



# Social and Economic Impact of Hybrid Electric Vehicles on Environment: An Indian Case Study

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**Abstract:** There have been developments in the vehicle business as a result of the introduction of new technology and the rise in pollution levels. Hybrid electric vehicles can be thought of as alternatives to vehicles powered by internal combustion engines, and the use of regenerative braking systems could provide a solution for reusing energy and limiting vehicle speeds. Electric vehicles emit less CO<sub>2</sub>, which is rising demand in every country. In addition, the Indian government intends to promote the use of electric vehicles in the automobile industry. Through a brief examination of history and laws adopted by the Indian government, this article explores the prospects, difficulties, and future of hybrid electric vehicles in the Indian market. This article examines the economic and social aspects that influence the hybrid electric car market in India. The issues are then addressed, and recommendations are offered to help the hybrid electric vehicle market flourish.

**Index Terms - Automobile, Internal Combustion Engine, Electric Vehicle, CO, Regenerative braking**

## I. INTRODUCTION

Can long traffic jams lead to reduced carbon emissions? Road transport is one the major contributors to air pollution in the world. A recent report shows 24% of the air pollution is caused by road transport in the world and the situation is getting worst in India as 94% of the air pollution is caused by Road transport. This issue is taught and talked about for over decades but no major implementation of policies is seen. During the budget of fiscal year 2021-22, we saw that the government announced various schemes about the adoption of electric vehicles and hybrid electric vehicles.

Hybrid electric vehicles are powered by an internal combustion engine and an electric motor, which uses energy stored in batteries. A hybrid electric vehicle cannot be plugged in to charge the battery. Instead, the battery is charged through regenerative braking and by the internal combustion engine. This regenerative braking system will use the power lost at the time of slowing down a car and using it to recharge the car's batteries. On a normal car, braking simply wastes energy - but with regenerative braking, some of the energy is able to be reused.

As, 85% of the car is made up by reused material by using the technique it could reuse the energy while on road as well.

## II. RESEARCH PROBLEM

Even after so many policies announced by the government, there is still hesitation in adoption of Hybrid Electric Vehicles.

## III. OBJECTIVES OF THE STUDY

To understand the Indian Automobile Production and Sales

To identify the opportunities and challenges of using electric vehicles in India.

To study the economic and social impact of HEV's in India and its vision for 2030.

## IV. RESEARCH METHODOLOGY

The methodology adopted would be Descriptive research; which is a methodology approach that investigates research questions that have not previously been studied in depth. In India though Hybrid Electric Vehicles are talked about and many companies have started manufacturing the same but it is still a long way to go when till will be seen in every household and this will make the perfect base for my study. The data used is secondary data collected from the respective source. The survey conducted by Deloitte helps in better understanding of the research questions. (2020) 2020)

## V. BACKGROUND

• The beginning: The launch of the first hybrid electric car was done in 1899 by Ferdinand Porsche. The car made used a gasoline engine to supply power to the motor. Even though it took into consideration some major issue that needed to be addressed for the future but like every other business it needed profit to run and due major losses it shut down and became obsolete for a long period.

- **Renewed Interest:** As the first step is usually taken by the developed countries, USA introduced a legislation to encourage the use of electric vehicles in order to reduce air pollution. But this time like before even though the government was in favor of hybrid vehicles it didn't gather much people interest even after facing the oil crises in 1973. A major portion of Americans drove to work but as known a fact people didn't care about the environment at that time.
- **The Rebirth:** Developed countries although introduced relevant technology and reduced the carbon emissions, it the developing countries like India which are struggling. The adoption of hybrid vehicles is still in process as many factors are to be considered when it comes to a diverse economy like India.
- **The Future:** By 2050, for the economies to go to net zero emissions it is the goals that we make for the future which are important and so by 2030, almost all automobiles will switch to electric vehicles which will make the vehicles more affordable and proper infrastructure for adoption.

In Indian context,

The policies introduced the Indian Government for the promotion and adoption of Hybrid Electric vehicles include:

- **Auto PLI Scheme:** In September, the Union Cabinet approved a Rs 26,058 crore production-linked incentive (PLI) scheme to boost local manufacturing of electric and fuel cell vehicles, as well as drones, in India.
- **FAME II Amendment:** Under it, the government reduced the price gap between petrol-powered two-wheelers and electric two-wheelers by raising the subsidy rate for electric two-wheelers from Rs 10,000/kWh to Rs 15,000/kWh and capping incentives at 40% of the vehicle's cost, as opposed to 20% previously.
- **The Centre's Scrappage Policy:** In August of this year, Prime Minister Narendra Modi virtually announced the Vehicle Scrappage Policy at the Gujarat Investor Summit. In an environmentally beneficial manner, the strategy attempts to phase out unfit and polluting automobiles. Vehicles will be scrapped not only because of their age, but also if they are judged to be unfit through automated testing. In 2024, the scrappage policy for private vehicles will be adopted.

(News18.com 2020) As a result, "Maruti Suzuki and Toyota are collaborating on self-charging hybrid vehicles."

There are currently no electric automobiles available for less than Rs 10 lakh. Mahindra & Mahindra (M&M) had planned to unveil the eKUV100, which was supposed to be India's cheapest electric car, however due to a shift in product strategy and a scarcity of semiconductors, the introduction has been postponed significantly. The Tata Nexon is India's best-selling electric car, with a market share of 70% and a wait time of 14-16 weeks. The Nexon electric car costs Rs 14 lakh (excluding State subsidies)

## VI. LITERATURE REVIEW

Everything in the world has its own advantages and disadvantages but when these disadvantages tends to increase over the years this causes a point of introspection of what needs to be done in order to turn up the situation and once again make it to the equilibrium.

### Problems caused by fueled vehicles

(Shrivastava R. K. n.d.) (Michal Krzyzanowski n.d.) (<https://www.ijert.org/opportunities-and-challenges-of-electric-vehicles-in-india> n.d.) There are some key problems that arise due to fueled vehicles though these problems seem very large at macro level but have started effecting on the micro level as well. The problems at macro level concerned like increased carbon emissions causing global warning, air and noise pollution leading to poor air quality etc. and these problems at macro level affect at micro level like long traffic congestions, health problems like asthma, lung diseases etc.

### Comparative Study of Fueled Vehicles with Hybrid Vehicles

(Anderson J n.d.) (Amin paykani n.d.) (459 n.d.) The problems caused by fueled vehicles has been a major issue for many decades leading to many solutions or alternatives coming up but the one that continued and contributed to the issue is substitution of fueled vehicles to electric and hybrid vehicles. The study shows that there are two main key points of preferring hybrid vehicles over fueled vehicles would be (1) These vehicles are more fuel efficient and (2) These vehicles work on the model of 'Regenerative Braking'.

### Challenges faced in Adoption of Hybrid Electric Vehicles by India

(Rupesh Kumar n.d.) (Sonali Goel n.d.) (Menonjyoti Kalita n.d.) When something is good for the environment as well as for its people but is still taking time to be adapted worldwide then there has to be some challenges in its way. Continuing the approach, similar is the case with adoption of Hybrid vehicles. Economic, social, technical and environmental factors affecting the hybrid electric vehicles market in India. The challenges include: developing nation HEV adoption and large market growth is difficult, availability of raw materials, building of semi-private and public charging infrastructure, cost of materials, packaging, power conversion, replacement, operation, maintenance as well as labor, power generation etc.

## VII. DATA ANALYSIS

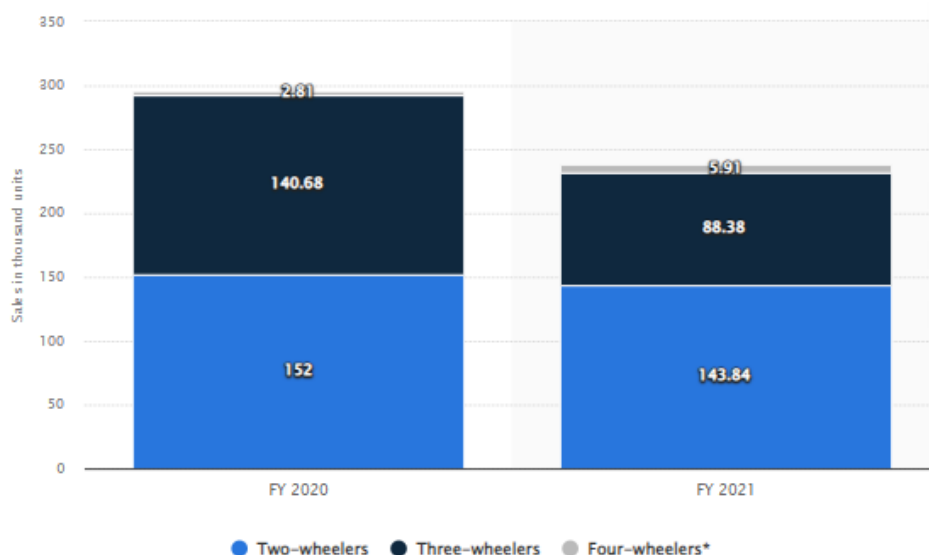
In this section, I have taken data of domestic sales trends in India from the year 2015 to 2021 and sales of Electric vehicles across India for the year 2020 to 2021 to compare and analyze the results.

### Automobile Domestic Sales Trends (In Numbers) (siam.in 2021)

Category	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Passenger Vehicles	2,789,208	3,047,582	3,288,581	3,377,389	2,773,519	2,711,457
Commercial Vehicles	685,704	714,082	856,916	10,07,311	717,593	568,559
Three Wheelers	538,208	511,879	635,698	7,01,005	637,065	216197
Two Wheelers	16,455,851	17,589,738	20,200,117	21,179,847	17,416,432	15,119,387
Quadricycle	0	0	0	627	942	-12
<b>Grand Total</b>	<b>20,468,971</b>	<b>21,863,281</b>	<b>24,981,312</b>	<b>26,266,179</b>	<b>21,545,551</b>	<b>18,615,588</b>

The automobile market in India is categorized as passenger vehicles, commercial vehicles, three wheelers, two wheelers and quadricycle out of two wheelers and passenger vehicles are the two sectors with most sales. These are the sectors that are most considered in manufacturing of Electric Vehicles. As, Hybrid Electric vehicles is a future concept and would depend on the outcome of sales of Electric Vehicles. Following is the data representing sales of Electric Vehicles for the years 2020 and 2021.

**Sales of electric vehicles across India from financial year 2020 to 2021** (<https://www.statista.com/statistics/1234761/india-electric-vehicle-sales-by-type/2021>)



In financial year 2021, the leading type of electric vehicles sold in India was two-wheelers, reached around 144 thousand units. This was a five percent decrease from the previous year's 152 thousand units. The only section that saw growth was four-wheelers. In order to understand the Indian automobile sales with the introduction of Electric vehicles in the Indian market, I have done linear regression analysis:

$$y = a+bx$$

Where, y = dependent variable = monthly automobile sales in India in 2021

x = independent variable = monthly sales of electric vehicles in India in 2021

Hypothesis:

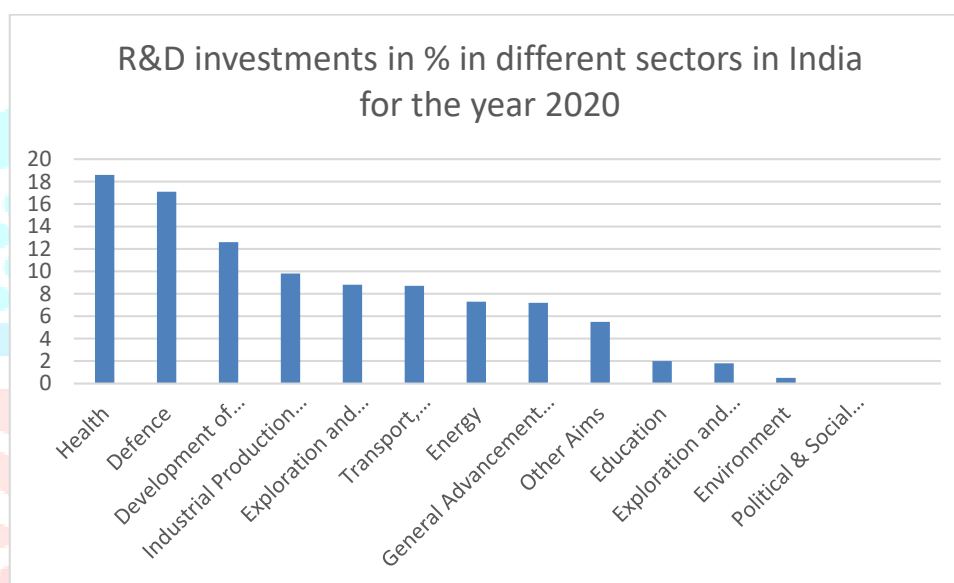
Ho: There is a no impact on automobile sales with the introduction of Electric Vehicles

Ha: There is impact on automobile sales with the introduction of Electric Vehicles

Regression Statistics	
Multiple R	0.34892166
R Square	0.121746325
Adjusted R Square	0.033920957
Observations	12

After conducting the regression analysis in Excel it was found that there is 35% correlation existing between the two variables and 12% variation in the sales of automobile sector is explained by the sales in electric vehicles. Thus, rejecting the null hypothesis and accepting the alternate hypothesis as there is a variation in automobile sales due to the introduction of electric vehicles.

As there is potential seen in the transport sector so the government is also spending major portion of R&D in the transport sector as depicted in the graph chart below, where the government has allocated 8.7% of its total funds in R&D to transport.



### VII.1. Deriving the Social and Economic Impact of Hybrid Electric Vehicles on Environment on India

In India, the economic difficulty is a big issue for HEV. HEV adoption and big market growth are tough in India. Economic issues come in a variety of shapes and sizes. Because of the higher initial investment, petroleum is more expensive than electricity, while the cost of infrastructure installation is higher for hybrid electric vehicles.

Charging infrastructure is required. Public charging infrastructure is available to the whole public and is commonly located at public parking areas, whereas semi-public charging infrastructure is restricted to a specific set of people. The charging infrastructure built in a private garage or home is referred to as private charging infrastructure. One of the issues in developing countries like India is the high starting cost.

The scarcity of raw materials has made it difficult to manufacture and develop energy storage devices for electric vehicles. This is because an electric vehicle's energy storage system is made of high-grade components to assure great performance and safe operation free of corrosion and explosion. Given the available energy, a modern hybrid electric vehicle system is designed to properly manage all of the possible energy resources. The size and expense of present energy storage devices are also important issues. The energy storage system accounts for one-third of the entire cost of the hybrid electric vehicle. Materials, packaging, power conversion, replacement, operation, maintenance, and labor all contribute to the high cost of the energy storage system.

Instead of using fuel, HEVs use energy storage devices such as batteries, which must be recharged. This, in turn, necessitates the delivery of additional energy from the current power grid and power plants. As a result, renewable energy sources such as wind and solar energy must be utilized. This means that the technology employed in power grids and the charging infrastructure itself may have an impact on the charging price.

Consumer perceptions of cost, benefits, and attitudes toward new technologies and social impact are all psychological aspects. Range anxiety is a condition in which HEV drivers are always concerned about being stuck with a depleted battery due to the vehicle's restricted range. Consumer attitudes play a significant role in determining whether or not they should invest in HEVs. The attitude of HEVs regarding new technology has a significant impact on their decision. Despite the fact that many early adopters are investing in HEVs, the majority of consumers are hesitant to accept new technology.

## VIII. ROAD AHEAD

Automobile industry is dependent on various factors such as skilled labour, R&D centres and low-cost steel production. The industry offers many opportunities in terms of investment and direct and indirect employment to skilled and unskilled labour. By 2026, the automobile industry is expected to reach 18 trillion.

Emphasizing on economic activities like charging infrastructure and battery recycling, there is great opportunity for job creation. Adoption of skill and training programs has to be done for the people to make aware about the new technology and how to work around it. Policymakers must include policies which increase public private partnership and hence promoting hybrid vehicles and making a profit for the same without burdening the people of the nation.

## IX. CONCLUSION

Hybrid Electric Vehicles reduces the gas emissions. But the power generation process for charging HEVs also produces greenhouse gas emissions. The emission of greenhouse gases into the atmosphere causes global warming. The processing and production of energy storage systems as well as the disposal of electrochemical batteries may cause respiratory, pulmonary, and neurological diseases. Therefore, safety measures must be taken into consideration during the production of energy storage systems especially the batteries. HEVs are not totally clean from emission throughout its life cycle but with the advancements in manufacturing technology and utilization of alternative energies, the overall environmental impact can be reduced. Social aspect also plays important role as it indirectly attracts the customers to adopt EV, consumer's attitudes and the performance of the HEVs simultaneously and that's when the role of government plays an important role in making people aware about the same. Adoption of Hybrid Vehicles would not completely eliminate the carbon emissions but would create a better environment for all.

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