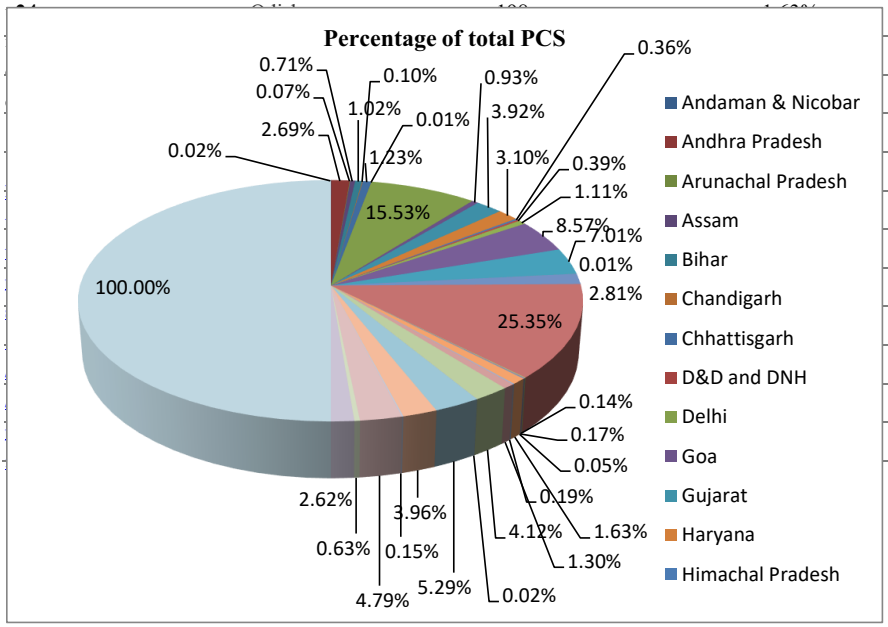
Bangalore based electric bike Rental Company based in India has signed a strategic collaboration with Bajaj Auto and raised $8 million in funding**.** It has obtained authorization to provide electric bikes at 250 metro stations in Delhi. They plan to deploy about 1000 cars and install 200 to 300 parking stations and 25 to 30 charging stations. Yulu aims to make urban mobility in India more accessible, shareable, and sustainable.

EV Charging Infrastructure: The primary obstacle to widespread electric vehicle adoption in India has been the insufficient availability of public charging infrastructure. To address this, India must establish a robust and extensive charging network across the country, taking into account factors such as traffic patterns and population density. As per (**Tarei, et.al.2021; Bhattacharyya, et.al.2020).** Lack of charging infrastructure is one of the major barriers for adoption of electric vehicles in India. As per the information received from Ministry of Power, 12,146 nos. of public EV charging stations are

Table3: State wise operational public EV charging stations as on 02.02.2024

S. No.	**State**	**No. of Operational PCS**	**Percentage of total PCS**
1	Andaman & Nicobar	3	0.02%
2	Andhra Pradesh	327	2.69%
3	Arunachal Pradesh	9	0.07%
4	Assam	86	0.71%
5	Bihar	124	1.02%
6	Chandigarh	12	0.10%
7	Chhattisgarh	149	1.23%
8	D&D and DNH	1	0.01%
9	Delhi	1886	15.53%
10	Goa	113	0.93%
11	Gujarat	476	3.92%
12	Haryana	377	3.10%
13	Himachal Pradesh	44	0.36%
14	Jammu & Kashmir	47	0.39%
15	Jharkhand	135	1.11%
16	Karnataka	1041	8.57%
17	Kerala	852	7.01%
18	Lakshadweep	1	0.01%
19	Madhya Pradesh	341	2.81%
20	Maharashtra	3079	25.35%

21	Manipur	17	0.14%
22	Meghalaya	21	0.17%
23	Nagaland	6	0.05%



b.gov.in/PressReleaseIframePage.aspx?PRID=2003003.

This pie chart illustrates the distribution of public charging stations (PCS) across various states in India based on data provided by ministry of heavy industries. The data shows that Maharashtra leads with the highest percentage of PCS (25.35%), followed by Delhi (15.53%), and Karnataka (8.57%). Other states with comparatively lower PCS are Tamilnadu, Uttar Pradesh, Rajasthan and Gujarat. The remaining states have a relatively low percentage of PCS, with many states having less than 1% of the total PCS in India. This indicates a significant concentration of charging infrastructure in Maharashtra, Delhi, and Karnataka, suggesting that these states have higher EV adoption rates and there is a significant disparity in the availability of charging infrastructure across different regions of India.

*Types of EV charging station***:** As we have seen there are 12146 public charging stations in India. These charging stations are being installed in key areas throughout the country for public charging and workplace charging as a supplement to residential charging. Most EV owners do the majority of their charging at home only. Here are the types of charging station available in India.

- AC: AC Chargers are slower, typically used at home, and take around 6 to 8 hours to fully charge an EV. They work by providing power to the vehicle's onboard charger, which converts AC to DC for the battery.
- DC: DC Chargers are faster and more efficient, directly delivering DC power to the vehicle's battery. These are ideal for public charging stations, including those in cities and along highways.
- Level 1: Level 1: Uses a 120V AC outlet, offering a slow charging option suitable for over-night charging at home.
- Level 2: Uses a 240V AC, provides fast charging, and is suitable for public and fleet settings.
- Level 3 (DC Fast Charging): Uses direct current (DC) for rapid charging, ideal for quick top-ups during long journeys.
- However, the connector types vary depending on the changing levels and compatibility of the vehicles:
- Bharat Standard (AC-001 and DC-001) Connectors: Used in two-wheeler and three-wheeler EV models, perfect for Level 1 and Level 2 charging.
- CCS-2 and CHAdeMO Connectors: Caters to higher voltage charging for four-wheelers and buses. It aims at promoting interoperability along with ease of charging.

Source: https://pulseenergy.io/blog/ev-charger-types

Table 4: Types of EV Charging Station

charging station	**Voltage (V)**	**Power (kW)**	**Type of Vehicle**	**Type of compatible charger**
Level 1 (AC)	240	<=3.5 kW	4w, 3w, 2w	Type 1, Bharat AC-001
Level 1 (DC)	>=48	<=15 kW	4w, 3w, 2w	Bharat DC-001
Level 2 (AC)	380-400	<=22 kW	4w, 3w, 2w	Type 1,Type 2, GB/T, Bharat AC-001
Level 3 (AC)	200-1000	22-4.3 kW	4w	Type 2
Level 3 (DC)	200-1000	Upto 400 kW	4w	Type 2, ChAdeMO, CCS1, CCS2

Source: https://www.smev.in/charging-infrastructure

Charging infrastructure manufacturers: These companies offer EV charging equipments including both AC and DC chargers for residential, official and entrepreneurial charging purposes. Here are few key players of this sector of EV industry: Delta Electronics, Mass Tech, ABB India, and Exicom

Charging station operators: These are the firms which provide EV charging infrastructure over the country to set up a charging station. Here are some major players of this sector in India:

- Amara Raja
- EESL
- Megneta power green energy solutions
- Tata Power
- Fortum India
- Volttic

Energy as a service: Research shows that private vehicles sit unused about 95% of the time. This opens up a big opportunity in the energy sector for the EV industry. Electric vehicle (EV) batteries store electricity, and when these vehicles aren't being driven, owners can sell or use the stored power to make extra money.In the energy segment, this includes the electricity used to charge EVs and the power stored in their batteries. EVs can be charged using renewable energy sources like wind and solar power. By storing wind power at night and solar power during the day, EVs can help stabilize the electricity grid. This not only supports the growth of renewable energy but also helps reduce greenhouse gas emissions. Here are some business models that can be explored:

- Virtual power plant
- Renewable Energy and EV Charging System
- Network as a service: Numocity Technologies.

EV Software solution services: EV software falls into two primary categories:

Control software: This is the central nervous system of the electric vehicle, handling things like the battery, motor, and charging systems. Software updates are also supported, which enables the gradual addition of new features and performance enhancements.

Infrastructure and EV charging software: This software, which includes user interfaces and invoicing systems, is essential for controlling fleet operations and charging stations. Efficient management of charging and related services is critical for both individual EV owners and EV charging firms.Here is a list of EV Software Solutions Providers in India – You will find EV Software Solutions Providing Companies along with their diverse services.

Table 5: Companies and services

Name	**City**	**Website**	**Services**
Aarjay International Pvt Ltd	Bangalore	**www.aarjay.com**	Software testing
APSG Engineering	Bangalore	**www.apsgengineering.com**	AI Solutions
Bacancy Systems Pvt Ltd	Ahmedabad	**www.bacancytechnology.com**	Embedded & Cloud Solutions

Cadfem Solutions	Hyderabad	**www.cadfem.net**	Custom Software Solutions
E-infochips	Pune	**www.einfochips.com**	Data Analytics , ML, Embedded Software Development
Devise Electronics Pvt Ltd	Pune	**www.deviseelectronics.com**	IoT , Data Science , ML
Eleno Energy	Pune	**www.elenoenergy.com**	Training , Design Optimization
Evy Energy	Jaipur	**www.evyenergy.com**	Custom Software Solutions
Gannet Solutions	Bangalore	**www.gannetsolutions.com**	Data Analytics, IoT, Control Systems
Geogo Techsolutions	Jaipur	**www.evyenergy.com**	Custom Software Solutions
Intellicar telematics	Bangalore	**www.intellicar.in**	EV Telematics , Iot
Irasus Technologies	Gurgaon	**www.irasus.com**	Data Visualization, Data analytics,
ITK Services	Chennai	**www.itkeduserv.com**	Automation, Training
Kaizenat	Bangalore	**www.kaizenat.com**	Embedded software
Kloudq	Pune	**www.kloudq.com**	Cloud Solutions, IoT
Magenta EV Solutions	Navi Mumbai	**www.magentamobility.com**	Cloud Solutions
Nesh Technologies	Chennai	**www.neshinc.com**	Cloud Architecture , IoT
Pavone Technologies	Delhi	**www.pavonetech.in**	BEE Certification
Pragyatmika	Ghaziabad	**www.pragyatmika.co.in**	Industrial IOT
Qodenext India Pvt Ltd	Mumbai	**www.qodenext.com**	Hardware , IoT

Telio EV	Hyderabad	**www.telioev.com**	Charging Management Solutions,

Source: https://e-vehicleinfo.com/ev-software-solutions/

EV Battery manufacturer: Since batteries are the foundation of all electric vehicles, choosing the best battery manufacturer is essential to the growth of the EV market. There are various types of batteries that are used in various electric vehicles, such as, Lithium-Ion Batteries, Nickel-Metal Hydride Batteries, Lead-Acid Batteries and Ultra capacitors. Following is the list of some Electric Vehicle Battery Manufacturers in India that make electric vehicle batteries, Battery Cells, and Battery components around India.

1. Excide Industries
2. Amara Raja Batteries Ltd.
3. Luminous Power Technologies
4. Okaya power
5. Livguard energy technology
6. HBL power systemCoslight India telecom pvt. Ltd.
7. Eveready industries India ltd.

Source: https://diyguru.org/battery/electric-vehicle-battery-manufacturers-in-india/

EV Components Manufacturers: These companies manufacture various components of electric vehicles such as, battery, lights, switch, sensor, breaks, EV conversion kit and other components as well. Here is the list of Top EV Components Manufacturers Companies in India.

Company Name	Components
Amara Raja Batteries LTD	Electric Vehicle battery manufacturer
Minda Industry	Lights, switches, sensors, brakes, and other parts
Bharat Power Solution	Electric vehicle battery manufacturer
GoGoA1	R.T.O. approved EV Conversion kit/ and EV Equipment
Okaya Power	Lithium-Ion Battery
Compage Automation	Electric motor manufacturer
EV Battery Solution	Lithium batteries for electric vehicles
Karacus Energy	Lithium-ion battery manufacturer
Exicom Power Solution	Li-ion Batteries, Charging system, and battery management system

Source: https://e-vehicleinfo.com/ev-components-manufacturer/

EV retrofitting service providers: Electric propulsion kits are available for retrofitting ICE vehicles of all classes. Two advantages would result from this: reduced carbon emissions and cost-effectiveness when driving. An ICE vehicle's retrofitting might cost anywhere from Rs. 3 lakhs to more than Rs. 10 lakhs. The

price of an ICE motorbike or scooter starts at about Rs. 55,000. The battery and manpower are the two main reasons why the cost of vehicles is significantly greater. We must customise batteries for various vehicle types because one battery will not fit all vehicle types. Since the battery is the most expensive part of an electric car, purchasing a new one is far more expensive than converting an existing internal combustion vehicle.

Table 6: Retrofitting Companies in India

Company Name	**Category**
E-trio	E4W
Loop moto	E2W & E4W
EV retron energies	E2W& E4W
Cell propulsion	E4W
RACEnergy	E3W
Folks Motor	E4W
Volta Automotive	E3W
Northway Motorsport	E4W
Motor Kit	E2W & E3W
Bosch	E4
GoGoA1	E2W, E3W & E4W
Zuink	E2W
EVZoN	E2W, E3W

vehicleinfo.com/ev-conversion-retrofitting-companies

4.3. Challenges for EV entrepreneurs:

Rising awareness over environmental sustainability boosts EV production and sales in India. There are various government initiatives to promote electric vehicle manufacturing and adoption but still people are hesitant to switch to electric vehicles. Based on various literature reviews we have noticed that in spite of growing popularity electric vehicle adoption is much lesser in India. Here are key challenges faced by electric vehicle entrepreneurs based on various literature reviews are:

Infrastructural challenges:

*Sporadic Charging infrastructure***:** The limited availability of charging stations and necessary infrastructure has resulted in consumer averseness to adopt electric vehicles (EVs). Charging station is mostly located in urban area, which hinders adoption of Ev in rural area. Many potential users are concerned about the possibility of being stuck during their journey due to a lack of charging facilities. For these consumers, refueling at a traditional gas station is perceived as more convenient, as it eliminates the need to wait for extended periods often an hour or more to recharge their EVs mid-journey. If an entrepreneur wants to open an EV charging station, they have no idea about the suitable place to start their business. similarly, from consumer point of view, they don't

know about EV charging stations positions to plan their journey accordingly. Now Indian government has launched this facility through which they can locate the charging station as per their requirements.

*Supply chain challenges***:** The supply chain for parts like batteries, motors, and electronics is intricate in the EV business. Supply chain disruptions, such as material shortages or logistical difficulties, can affect lead times, production prices, and general business operations. A strong supply chain is necessary for EV production. Many EV companies rely on third-party suppliers for essential components like batteries and motors, in contrast to established competitors who frequently own their whole supply chain (from battery manufacture to vehicle assembly). This dependency can lead to greater prices, longer lead times, and less control over quality compared to vertically integrated competitors.

Economic challenges:

High manufacturing Cost of EV: Even with revolutionary technologies and components, the cost of manufacturing electric vehicles is still much more than that associated with conventional *automobiles. This makes it difficult for entrepreneurs to offer prices that are competitive,* particularly in price-sensitive areas like India. Compared to conventional automobiles, the production of electric vehicles (EVs) frequently entails more manufacturing costs, particularly in the early phases of adoption. Because of this, it could be challenging for business owners to grow their companies and offer competitive prices.

Battery replacement cost: The high cost of battery replacement raises the overall cost of ownership for consumers, making electric vehicles less appealing and making it more difficult for business owners to create a profitable business models. It can be costly to replace an EV battery because they account for a large portion of the vehicle's cost. This poses a significant financial burden for consumers and impacts the adoption of EV.

Industry based challenges:

*Lack of consumer awareness***:** Many potential consumers lack awareness about the benefits of EVs, such as cost efficiency, reduced operating costs, improved technology and environmental advantages. Expanding the market requires smart marketing and consumer education initiatives. Driving demand for EVs requires raising awareness and debunk the myths about EVs.

*Competition from existing automobile competitors***:** already established automobile companies with substantial financial resources, variety of options to choose from and wide-ranging distribution channels might provide a serious obstacle for EV entrepreneurs. They possess a large part of market.

Competing with those automobiles demands, business models, competitive pricing, and powerful marketing methods creates a great obstacle for emerging EV industry.

*Competition with other EV entrepreneurs***:** Global EV producers with a lot of experience in large-scale EV production, increased R&D investments, and cutting-edge technology are advantages that Tesla, BYD, and Hyundai enjoy. These businesses can frequently release more inventive and effective EV models, which makes it difficult for Indian business owners to compete on both price and performance. Large automobile corporations generally lead in critical advancements such as battery technology, energy efficiency, autonomous driving systems, and charging infrastructure. It's hard for smaller EV firms to stay up with them because of their rapid adoption of new technology, particularly when it comes to user experience, performance, and range.

*Perception of consumers about Safety issues***:** Although EVs are usually considered safer than conventional vehicles, but public perception may be influenced by worries about battery safety and possible fire threats. EVs can spontaneously catch fire while parked or charging, and these fires can spread quickly. Extreme weather can impact the performance of EVs, like extreme summer or winter, heavy rains.

Technical challenges:

Battery technology: Continuous battery technology developments are essential for enhancing cost-effectiveness, performance, and range. India's battery technology is still evolving. India is lagging behind in the development of modern batteries with greater energy density, longer lifespans, and enhanced safety features. The difficulty faced by entrepreneurs is staying updated of the newest advancements while cutting expenses. Innovation in battery materials, energy density, and charging durations depends heavily on research and development.

*Range anxiety***:** limited driving range of EVs and the insufficient number of charging stations continue to discourage consumers from switching to electric vehicles. Different types of Ev offers different driving range which is affected by type of battery used in such vehicles.

*Charging time of EV***: I**n India there are 12146 operational public charging stations as on 02.02.2024 (ministry of heavy industries). Most of the charging stations provide AC and DC chargers. High capacity chargers are still not available in India at large. Charging time required for different EVs are dependent upon capacity of battery used and type of charger opted for charging the vehicle.

*Lack of technological innovation***:** India's battery technology is still in its early stages and is not keeping up with other countries' superior batteries in terms of energy density, longevity, and safety. Despite the fact that infrastructure for charging is being invested in, the number of fast-charging stations and creative solutions being added is still small when compared to international standards.

Furthermore, even though the design of Indian EVs has improved, overall performance still needs to be improved by additional developments in energy efficiency, lightweight materials Etc.

Grid capacity: Increasing demand of electricity due to adoption of electric vehicles are putting a strain over current grid generation capacity. In India 56.8% of Installed GENERATION CAPACITY is from fossil fuels and out of which approx. 49.1% electricity is generated from coal only (As on 31/05/2023 Central Electricity Authority (CEA). For growth of EV market and to ensure sufficient grid capacity, electricity generation should be integrated with renewable energy resources in increased capacity.

Lack of skilled employees: The lack of skilled workers with experience in EV development, maintenance, and manufacturing is a serious issue that could impede innovation and production of EVs. Developing a skilled workforce can be challenging, especially in regions with limited access to technical education and training.

Energy efficiency: Energy efficiency is a critical concern for EV entrepreneurs in India due to the country's growing energy demand and the need to reduce carbon emissions**.** Optimizing the energy consumption of EVs requires efficient motor design, aerodynamics, and lightweight materials. Entrepreneurs must focus on these areas to improve the overall efficiency of their vehicles.

Regulatory challenges:

*Inconsistent Policy Framework***:** Businesses that deal with electric vehicles face difficulties navigating the various incentives, subsidies, and restrictions that exist in different jurisdictions due to the absence of consistent policies between states.

Taxes and Import charges: Exorbitant import charges raise the cost of manufacture when it comes to EV components, especially batteries and motors. Entrepreneurs may be discouraged from expanding their businesses or investing in cutting-edge technologies due to inconsistent tax rules.

Standards and Certifications: The development of the EV market is hampered by the lack of precise, uniform laws governing the manufacture, performance, and safety of EVs. The uncertain certification processes for novel products and technology cause delays for entrepreneurs.

Charging Infrastructure Standards: Interoperability between EV brands is hampered by a non-standard charging infrastructure. EV firms must manage varying charging procedures, adding to added costs and technological challenges.

Environmental challenges

Sourcing of Raw Materials: metals and other essential minerals are frequently needed in the manufacturing of electric vehicles (EVs) and their batteries. Inspite of zero tailpipe emission, Process of manufacturing EVs result in huge amount of CO2 emission. In order to reduce environmental effects, it is imperative to ensure sustainable procurement and recycling processes.

Disposal and Recycling: In order to protect the environment and salvage valuable resources, it is crucial that EV batteries be disposed of and recycled properly. Establishing effective recycling policies and procedures is crucial.

4.4. Government Initiatives:

The perception may arise that the acquisition of an electric vehicle incurs a greater financial burden than the procurement of a vehicle powered by an internal combustion engine; however, this sentiment is primarily attributable to the high initial expenditure (eAmrit). The effective total cost throughout the operational lifespan of electric vehicles remains comparatively lower. The government implements various financial incentives aimed at enhancing the affordability of electric vehicles for consumers. The principal mechanisms by which these incentives can be obtained include:

- **Purchase Incentives:** A direct reduction in the purchase price granted to the consumer at the time of transaction.
- **Coupons:** A financial incentive whereby the consumer is reimbursed a certain amount subsequent to the purchase.
- **Interest Subventions:** A reduction in the applicable interest rate when securing a loan for the vehicle.
- **Road Tax Exemption:** The waiver of road tax obligations at the point of purchase.
- **Registration Fee Exemption:** The elimination of the one-time registration fee associated with the acquisition of a new vehicle.
- **Income Tax Benefit:** A deduction provided against the tax liability owed by individuals to the governmental authority.
- **Scrapping Incentives:** Financial benefits awarded upon the de-registration of older petrol and diesel vehicles.
- **Others:** Additional incentives, such as interest-free loans, supplemental subsidies, and exclusive incentives for electric three-wheelers, may also be accessible.

Central Government initiatives: To assist the acceptance of electric vehicles (EVs) in India, the central government has announced a number of promotional measures in the previous ten years, including tax incentives for electric vehicle owners, public EV charging infrastructure development, and so on. Timeline for various initiatives taken by policymakers and regulators:

Source: https://e-amrit.niti.gov.in/national-level-policy

Faster Adoption and Manufacturing of (Hybrid and) Electric Vehicles (FAME) – I and II: FAME, or Faster Adoption and Manufacturing of (Hybrid and) Electric vehicles, is currently India's flagship scheme for promoting electric mobility. The scheme was launched by DHI (Department of heavy industry) in 2015 to promote electric and hybrid vehicles through subsidies. Currently in its 2nd phase of implementation, FAME-II is being implemented for a period of 3 years, eff. 1st April 2019 with a budget allocation of 10,000 Cr which includes a spillover from FAME-I of Rs 366 Cr. The incentives offered in the scheme are:

Table7: Incentives and Size of Battery

S.No	Total Approximate Incentives	Approximate Size of Battery
1	**Two Wheeler:** Rs 15000/- per kWh up to 40% of the cost of vehicles	**Two Wheeler:** 2 kWh
2	**Three Wheeler:** Rs 10000/- per kWh	**Three Wheeler:** 5 kWh
3	**Four Wheeler :** Rs 10000/- per kWh	**Four Wheeler:** 15 kWh
4	**E Buses:** Rs 20000/- per kWh	**E Buses:** 250 kWh
5	E Trucks: Rs 20000/- per kWh	-

Source: https://e-amrit.niti.gov.in/national-level-policy

The Department of Heavy Industries has also sanctioned 2636 charging stations in 62 cities across 24 States/UTs under FAME India scheme phase II.

National Mission on Transformative Mobility and Storage: Inaugurated in 2018, the National Mission on Transformative Mobility and Battery Storage represents a multi-disciplinary endeavor designed to facilitate India's progression towards electric mobility. Facilitated by NITI Aayog, the initiative brings together diverse governmental agencies and stakeholders to develop a holistic framework for the modernization of the mobility ecosystem. The aim of the mission is to drive strategies for transformative mobility and Phased Manufacturing Programmes for electric vehicles, electric vehicle Components and Batteries. The National Mission on Transformative Mobility and Battery Storage is anticipated to exert a considerable influence on India's economy, environment, and societal fabric. By transitioning towards electric mobility, India is poised to diminish its reliance on fossil fuels, enhance air quality, and generate new employment opportunities within the EV sector. Furthermore, the mission aspires to elevate the quality of life for Indian citizens by ensuring the availability of affordable, accessible, and sustainable transportation alternatives. There are some objectives:

- **Manufacturing:** Facilitate the domestic production of electric vehicles (EVs), their components, and batteries.
- **Standards:** Establish and enforce standardized specifications and quality benchmarks for EVs, their components, and charging infrastructure.
- **Fiscal Incentives:** Implement fiscal incentives aimed at promoting EV adoption and fostering investment within the EV sector.
- **Demand Creation:** Stimulate demand for EVs through awareness initiatives, consumer education, and targeted policy interventions.
- **Regulatory Framework:** Develop a supportive regulatory environment for the EV sector, addressing critical issues such as charging infrastructure, safety regulations, and taxation frameworks.
- **Research and Development:** Encourage research and development efforts in EV technologies, battery storage solutions, and related domains.

Key Initiatives:

Phased Manufacturing Program (PMP): The PLI scheme aims to boost domestic manufacturing of EVs and their components, including batteries. It offers financial incentives to manufacturers based on their production levels, encouraging investment in the EV sector (Ministry of Electronics and Information Technology, 2021). To localize production across the entire EV value chain and to boost electric mobility and promote development of electric vehicles, a phased manufacturing roadmap has been developed, taking into account the current state of the manufacturing ecosystem in the country, in which indigenous manufacturing of electric vehicles, their

assemblies/sub-assemblies, and parts/sub-parts/inputs of the sub-assemblies will be promoted over time through a graded duty structure. The goal is to significantly boost value addition and capacity building in the country.

"GO ELECTRIC" Campaign: The "GO ELECTRIC" initiative was instituted in India to enhance awareness regarding the merits of electric mobility, encompassing electric vehicles (EVs) and electric cooking methodologies. The Bureau of Energy Efficiency (BEE), appointed as the Central Nodal Agency (CNA), is leading this initiative in conjunction with State Designated Agencies (SDAs), State Nodal Agencies (SNAs), industry stakeholders, research institutions, and pertinent government entities. The initiative seeks to inform consumers about the benefits associated with EVs and electric cooking, debunk prevalent misconceptions related to the EV ecosystem, and foster adoption. Principal activities encompass:

- **Information Dissemination:** Formulating and distributing educational resources such as brochures, pamphlets, and digital materials to elevate awareness regarding the advantages of EVs and electric cooking practices.
- **Consumer Education:** Coordinating workshops, seminars, and webinars to enlighten consumers about the characteristics, advantages, and operational use of EVs and electric cooking devices.
- **Public Events:** Engaging in exhibitions, fairs, and roadshows to present EVs and electric cooking solutions to a broader audience.
- **Social Media Campaigns:** Leveraging social media platforms to disseminate information about the initiative and interact with prospective consumers.
- **Collaboration with Stakeholders:** Establishing partnerships with industry participants, governmental bodies, and non-governmental organizations to enhance the initiative's outreach and effectiveness.

Through the execution of these activities, the "GO ELECTRIC" initiative aspires to create a positive atmosphere for the adoption of EVs and electric cooking in India, thereby contributing to a cleaner and more sustainable future (evyatra).

State level incentives:

Various states of India provide variety of incentives to promote electric vehicle adoption in their states. As per evyatra portal and eAmrit portal Every state offers some incentives to us for adopting electric vehicles. Some of them are Delhi electric vehicle policy, Karnataka Electric Vehicle and Energy Storage Policy, Uttar Pradesh electric vehicle policy. These initiatives focus on promoting electric vehicles and energy storage systems, providing incentives for manufacturers and buyers for electric two-wheelers, three-wheelers, and cars, along with subsidies for charging infrastructure.

5. Limitations:

This study is limited by the availability of data. It excludes primary data from consumer perceptions about the adoption of sustainable vehicles. Due to the rapid advancements in the electric vehicle sector, characterised by

frequent legislative modifications, technology improvements, and market volatility, the findings may quickly become obsolete. State level EV policies need to be focused to understand the differences. Further research could explore the long-term environmental and economic impacts of EVs in India.

6. Conclusion & Recommendation:

India's EV market is rapidly expanding because of growing environmental concerns, supportive government policies, and focus on sustainable transportation. While entrepreneurs see opportunities in manufacturing, charging infrastructure, and battery production, challenges include inadequate infrastructure, high costs, technical limitations, and regulatory complexities. Government initiatives works to overcome these barriers, but infrastructure gaps and policy inconsistencies continues, making it crucial for entrepreneurs to travel through this dynamic landscape.

6.1. Key Recommendations:

- Entrepreneurs and consumers, both should capitalize on governmental subsidies and initiatives to minimize expenditures while remaining conscious of legislative alterations.
- Allocation of resources to develop advanced charging solutions to rectify infrastructural deficiencies and alleviate range apprehension.
- Optimization of operational efficiency and enhanced consumer experience through collaboration with Technology Providers.
- Emphasize sustainability by procuring environmentally-friendly materials and instituting recycling frameworks to reduce CO2 emission during manufacture and recycling of EVs.
- Continuous research and development for improved battery technology to achieve superior performance, lower costs, and extended range.
- Implement educational initiatives aimed at consumers to rectify misunderstandings and promote adoption.
- Engage with suppliers and emphasize local manufacturing to alleviate risks associated with the supply chain.
- Continuously monitor and modification to regulatory landscape to ensure compliance and maintain a competitive edge.

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References:

- Annual India EV Report Card: FY2023.https://jmkresearch.com/annual-india-ev-report-card-fy2023.
- Aswani, G., Bhadoria, V. S., & Singh, J. (2018). Electric Vehicles in India: Opportunities and Challenges. *2018 International Conference on Automation and Computational Engineering, ICACE 2018*, 65–71. https://doi.org/10.1109/ICACE.2018.8687043
- B, N. K., & M, N. E. (2024). Powering Ahead: Current Landscape of Electric Vehicles (EV) in India. *International Journal of Environment and Climate Change*, *14*(1), 639–647. https://doi.org/10.9734/ijecc/2024/v14i13879
- Bhattacharyya, S. S., & Thakre, S. (2020). Exploring the factors influencing electric vehicle adoption: an empirical investigation in the emerging economy context of India. *Foresight*, *23*(3), 311–326. https://doi.org/10.1108/fs-04-2020-0037
- Carvalho, M. (2020). "The Role of Entrepreneurial Mindset in Driving Innovation: A Case Study of Tesla Inc. "International Journal of Innovation and Technology Management, 17(3), 1-15.
- Chhikara, R., Garg, R., Chhabra, S., Karnataka, U., & Agrawal, G. (2021). Factors affecting adoption of electric vehicles in India: An exploratory study. Transportation Research Part D: Transport and Environment, 100, 103084. https://doi.org/10.1016/J.TRD.2021.103084
- Gerwe, O., & Houde, D. (2024). *From Here to Net Zero: Entrepreneurial Opportunities in Sustainable Transportation*. https://bura.brunel.ac.uk/handle/2438/28505
- Jami Pour, M., Hosseinzadeh, M. and Moradi, M. (2024), "IoT-based entrepreneurial opportunities in smart transportation: a multidimensional framework", International Journal of Entrepreneurial Behavior & Research, Vol. 30 No. 2/3, pp. 450-481. https://doi.org/10.1108/IJEBR-06-2022-0574.
- Malakhatka, E., Pitz, M., Maghnie, M., Mazidi, M., Plamanescu, R., Sumereder, C., Prüfer, T., Wallbaum, H., Müller, D., & Monti, A. (2024). From use cases to business cases: I-GReta use cases portfolio analysis from innovation management and digital entrepreneurship models perspectives. *Energy Informatics*, *7*(1). https://doi.org/10.1186/s42162-024-00310-w.
- Pour, M. J., Hosseinzadeh, M., & Moradi, M. (2023). IoT-based entrepreneurial opportunities in smart transportation: a multidimensional framework. *International Journal of Entrepreneurial Behaviour & Research*, *30*(2/3), 450–481. https://doi.org/10.1108/ijebr-06-2022-0574.
- Ritchie, H., & Roser, M. (2024, March 12). *Tracking global data on electric vehicles*. https://ourworldindata.org/electric-car-sales#article-citation
- Saxena, Dr., Sharma, S., Sharma, S., & Jindal, V. (2023). Electric Vehicles: A Catalyst for Economic Growth in India. *Journal of Informatics Education and Research*, *4*(1). https://jier.org/index.php/journal/article/view/595/528.
- Shinde, A., Ambre, A., & Nor, C. (2024). Futuristic Trends in Mechanical Engineering. In *IIP Series* (No. 7; Vol. 3, pp. 184–185).
- Singh, R. R., Gupta, N., & Yadav, G. R. (2023). Scope of electric vehicles and the automobile industry in Indian perspective. *THE SCIENTIFIC TEMPER*, *14*(03), 563–569. https://doi.org/10.58414/scientifictemper.2023.14.3.01.

- Singh, S. P., Teli, G., & Tyagi, R. (2024). The Current Landscape of Electric Vehicles in India: Developments and Challenges. In Indian Institute of Technology (Banaras Hindu University) Varanasi, ARYA COLLEGE OF ENGINEERING & I.T., & Arya College of Engineering & IT, *7th Int. Conf. on Advanced Technology and Engineering Trends (ICATET-2024)* (p. 7). ACEIT Jaipur. https://www.researchgate.net/publication/381670986.
- Tarei, P. K., Chand, P., & Gupta, H. (2021). Barriers to the adoption of electric vehicles: Evidence from India. *Journal of Cleaner Production*, *291*, 125847. https://doi.org/10.1016/j.jclepro.2021.125847
- Tomar, H. (2023). Rise Of Evas An Emerging and Convenient Market in Automobile Sector in India. *International Journal for Multidisciplinary Research (IJFMR)*, *5*(2).
- Un-Noor, F., Padmanaban, S., Mihet-Popa, L., Mollah, M. N., & Hossain, E. (2017). A Comprehensive Study of Key Electric Vehicle (EV) Components, Technologies, Challenges, Impacts, and Future Direction of Development. *Energies*, *10*(8), 1217. https://doi.org/10.3390/en1008121.

- Ministry of Heavy Industries and Public Enterprises, Government of India. (2023). FAME India Scheme. https://pmfme.mofpi.gov.in
- https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2003003
- https://pulseenergy.io/blog/ev-charger-types
- https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1567807
- NITI Aayog. (2020). National Electric Mobility Mission Plan 2020. https://evyatra.beeindia.gov.in/central-govt-initiative-details/dhi-2
- Society of Manufacturers of Electric Vehicles (SMEV). (2023). India's Electric Vehicle Industry Report. https://www.smev.in
- International Energy Agency (IEA). (2023). Global Electric Vehicle Outlook. https://www.iea.org/reports/global-ev-outlook-2023
- https://www.investindia.gov.in/team-india-blogs/indias-ev-economy-future-automotive-transportation#:~:text=With%20supportive%20government%20policies%2C%20increasing,to%20transition%20towards%20a%20more
- https://e-vehicleinfo.com
- https://www.manufacturingtodayindia.com/9364-indias-ev-market-to-grow-at-cagr-of-44-between-2020-2027-iesa-report#:~:text=In%20the%20base%20case%20scenario,be%20on%20lithium%2Dion%20batteries.
- IBEF. (2022). EV Market in India. IBEF. Retrieved from www.ibef.org
- *Topic: Electric vehicles in India*. (2023). https://www.statista.com/topics/12011/electric-vehicles-in-india/#topicOverview
- *India's Electric Vehicle sales trend | April 2024 • EVreporter*. (2024, May 6). https://evreporter.com/indias-electric-vehicle-sales-trend-april-2024/#oem-wise-e4w-sales-april-2024

- Muneer, T., Kolhe, M., Doyle, A. (2017). Electric Vehicles: Prospects and Challenges. Netherlands: ElsevierScience.**https://www.google.co.in/books/edition/Electric_Ve**

hicles_Prospects_and_Challeng/IhATDgAAQBAJ?hl=en&gbpv=1&dq=electric+vehicle+ecosystem+in+india&printsec=frontcover

- Shinde, A., Ambre, A., & Nor, C. (2024). Case Study on Market Share of Ev in India. *Futuristic Trends in Mechanical Engineering Volume 3 Book 7*, *3*, 177–183. https://doi.org/10.58532/v3bfme7p8ch2