

An Overview of Electric Vehicle Adoption and Challenges in India

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Abstract

Global pollution is rising, and steps are being taken to minimize emissions of CO₂. Also, with the current depletion of fossil fuels and price increases, another energy source is required to power the vehicle. In India, the automobile industry is considering electric vehicles as a solution to the industry and environment. The paper discusses the different factors that affect an user's adoption of an electric vehicle, as well as research on the essential obstacles, such as charging infrastructure, electric vehicle manufacturing and network modelling, and inadequate charging facilities for a developing country like India. It also presents the existing Indian EV industry, market competitors in two and four-wheeler, and latest advancements are discussed.

I. Introduction

The car industry, which has been around for over a century, is planning for transition. Individual transportation preferences have shifted as the price of fossil fuels has risen, as has the environmental effects of their pollution. The industry is gradually shifting away from internal combustion engines and toward electric vehicles (EVs). With rapid centralization, industrial development, automobile industry development, and rising car ownership, the automobile industry is causing serious problems such as pollution and energy shortages. These issues require more attention all over the world. Governments devote a significant amount of capital, manpower, and material resources to finding new solutions to these issues in terms of environmental protection and ensure the security of growing energy supplies. Electric vehicles (EVs), also known as "Zero Emission Vehicles," provide a number of noteworthy benefits, including zero emissions and long cycle life. So EV gives us with one of the most effective options to handle with human energy and environmental issues. Electric motors drive the EVs, which are powered by a rechargeable battery or another portable energy storage unit. These vehicles use less oil, emit less greenhouse gases (GHGs), and make less noise.

India is becoming more committed to lowering emissions and its carbon intensity. The National Electric Mobility Mission Plan 2020 (NEMMP 2020) includes a comprehensive report on EVs. The Government of India has issued a call for 'only Electric Vehicles' to be used on Indian roads by 2030. The transition to EVs in India is necessary, if not now, then in the not-too-distant future. Unscheduled centralization and rising pollution levels plague many cities. They are unqualifiedly degraded, with vehicular pollution as the major source.

India has the world's third-largest road system. With more than 60% of the people travelling by own or shared car, road transport appears to be a popular mode of transportation in India. To deter the purchasing and the use of more polluting vehicles, governments started to use fiscal policies such as road taxes. A green tax is imposed when re-registering a vehicle after 15 years of use in order to encourage people to switch from polluting vehicles to energy efficient and less polluting vehicles. The FAME India Scheme is a financial incentive policy aimed at encouraging the use of electric and hybrid vehicles in India. Its mission is to increase electric vehicle production and improve electrical transport system by offering financial incentives. The Ministry of Heavy Industries and Public Enterprises launched FAME in 2015 to encourage the production and promotion of eco-friendly vehicles, which includes EV and hybrid vehicles. This plan aims to increase national fuel protection, provide reliable and eco sustainable transport, and place India's automotive sector as a global leader in production.

ICE dominated the market after the development of low-cost IC engine technology. Despite various initiatives and donations for alternative energy source and technology, the entire world became increasingly aware of the pollution crisis. It was unable to minimize environmental pollution until 1997, when the Toyota Prius, the world's first hybrid electric vehicle, entered the market in Japan. Nearly 18,000 units were sold in the same year. After Tesla in the United States, Reva in India, Think in Norway, and BYD in China introduced their models to the industry and driven internal combustion engine car manufacturers were forced to make the decision to transition to electric vehicles. Global electric vehicle (EV) sales set a new high in December 2017, with more than 1, 70,000 vehicles delivered, a 67 percent increase over the same period in 2016. In India, the market position of electric and plug-in hybrid vehicles is about 0.1 percent. Almost every vehicles depend on fossil fuel-based transportation at the moment. This contaminates the environment and leads to global climate change by releasing greenhouse gas emissions. The Indian

transportation industry is booming. As a result, there is a pressing need to look into the elements that determine the creation of sustainable and eco - friendly transport options. Electric vehicles are one of the most successful, environmentally friendly, and long-term means of transport. With 1.726 billion Mt of CO₂ emissions, India ranks third. As shown in Fig 1, the 10 leading emitting countries represent nearly two-thirds of global CO₂ emissions. As a result, there is a pressing need to concentrate on zero-emission EV technologies for public mobility. Furthermore, due to the centralization of city centers, the number of private vehicles has increased rapidly.

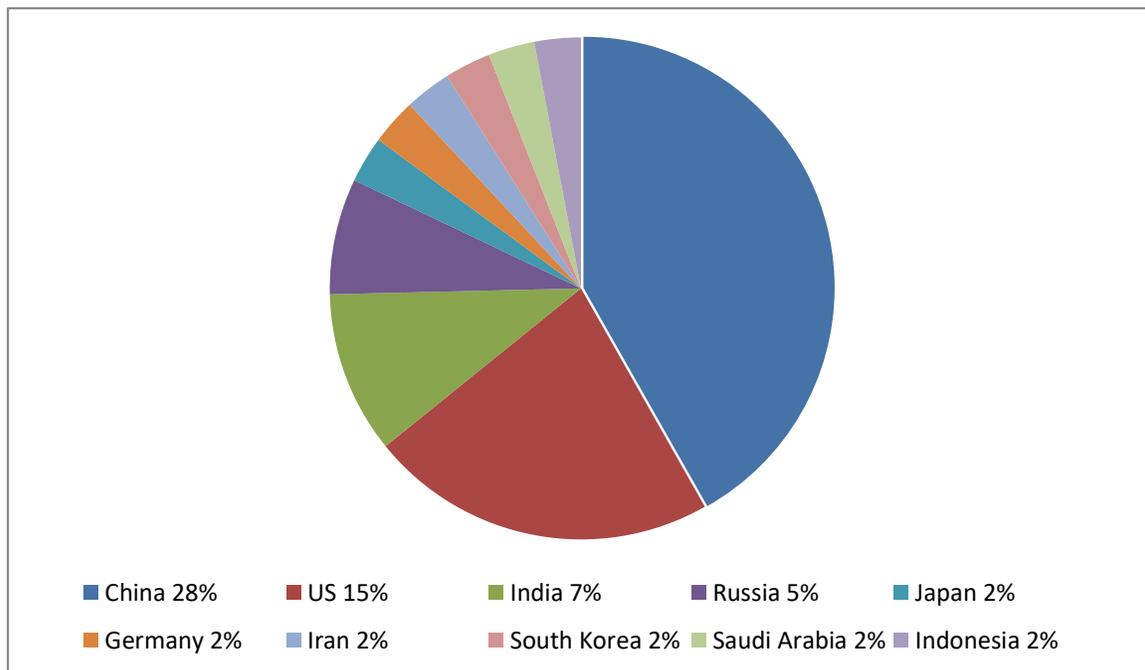


Fig 1 Top Ten CO₂ Emitting Countries.

I. Evolution of EV's

Top-tier automakers are currently investing in and emphasizing the production of electric vehicles. In order to encourage large-scale E.V growth, established countries are investing progressively in E.V Research and Development (R&D). Due to a range of critical issues, including battery pack capacity, range, and cost, for example, have failed to achieve any significant results. Because of some serious issues such as the battery pack's performance, range, and cost E.Vs, for example, have failed to achieve any significant results, breakthrough as a consequence, it has yet to find its intended use.

Because of some of its advantages, such as minimal price, improved driving ability, and energy efficiency, hybrid electric vehicles are becoming increasingly popular. Efficiency is generally acknowledged as a more cost-effective vehicle alternative. To promote the production of the Fuel Cell EV, Trans - national strategic alliances have been established between different countries. As an example:

- Toyota and General Motors
- Renault and De Nora
- Toshiba Corporation and American International Fuel Cells
- BMW and Siemens

Just a few companies in India, such as Mahindra & Mahindra (M&M) and the Hero Group, are working on developing electric vehicles to bring them to market. Two-wheeler start-ups like Ather Energy and Tork Motorcycles, are neither dealers nor manufacturers simply they are the designers, technologists, and visionaries who are pioneering a new field.

We investigated various types of electric vehicles that are currently on the market around the world. Aside from that, we have identified the EV barriers in the Indian market. There is also a discussion and presentation of various optimization techniques. Figure 2 depicts a concise overview of electric vehicles that was studied.

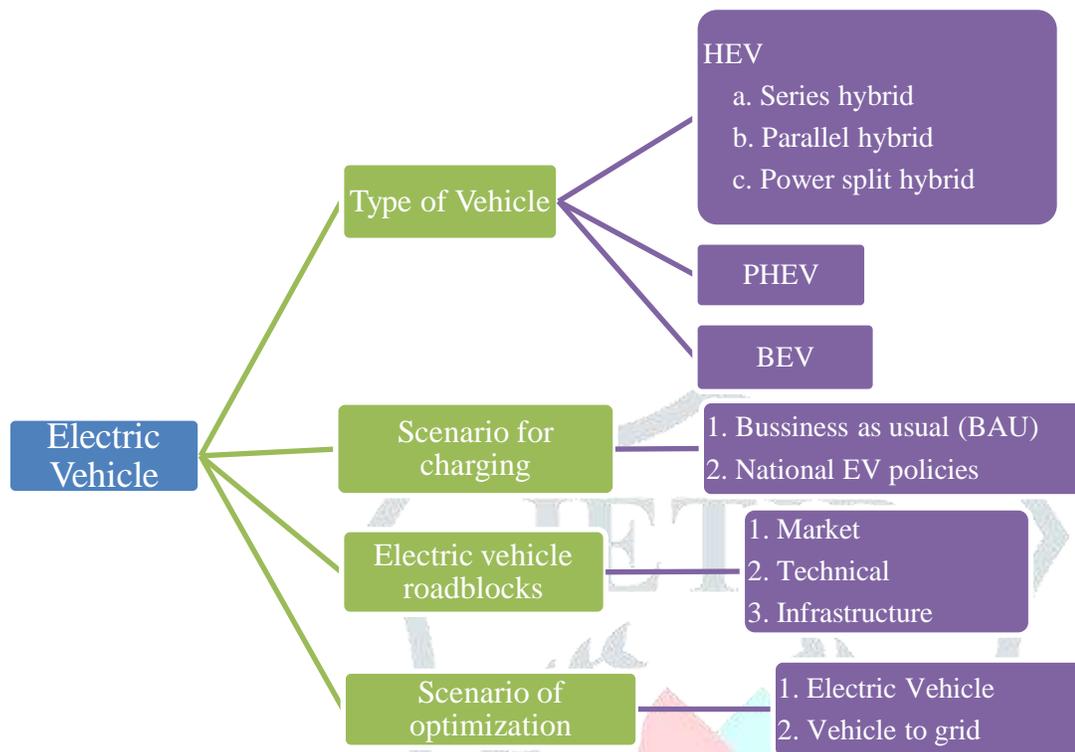


Fig 2 General review of electric vehicles

A. Types of Electric Vehicle

The following are the various types of EVs:

- **HEV:** Hybrid electric vehicles (HEVs) are vehicles with an engine and an electric motor that operate on both gasoline and electricity. The electricity provided by the braking system is used to charge the battery.
- **PHEV:** Plug-in hybrid electric vehicles (PHEVs) have a small engine and big batteries than HEVs. The batteries are recharged by using the braking mechanism or an external electric outlet.
- **BEV:** These vehicles do not have an engine and depend on electric motors for acceleration, with battery acting as energy storage systems. They charge the battery using outside sources of power. Plug-in hybrids, autonomous cars, and battery electric vehicles are all terms used to describe these vehicles (BEVs).

B. Scenario

Indian scenario for EVs is The Bangalore Municipal Transport Corporation launched a new electric transport on a busy city road. According to a survey conducted in the city of Ludhiana, 36% of current car and two-wheeler holders are interested in moving to electric vehicles. The Telangana state government is also promoting the use of electric vehicles by announcing that electric vehicle owners will not be required to pay any road taxes. The Hyderabad metro rail is the first in the country to just have charging points that are regulated and controlled by the power grid. Electric vehicles are also being considered by the Hyderabad government to replace diesel-powered public transport network. Recently the New Delhi government received authorizes to construct 131 public charging points in the capital.

C. Electric Vehicle Roadblocks

Barriers to EV adoption in India can be tackled from a range of perspectives including technical, market, and infrastructure issues. Fig 3 depicts these.

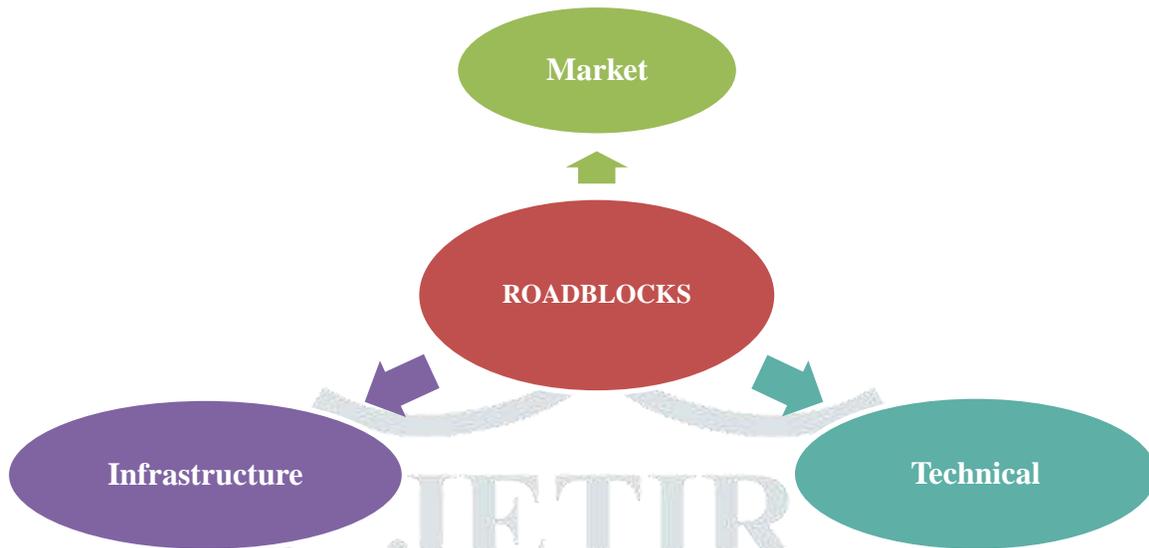


Fig 3 Types of barriers for EV

a. Market

- ❖ The majority of people in India prefer two-wheelers. Electric Rickshaws are becoming increasingly common, but the key drawbacks are their less speed, restricted range, high cost, and long charging hour. In terms of four-wheelers, they are not very common, and most people still tend to buy traditional I.C. engine vehicles. In India, for example E.V's are being implemented, such as:

| Name | Mahindra E Verito | Tata Tigor EV | Tata Nexon EV | MG ZS EV |
|------------------|--|---------------------|---------------------|---------------------|
| Price | 10.15 – 10.49 lakhs | 9.58 – 9.90 lakhs | 13.99 – 16.39 lakhs | 20.99 - 24.18 lakhs |
| Charging Time | 11hours 30mins (100%) / Fast charging 1h30min(80%) | 2 Hrs (Fast Charge) | 60 Min(0-80%) | 6-8hours |
| Driving Range | 110 km\ full charge | 213 km/full charge | 312 km/full charge | 419 km/full charge |
| Battery Capacity | 288ah Lithium Ion | 21.5 Kwh | 30.2 Kwh | 44.5 Kwh |
| Speed | 86 km\h | 80km/h | 127.0 Bhp | 140 kmph |

- ❖ Lithium, nickel, phosphate and manganese, graphite, and cobalt, which are rare earth elements, are among the raw materials used in EV batteries. Aluminium, copper, and steel are needed for an internal combustion engine. To filter toxic gases, catalysers for combustion automobiles require platinum, rhodium, and palladium. All of these materials are scarce, and their availability may be insufficient for battery manufacturing. Lithium-ion batteries alone absorb 5 million tonnes of nickel per year, implying that future lithium and cobalt demand would be 10–20 times higher.
- ❖ To properly care for the electric vehicle, a trained technician should be available to repair, run, and troubleshoot it. They must be able to apply their skills as quickly as possible to solve the problem.

b. Technical

Range of driving: The range of an electric vehicle on a single charge or tank is considered a major barrier to EV adoption in the global market. Driving range is known as the biggest obstacle to electric vehicles since EVs have a shorter range than comparable ICE vehicles. The majority of BEVs have a range of less than 250 kilometers on a single charge. Some of the more recent versions, on the other hand, can fly approximately around 400 kilometres. PHEVs today have a capacity of 500 kilometres or more according to the availability of liquid fuel internal combustion engines. The driver should schedule their trip diligently and may not be able to travel long distances. As a consequence, the size of the driving range serves as a stumbling block.

Charging an electric car: It can take even less as 30 minutes or as much as 12 hours to recharge an electric car. The capacity of the battery and the charging point's speed decide this. A standard electric car (60kWh battery) takes only about 8 hours to complete from empty to full using a 7kW charging station. Many electric vehicles can gain up to 100 miles on a charge in 35 minutes using a 50kW fast charger.

One of the most challenging obstacles for car suppliers, utilities, consumers, and other investors to tackle would be battery charging. Table 1 shows varying aspects of charging options and EV charging times.

| Level | Outlet | Usage | Range/ hour |
|--|---------|---------------------------|-------------------|
| 1.  | 110 V | Residential | 3.5 and 6.5 miles |
| 2.  | 240 V | Commercial / Workplace | 14 and 35 miles |
| 3 or DC Fast charging  | 480 V + | Public | 100-mile |

Table 1 Levels of Charging option

Charging an electric vehicle (EV) costs vary subject to local infrastructure and capacity to home charging. We discovered that charging an EV at home was substantially less costly than refueling the typical new gasoline car in a recent cost study. However, wherever you reside and the electric cost tariff you select will have an impact on your savings. Charging at public charging points has a large range. Some outlets are free, whereas others will charge more than double what it would to charge at home. On the other hand, the predominance of home charging also overpowers the effect of public charger prices.

Infrastructure

- For a large number of electric vehicles, more charging infrastructure is necessary, resulting in greater electric power requirements. Leading to a shortage of existing charging sector in India, electric vehicle sales are poor. From a design perspective, EV manufacturers can appreciate chargeable batteries so that discharged batteries can be substituted with fully loaded batteries.
- Electric vehicle batteries are typically designed to last for the vehicle's limited life, but they might inevitably fail. Manufacturers do not have accurate prices for battery replacements, but if a replacement is required beyond the warranty period, the costs are increased by removing the existing battery and replacing it with a new one.

D. Scenario of Optimization

Application of Optimization Method: Scheduling EV charging is a difficult optimization problem. To improve grid, aggregator, distribution transformer, and EV performance, an optimized charging schedule is needed. In the EV charging scheduling issue, channel power loss reduction, power consumption reductions, voltage infringement reductions, and distribution transformer overloading reduction are all goals. In this paper, different elements from different geographic locations are used to explain the charging demand of electric vehicles. Mathematical Optimization, Heuristic Method, General Algorithm Fuzzy logic, Random utility model, Activity-dependent equilibrium scheduling, Driving pattern recognition, Stochastic model, Trip prediction model, Probabilistic model, Fuzzy based model, Data mining model, Forecasting model, Distributed Optimization, and Hybrid particle swam are all included in the system. Various studies have been performed around the world by various scholars in order to determine the best electric vehicle optimization technique. Table 2 contains a list of these.

Vehicle to grid technology: A vehicle-to-grid (V2G) system creates an opportunity for electric vehicle owner to permit the grid to discharge the battery when it is necessary (to compensate a spike in local demand). In most cases, the customer is usually paid in the tariff of reduced EV charging cost or public subsidy for electricity supplied back to the grid. Bidirectional power transfer, Two-way communication, and the use of intelligent technology to reduce the electricity supply–demand mismatch are all part of V2G. Users of electric vehicles should be motivated to charge them for most of the day, when solar energy is plentiful. It can achieved by utilizing office EV chargers that take benefits of vehicles which are parked and unused for long durations. During evenings, when energy consumption rises (generally around 6–11 p.m. in India) and solar energy is not accessible, users can plug their EVs into a V2G charger nearby their residences. These V2G chargers will feed into the grid, assisting with peak demand management. Figure 4 depicts the Vehicle to Grid charging system.

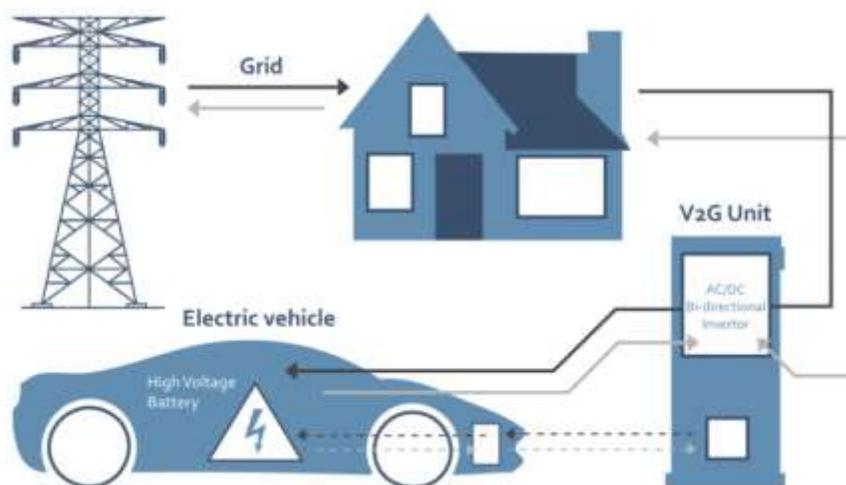


Fig 4 V2G Charging System

II. Conclusion

This paper gives an outline and suggestions for HEV, PHEV, and BEV adoption rate analyses as in Indian industry, as well as a detailed analysis of the literature. India's e-mobility push will be aided by the Indian government's recent policies and numerous incentives. Where non-conventional forms of energy are insufficient, a latest Vehicle-to-Grid concept may either supply electricity to the grid or be utilized to recharge the battery. The most unique aspect of this paper is a review of the challenges and issues surrounding electric vehicles in India. However, EV sales are not very promising, despite the fact that EV/HEV/PHEV's are more advantageous for Indian roads for the following reasons: At low Indian driving speeds, hybrid or electric powertrains are much more efficient than internal combustion engines (ICE). Braking uses more energy per Indian drive, which is nearly restored in a hybrid-electric vehicle or an electric vehicle (Regenerative braking). During stopping, and waiting time in traffic, HEVs and EVs consume no fuel which occurs more in India (than the U.S. & Europe). In India, the total distance travelled is much less than in the United States and Europe, making electric vehicles much more practical and with no range concerns for a single fee. Vehicle use as well as distance between vehicles – Electric vehicles perform well in urban driving cycles with frequent start and stop, as well as high traffic benefits. References

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