

Energizing Sustainable Mobility: Unlocking India's Electric Vehicle Revolution

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Abstract

In recent years, efforts have been made to align economic growth with sustainable development. This involves incorporating sustainability concepts into economic policies, business practices, and development strategies. The aim is to achieve a balance between economic progress, social equity, and environmental protection, ensuring an inclusive development. Sustainable energy plays a pivotal role in achieving sustainable development by ensuring a reliable and environmentally friendly source of power for economic activities, while simultaneously reducing greenhouse gas emissions and environmental degradation. Transitioning to sustainable energy sources, such as renewable energy (solar, wind, hydro, etc.), promotes a cleaner environment, energy security, and resilience to climate change impact. Science and innovation illuminate the path towards a sustainable future, pointing us toward the immense potential of transitioning to clean energy systems. Technological advancements, particularly in the field of battery technology, semiconductors and microelectronics, hold the key to enabling this transformative shift towards electric vehicles.

Sustainable development and electric vehicles (EVs) are closely interconnected topics within the broader context of addressing environmental concerns, reducing greenhouse gas emissions, and promoting a more sustainable future for our planet. Electric vehicles are seen as a key technology in achieving sustainable transportation systems. This study explores the potential growth and implications of the electric vehicle (EV) market in India with a specific focus on two-wheelers (2W). The major objective of the study is to gauge the potentiality of Electric Vehicle Market in India and to trace out various challenges and opportunities to materialize this potentiality. The data sources are secondary and has been taken from authorized sites like SIAM and SMEV. By employing the data analysis tools like Excel, Tableau and Python this study tries to predict the penetration of Electric Vehicles till 2028. It highlights the increasing market share of 2W-EVs, regional variations in penetration rates, and the need for robust charging infrastructure to support the growing demand. By the understanding of the challenges, opportunities, and barriers

that lie ahead, we can pave the way for a paradigm shift towards sustainable mobility solutions that mitigate climate change and foster a cleaner, healthier planet for all. To capitalize on the growth and contribute to a sustainable future, it is recommended to focus on expanding the charging infrastructure, encouraging collaboration between the government and private sector, investing in research and development of semiconductor technology, promoting domestic production and innovation, supporting skill development programs, enhancing R&D in battery cost reduction, measures to enhance non-fossil electricity generation and strengthening regulations and standards in the electric vehicle market.

The shift towards electric vehicles represents a transformative change in the automotive industry. The comprehensive understanding of various aspects such as charging infrastructure, market trends, and semiconductor demand is crucial for successful implementation and growth of electric vehicles. The projected sale of electric Vehicles in India are expected to increase and also from the annual growth rate of 65,33% in 2023 which will stabilize by 15.31% by 2028. Also the expected domestic supply over the domestic demand highlights future export potential. Based on the findings, it is evident that the Indian market has immense potential for electric vehicle penetration and sales. However, continued efforts in infrastructure development, technological advancements, and supportive policies are essential to facilitate this transition. With the right strategies and collaborations, India can accelerate the adoption of electric vehicles and contribute to a sustainable and environmentally friendly transportation ecosystem.

Key Words: *Sustainable Energy, Electric Vehicles, SDGs, 2W-EVs, Transition, India.*

Introduction

least one of the next five years, as well as the entire fiveyear period, will become the warmest on record In recent years, our planet has experienced profound shifts in climate patterns, with wide ranging effects on the atmosphere, oceans, cryosphere, and biosphere. The Intergovernmental Panel on Climate Change's 2023 Synthesis Report emphasizes that these changes are occurring at an alarming pace, and every increment in global warming amplifies the risks we face. Human activities, particularly the emission of greenhouse gases, have accelerated the incidence and frequency of extreme events such as droughts, heavy rainfall, and heatwaves. As evidence mounts, it becomes increasingly apparent that urgent action is required to address the root causes of climate change. NASA's analysis for the year 2022 revealed that the Earth's average surface temperature tied with 2015 as the fifth warmest on record, highlighting the persistent trend of rising temperatures. The World Meteorological Organization has even predicted a 98% likelihood that at. The consequences of delaying action on climate change are dire. The report warns that even a delay until 2030 could push temperatures beyond the critical threshold of 1.5 degrees Celsius, leading to further calamitous consequences for our planet and future generations. However, amidst these challenges, there is hope. Science and innovation illuminate the path towards a sustainable future, pointing us towards the immense potential of transitioning to clean energy systems.

Technological advancements, particularly in the field of battery technology, semiconductors and microelectronics, hold the key to enabling this transformative shift towards electric vehicles. The assessment of emissions and energy consumption throughout the entire lifecycle of electric two-wheelers (2W-EVs) is crucial to fully understand their environmental impact. In addition to operational emissions, it is essential to consider the emissions released and energy consumed during the manufacturing and end-

of-life stages of the vehicle. Furthermore, the carbon emissions associated with the energy value chain, including extraction, distribution, and conversion, play a significant role in determining the overall "well-to-wheel" emissions of the vehicle. According to the International Energy Agency (IEA) report of 2019, plug-in electric cars globally emit similar amounts of greenhouse gases (GHGs) as hybrid vehicles, and fewer GHGs compared to the average internal combustion engine (ICE) vehicles using gasoline, over their life cycle. However, the specific impact varies depending on the country, influenced by the carbon intensity of the power generation mix and average fuel consumption of ICE vehicles. In countries where coal dominates power generation, very efficient ICEs like hybrid vehicles may exhibit lower emissions than EVs. Nevertheless, the potential for emission reduction throughout the life cycle of EVs increases with the accelerated decarbonization of electricity generation. By understanding the environmental impact of electric two-wheelers holistically, including the upstream and downstream emissions, it will be possible to evaluate their overall contribution to reducing greenhouse gas emissions and promoting sustainable transportation in India.

As the world's attention turns to electric vehicles (EVs) as a viable solution for sustainable development, the penetration of 2W-EV market over the next five years emerges as a crucial avenue for progress.

Literature Review and Problem Statement

Within the realm of the transportation sector, we are witnessing a rapid increase in both the number of vehicles and the demand for passenger transportation services. From 2001 to 2011, there was an 88% surge in the number of households owning cars and a 79% increase in 2-wheeler ownership, as highlighted by Dhar et al. (2015). Despite this growth in vehicle ownership, the statistics for 2010 showed only 15.7 cars per 1000 individuals and 81.7 2-wheelers per 1000 individuals. These figures are notably lower when compared to the considerably higher vehicle ownership rates seen in most developed nations, as reported by the World Bank (2014). The expected population and GDP growth, coupled with the relatively low levels of vehicle ownership, indicate a significant expansion in the number of vehicles in the future, thus driving the demand for road transport services. Projections from the National Transport Development Policy Committee (NTDPC) (2014) suggest that the demand for travel services provided by road transport is anticipated to reach 163,111 billion passenger kilometres (bpkm) by 2031, nearly 17 times the 2011 levels. In contrast, the International Energy Agency (IEA) (2013) maintains a more conservative outlook regarding demand growth, predicting that the demand for energy in the transport sector will climb to 174 Million Tonnes oil equivalent (Mtoe) by 2030, nearly three times the 2011 levels. Regardless of these varying expectations for the future, the growth in energy consumption within the transport sector appears to be inevitable, presenting significant challenges related to energy security, local environmental impact, safety, traffic congestion, and greenhouse gas emissions.

The adoption of electric vehicles (EVs) encounters a substantial hurdle due to their comparatively higher cost when compared to traditional vehicles. Nevertheless, research indicates that various incentives play a pivotal role in encouraging EV adoption. A study conducted by Aasness and Odeck (2015) underscores that the lower running and maintenance costs associated with battery electric vehicles (BEVs) serve as compelling reasons for their adoption. Kahn (2007) suggests that individuals who exhibit concern for the environment tend to have a stronger inclination toward adopting electric vehicles (EVs). These findings find support in the research conducted by Pierre, Jemelin, and Louvet (2011). Individuals who display a proclivity for environmental protection and energy conservation show a heightened intention to adopt EV technology. It can be inferred that pro-environmental consumers are the most likely candidates for embracing EVs, as highlighted in the research by Schuitema, Anable, Skippon, and Kinnear (2013). Furthermore, the adoption of EVs is regarded as a means to mitigate environmental risks, as concluded by Bockarjova and Steg (2014). This perspective is reinforced by the findings of Jensen et al.

(2013) and Sang and Bekhet (2015), both of whom identified that reducing environmental risks through EV adoption has a positive influence on the decision to adopt electric vehicles. As supported by studies conducted by Adepetu and Keshav (2015), Barth et al. (2016), and Lieven, Henkel, and Waller (2011), lower operating costs emerge as a driving force behind EV adoption. The importance of environmental benefits as motivating factors for EV adoption is further underscored by the results of a consumer survey in Germany, as reported by Peters and Dutschke (2014). Their research suggests that these environmental advantages play a pivotal role in inspiring individuals to opt for EVs.

India's motorization rate is one of the lowest globally, with only 22 cars per 1,000 people. However, the country is experiencing rapid growth in the transportation sector, driven by rising income levels and urbanization. From 2011 to 2020, domestic vehicle sales, including two wheelers, three-wheelers, passenger vehicles, and commercial vehicles, grew at a compound annual growth rate (CAGR) of around 4%. While the growth in the transport industry presents economic opportunities, it has also contributed significantly to India's greenhouse gas (GHG) emissions. In 2016, the transport sector accounted for 270.6 million metric tons of CO₂ equivalent (CO₂e) emissions, making it the third-highest contributor after the power industry and industrial combustion. Within the transportation sector, road transport has been the largest contributor to GHG emissions. India faces intense emission challenges due to the increasing transport industry. Past pollution levels in the country have been alarming, highlighting the need for urgent action. India has a significant opportunity to leapfrog towards decarbonizing its transport system, not only to fulfil its Nationally Determined Contributions (NDC) commitments but also to address environmental issues that could worsen if left unaddressed. The country has substantial growth prospects, making it crucial to tackle emissions and promote sustainable transportation solutions. By prioritizing decarbonization and implementing measures to reduce emissions, India can achieve its environmental goals, mitigate the adverse effects of pollution, and pave the way for sustainable and cleaner mobility in the future. India is currently facing significant challenges in controlling its carbon emissions, and these challenges are expected to intensify as the country's transport industry expands. To address the emissions from the transport sector, India is actively transitioning towards a "zero or low carbon emission" transportation model by promoting the adoption of alternative fuel vehicles and electric vehicles (EVs). In 2009, India established the National Biofuels policy with an ambitious target of blending 20% biofuels into diesel and petrol by 2017. However, progress towards this target has been limited, with only approximately 2% bioethanol and 0.1% biodiesel blend achieved by 2018. To improve fuel efficiency, India introduced its first passenger vehicle fuel efficiency standards in 2014, which came into effect in 2017. However, these standards are still less stringent than the norms followed by the European Union (EU). Recognizing the importance of EVs in reducing emissions, India has set a national target of achieving 30% EV sales penetration by 2030. To support this goal, the government launched the National Mission on Transformative Mobility and Battery Storage, which aims to promote the localization of EV component manufacturing within the country. In addition to central-level interventions, several states in India have implemented their own policies to encourage the adoption of electric vehicles. These policies include subsidies, tax exemptions, and other incentives for consumers and buyers. Overall, India is committed to transitioning towards a sustainable transportation system by promoting alternative fuel vehicles, improving fuel efficiency standards, and accelerating the adoption of electric vehicles. The adoption of electric two-wheelers in India is witnessing significant growth, outpacing other personal vehicle segments, and offering potential benefits such as reduced air pollution and cost savings for users. However, the current rate of adoption is far below the required pace to achieve the national target. This situation necessitates an analysis of the future penetration of electric two-wheelers. Understanding the factors hindering the widespread adoption of electric two-wheelers is crucial to address the challenges and develop strategies to accelerate their market growth. Therefore, a comprehensive investigation into the barriers and opportunities for the electric two-wheeler segment becomes imperative in this study.

Objectives

- To identify the need of Penetration of Electric Vehicles in India's Transportation scenario.
- To analyse challenges and opportunities in the decarbonization process of Indian transportation.
- To analyse the Penetration of semiconductor and microelectronics in connection with the emerging Electric Two Wheeler segment in India.

Methodology

The data for the analysis has been taken from SIAM (Society of Indian Automobile Manufacturers), SMEV (Society of Manufacturers of Electric Vehicles) and compiled from various sources. The scheduler formation of data and its visualization are done with the help of Excel and Tableau. The study is mainly descriptive in nature rather than analytical. Discussions with the Company Head, Sr. Director held to identify the problems and prospects of the study topic. The various stages through which the study done can be summed up as follows

- Literature Review: Conduct an extensive review of academic papers, industry reports, and relevant literature to gain insights into the current state of the 2W-EV market and related factors affecting market penetration.
- Data Collection: Collect quantitative data on the current market size, sales trends, and adoption rates of electric two-wheelers in India.
- Stakeholder Interviews: Conduct interviews with industry experts, manufacturers, policymakers, and key stakeholders involved in the electric vehicle industry to gather qualitative insights, identify challenges, and explore growth opportunities.
- Market Analysis: Analyse market trends, consumer preferences, and regulatory frameworks impacting the adoption of electric two-wheelers.
- Future Projection: Utilize the collected data and market insights to forecast the growth trajectory of the 2W-EV market over the next five years.
- Recommendations: Based on the findings, develop practical recommendations and strategies for industry players, policymakers, and stakeholders to promote the adoption of electric two-wheelers technology effectively.

Results and Discussions

Electrification of vehicles- Major Challenges

High Battery Cost. The high cost of batteries is a significant challenge for the adoption of electric two-wheelers in India. The higher price of EVs could restrain EV adoption. While the cost of lithium-ion batteries has decreased over the past decade, concerns about the availability of lithium have slowed down the downward trajectory and even led to slight cost increases. However, some studies project that the cost of lithium-ion batteries could reduce in the future, driven by advancements in solid-state technology. In India, the local manufacturing of batteries, supported by initiatives like the Production Linked Incentive scheme for Advanced Chemistry Cells could further contribute to cost reduction.

Supply chain constraints. The Indian electric two-wheeler (E2W) industry faces challenges due to the dependence on imported key components such as batteries, motors, and power electronics, which account for approximately 60% of the total cost. This reliance on imports hinders the localization efforts of E2W original equipment manufacturers (OEMs), making it difficult for them to meet the 50% localization

criteria required to avail government incentives. Currently, most Indian manufacturers import completely knocked-down E2W kits from China and assemble them locally for sale in the domestic market. However, these assembled E2Ws often lack comprehensive testing under actual Indian riding conditions, leading to issues like fire accidents. To address this, it is crucial for the E2W industry to focus on enhancing the indigenous supply chain and prioritize rigorous product testing and research and development (R&D) activities.

Lack of Sufficient Charging Infrastructure. One of the major obstacles impeding the widespread adoption of electric vehicles (EVs) in India is the insufficient charging infrastructure. The availability of a robust and widespread charging network is vital to alleviate range anxiety among EV users and provide convenient charging options throughout the country. In March 2021, India had approximately 1800 charging stations for electric vehicles. The government has approved the installation of an additional 3300 charging stations under the FAME (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles) scheme. In the first phase of the scheme, 520 charging stations were sanctioned, and of these, 429 have already been commissioned. In the second phase, 2877 charging stations have been approved. Currently, the number of charging stations in India falls significantly short in comparison to the growing number of EVs on the road. This disparity is particularly evident in residential areas, public spaces, and along highways, where EV owners require easy access to charging facilities.

Major Opportunism Ahead

Discovery of Lithium Deposits. Recent media reports have indicated the discovery of lithium reserves in Rajasthan's Degana region, following the previous discovery in Jammu and Kashmir. According to state government officials, the lithium reserves in Rajasthan are believed to be even larger than those found in Jammu and Kashmir, potentially meeting up to 80% of India's lithium demand. The exploration of rare metal reserves, including lithium, has become a priority for the Indian government due to its crucial role in electric vehicle (EV) batteries.

Anti-inflationary Perception on Electric Vehicles. Fuel has been the largest driver of inflation in the last 10 years as per the Indian Economy Data. Overall consumer prices in the FY 2023 were 1.5 times what they were in FY 2013, while fuel index was 1.75 times. Households tend to perceive inflation higher than it actually is and are very sensitive to changes in food and fuel prices (Inflation expectation survey of households - RBI).

Growing Economy and Market. EVs also offer an opportunity for many countries with no fossil reserves to be independent of foreign oil and to develop flexible infrastructure based on renewable sources of energy. Countries such as India, which are less industrialised but have significant potential for economic growth, are also trying to capitalise on the economic opportunities that EVs provide. Indian economic growth refers to the sustained increase in the country's gross domestic product (GDP) over time, reflecting the expansion and development of various sectors of the economy. India has emerged as one of the world's fastest-growing major economies, with several factors contributing to its economic growth.

Source of energy-relative advantage. Similar to carbon emissions, the local pollution associated with charging an electric vehicle (EV) depends on the emissions of the marginal generating unit. In the United States, the marginal generator is typically coal or natural gas, as they can easily increase production on demand. According to the Energy Information Administration's 2020 report, approximately 60 percent of electricity in the United States was generated from coal or natural gas, a decrease from 70 percent in 2014. India, on the other hand, has a relative advantage compared to many other countries. Only 49.3 percent of electricity generation in India relies on fossil fuels. Furthermore, the Central and South Asia region,

which includes India, has experienced significant growth in electricity access (electricity generation outpacing population growth).

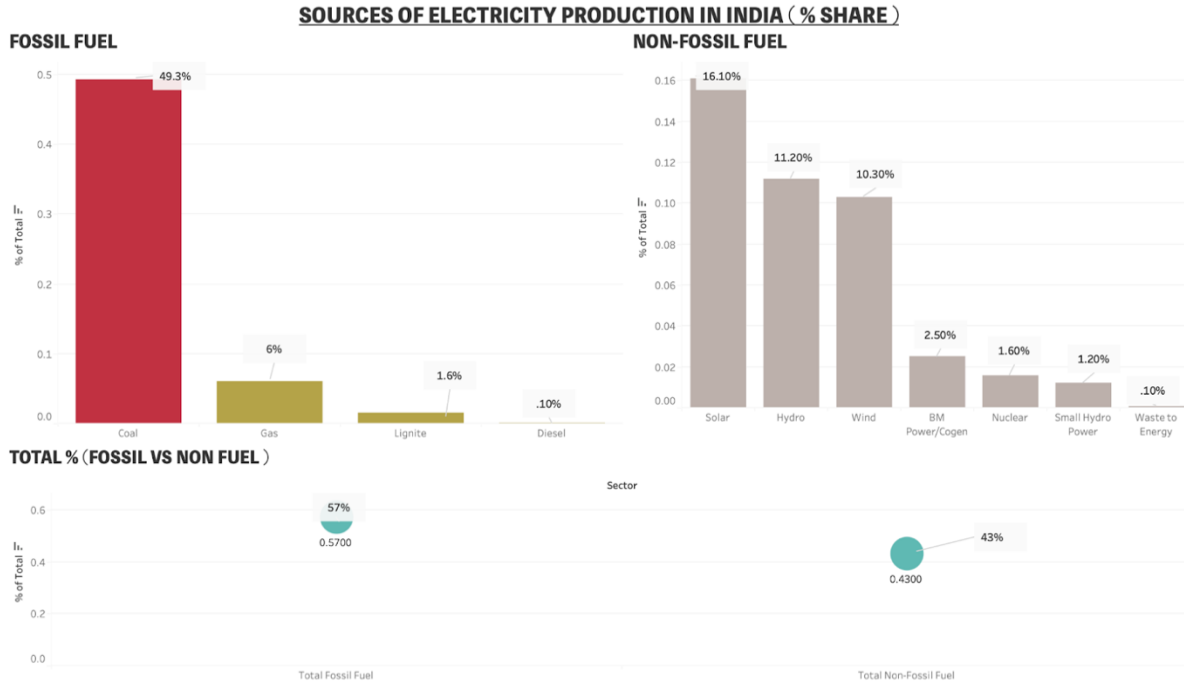


Fig 1

Source : Government of India (Ministry of Power)

Note : Dashboard created using tableau

Electric Vehicles- Penetration Ahead (2023-24 to 27-28)

Since 2017, the market has registered a continuous growth in sales(except the pandemic year of 2020). The gradient of growth line became tremendously steep in the year 2021-2022. In 2022 the sale of EV scaled up to 1179274.



Fig 2

Source : SMEV (Society of Manufacturers of Electric Vehicles)

Note : Visualization created using Excel

On the basis of the historical data from 2017-22, this study projected the sale of Electric Vehicles expected to be sold in Indian market for the next five years by using the software Python. The result is depicted in the Fig5.6.

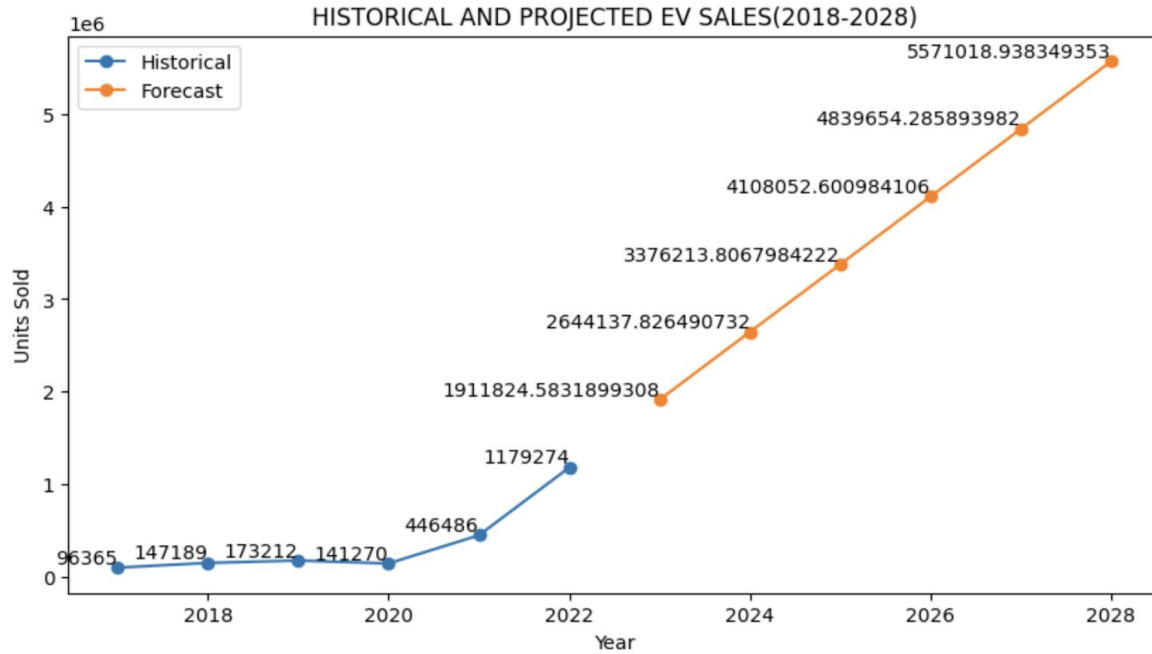


Fig 3

Source : Historical Data : SMEV (Society of Manufacturers of Electric Vehicles)

Note : Projection done using Python

Table 1
Projected Annual Growth of EV sales in India

Year	Projected Sales (in Lakhs)	Annual Growth rate(%)
2023	19.12	62.17
2024	26.44	38.28
2025	33.76	27.68
2026	41.08	21.68
2027	48.40	17.81
2028	55.71	15.10

Based on the assumption of technology, battery cost, government subsidies, and regulations remaining unchanged, the sales of electric vehicles (EVs) in the Indian market are projected to increase from 19.12 lakhs in 2023 to 55.71 lakhs in the calendar year 2028. These projections indicate the annual growth rates, as outlined in Table 1. The recorded annual growth rate for 2023 stands at 62.17 percent. However, the subsequent years display a declining trend in growth rates. By 2028, the growth rate is expected to stabilize at a moderate level of 15.1 percent.

These projections are based on the assumption that the current factors affecting EV sales, such as technology advancements, battery costs, government support through subsidies, and regulatory frameworks, remain consistent during the forecast period. Any changes in these factors could impact the actual growth rates and sales figures.

Penetration of Electric Two Wheelers- Current scenario (2023-28)

The representation of sales of 2W-EV in total EV sales recorded in India in 2022 unveils the fact that out of the total electric vehicles sold in India , two wheelers represent 61.67%.

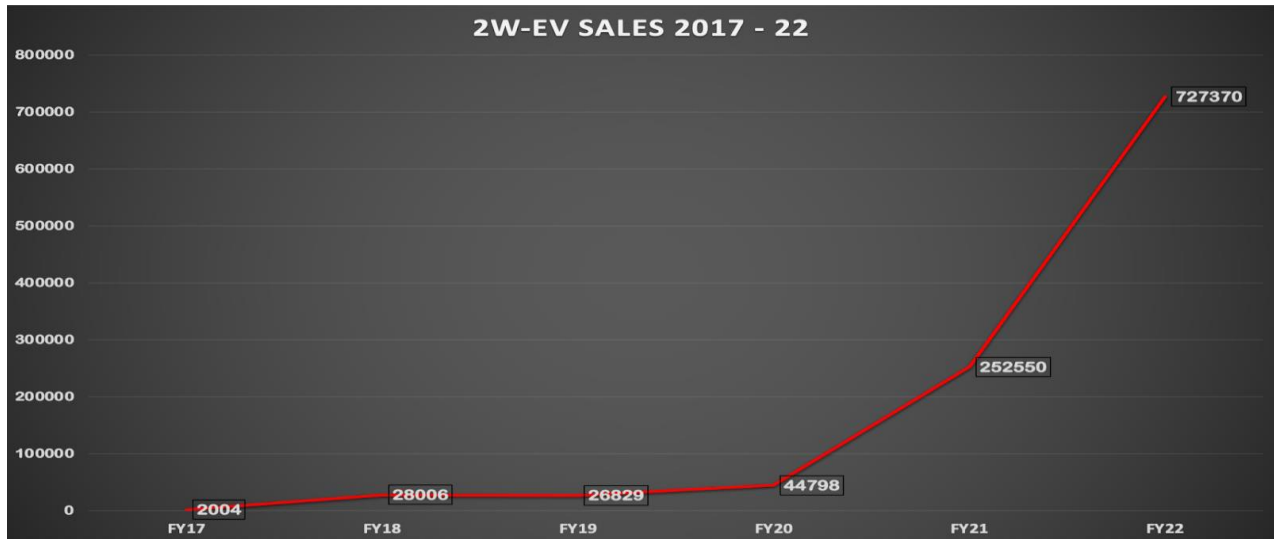


Fig 4

Source : SMEV(Society of Manufacturers of Electric Vehicles)

Note : Line graph created using Excel.

The sales trend of 2W-EV between 2017 and 2022 is depicted in the Fig 4, which shows after 2020, the market has registered a steep growth. Only 2004 Electric two-wheeler vehicles were sold in FY2017. But within five years the figure galloped to 727370 in FY2022, with 362 times of difference.

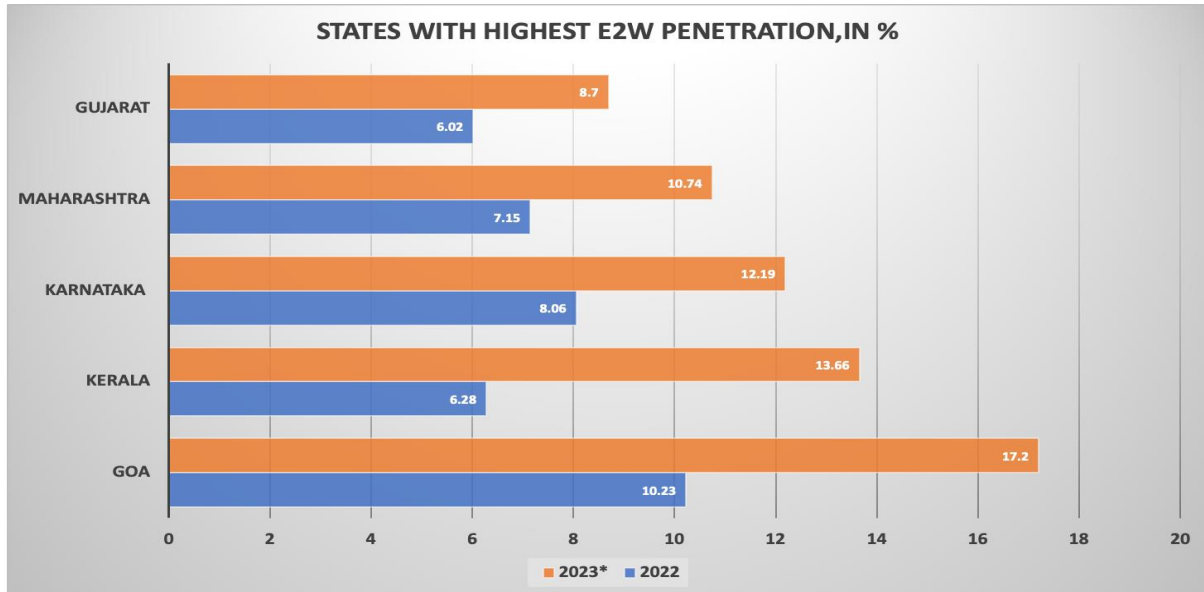


Fig 5

Source : Economic Times

Note : Visualization created using Excel

The penetration of 2W-EV sales (as a percentage of total two wheelers sold) across different states in India is shown in the figure 5.10. Among the states in India, four have surpassed the 10% mark in electric two-wheeler (2W-EV) penetration. Leading the way is Goa with a penetration rate of 17.20%, although the actual number of E2Ws sold in the state is relatively modest. Kerala follows closely with a penetration rate of 13.66%, and Karnataka is next with 12.19%. Maharashtra, on the other hand, has a penetration rate of 10.74% and stands out as the largest state in terms of the number of 2W-EVs sold (Fig 5)

Overall, India has achieved a 2W-EV penetration rate of 5.63%, showing an increase from 4.05% in 2022. According to the data, 392,681 E2Ws were sold in the first five months of 2023 out of a total of 6.98 million two-wheeler sales. However, it is worth noting that electric vehicle adoption has yet to gain momentum in the North East states of India.

2W-EV Production-Projection 2023-28.

The projected future production of 2W-EV is done by SIAM which is depicted in Fig 6, which upholds a tremendous growth trajectory. Their study predicts the production of 61.5 lakhs in FY 2027-28. The projected ICE 2W production is also depicted in the Fig 7.

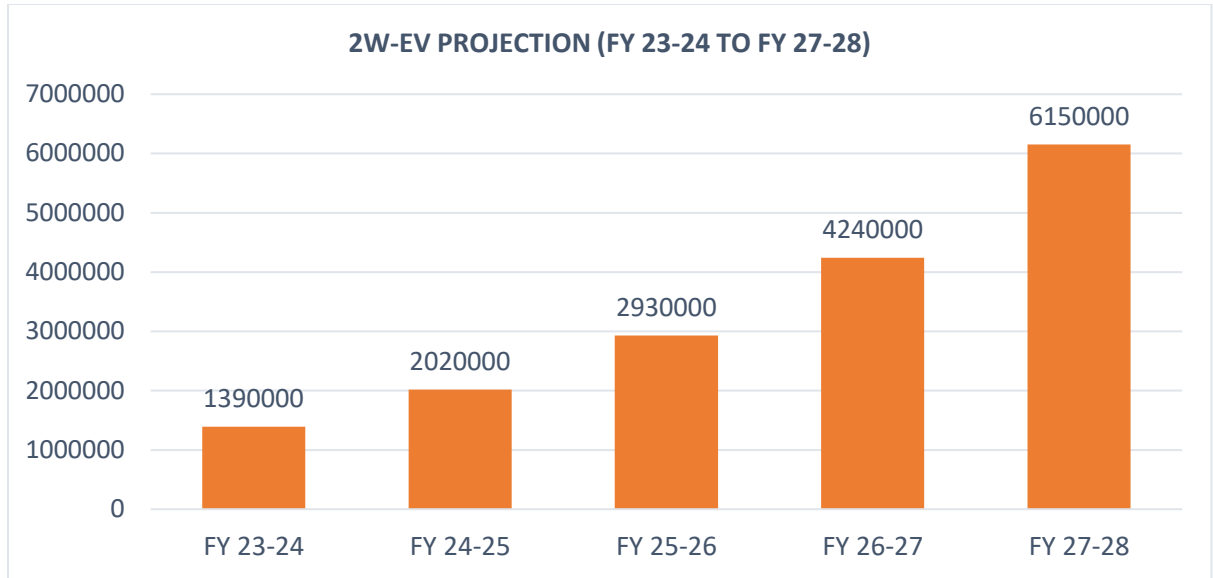


Fig 6

Source : SMEV(Society of Manufacturers of Electric Vehicles)

Note : Visualization created using Excel.

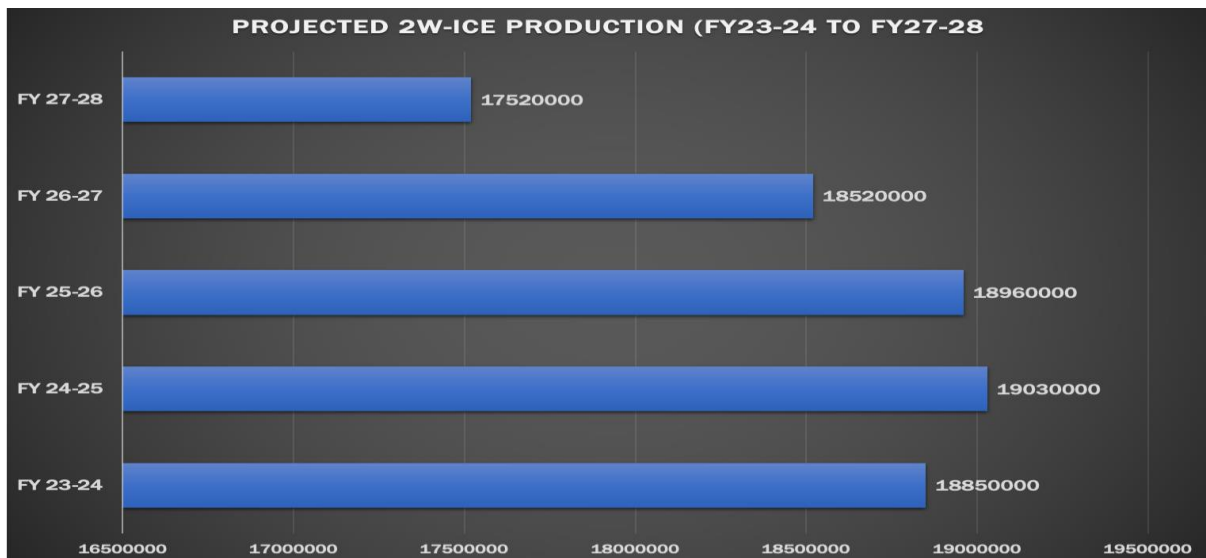


Fig 7

Source : SIAM (Society of Indian Automobile Manufacturers)

Note : Visualization created using Excel.

2W-EV Sales Projection

With the use of python this study projects the sale of 2W-EV for the next 5 years as shown in Table 2 and Fig 8

Table 2
Projected Annual Growth of 2W-EV Sales in India

Year	Sales(in Lakhs)	Annual Growth rate(%)
2023	12.02	65.33
2024	16.77	39.51
2025	21.52	28.32
2026	26.27	22.07
2027	31.01	18.04
2028	35.76	15.31

Assuming that there are no changes in technology, battery costs, government subsidies, and regulations, the sales of electric two-wheelers (2W-EVs) in the Indian market are projected to experience significant growth. From an estimated 12.02 lakhs in 2023, sales are expected to reach 35.76 lakhs by 2028, according to the provided projections in Table 2. The growth rate for 2023 is recorded at an impressive 65.33 percent. However, the subsequent years exhibit a declining trend in growth rates. By 2028, the growth rate is predicted to stabilize at a more moderate level of 15.31 percent.

It is crucial to note that these projections are contingent upon the assumption that crucial factors influencing EV sales, such as technological advancements, battery costs, government subsidies, and regulatory frameworks, remain constant over the forecast period. Any changes to these factors could potentially impact the actual growth rates and sales figures.

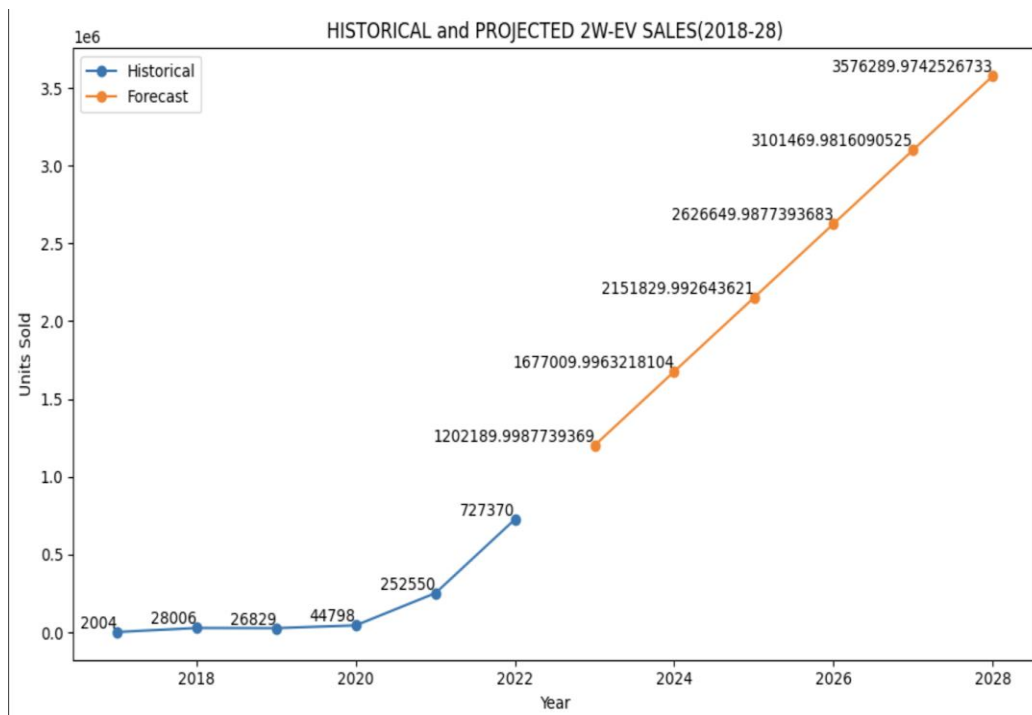


Fig 8

Source : Historical Data : SMEV (Society of Manufacturers of Electric Vehicles)

Note : Projection done using Python

To catch the future representation of 2W-EV in the Total 2W market of India, this study attempted to project 2W sales(both EVs and ICEs)also, which is shown in Fig 9.

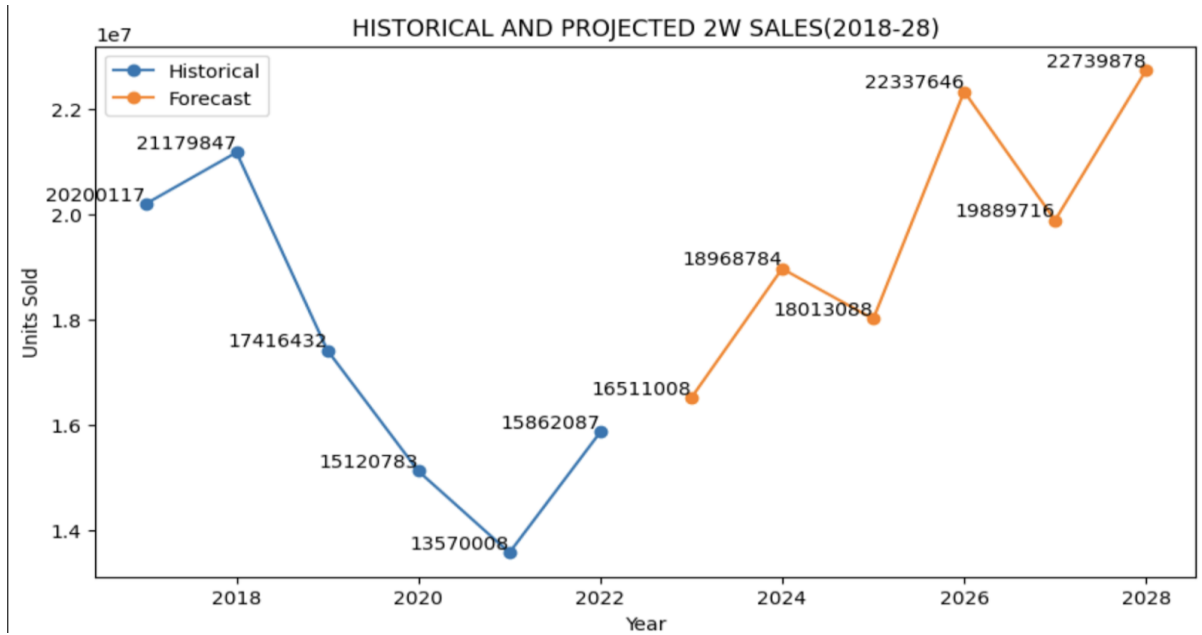


Fig 9

Source : Historical Data : SIAM(Society of Indian Automobile Manufacturers)

Note : Projection done using Python

Table 3

Projected% of 2W-EV in total 2W sales

Year	Two wheelers(in Lakhs)	Electric	Representation(%)
2023	165.11	12.02	7.27
2024	189.68	16.77	8.84
2025	180.13	21.52	11.94
2026	223.37	26.27	11.76
2027	198.89	31.01	15.59
2028	227.39	35.76	15.72

Table 3 highlights the projection of 2W sales in India for the next five years and also gives the data on percentage representation 2W-EV in it. Out of 227.39 lakhs of two Wheeler sales, the share of 2W-EV would be 35.76 lakhs, i.e. 15.72% in 2028.. The continuous increasing share is obvious.

The findings of the paper provide valuable insights into the current state of electric vehicles in India and offer projections for the future.

The projected sale of electric vehicles in the Indian market is expected to increase from 19.12 lakhs in 2023 to 55.71 lakhs in 2028, with an annual growth rate of 62.17% in 2023, stabilizing at 15.1% by 2028.

The sales of electric two-wheelers (2W-EVs) in India are projected to experience significant growth, from 12.02 lakhs in 2023 to 35.76 lakhs in 2028, with a growth rate of 65.33% in 2023, stabilizing at 15.31% by 2028.

The projected production of 2W-EVs in India is expected to reach 61.5 lakhs in FY 2027-28. The considerable gap identified in the projected figures of production and sale opens new vistas for export potential. The expected domestic supply over the domestic demand highlights future export potential.

Based on these findings, it is evident that the electric vehicle market in India holds immense potential. To capitalize on this growth and contribute to a sustainable future, it is recommended to focus on expanding the charging infrastructure, encouraging collaboration between the government and private sector, investing in research and development of semiconductor technology, promoting domestic production and innovation, supporting skill development programs, enhancing R&D in battery cost reduction, measures to enhance non-fossil electricity generation and strengthening regulations and standards in the electric vehicle market.

To harness this export potential, it is crucial for manufacturers to align their production capacities and capabilities with international standards and regulations. They need to focus on product quality, reliability, and cost competitiveness to gain a competitive edge in the global market. By implementing these recommendations and leveraging the projected growth, India can accelerate the adoption of electric vehicles and foster a greener and more sustainable transportation ecosystem.

Conclusion

The shift towards electric vehicles represents a transformative change in the automotive industry. The comprehensive understanding of various aspects such as charging infrastructure, market trends, and semiconductor demand is crucial for successful implementation and growth of electric vehicles. Based on the findings, it is evident that the Indian market has immense potential for electric vehicle penetration and sales. However, continued efforts in infrastructure development, technological advancements, and supportive policies are essential to facilitate this transition. With the right strategies and collaborations, India can accelerate the adoption of electric vehicles and contribute to a sustainable and environmentally friendly transportation ecosystem.

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