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Survey report on Electric vehicles in India

Ayush Sharma[*], Siddharth Singh[**]
[*] *M. Tech Student, Department of Mechanical Engineering, Lingaya's Vidyapeeth Faridabad, Haryana*
[**]*Assistant Professor, Galgotias University, Greater Noida*

Abstract-*This paper aims to provide a comprehensive review of the latest low emission vehicles, particularly for Electric vehicle applications in India. The challenges for electric vehicle applications and the necessity for low emission (EV) technologies for public transportation are addressed, the steps taken by the government to transfer its transportation industry to electric vehicle are also discussed. The review will be focusing on the Indian road environment, which represents one of the busiest road networks in the world. The low emission public transport will be studied by their cost effectiveness, loading conditions, benefits over at present technology and also the snag caused. This will conclude with a summary of the steps necessary to be taken in order to enhance the growth in the EV industry in India.*
Index Terms (Keywords)*- Electric vehicle, E- rickshaw, Electric scooter, Sales of EV, Problems in EV, Battery swapping stations.*

I. INTRODUCTION

O ver the past 100 years the transportation system of the globe is heavily dependent upon fossil product (mainly petrol and diesel) due to their cost efficiency and greater jump in technology. However, this comes at an environmental cost, for example, The latest World Air Quality Report 2021, published by IQ Air, a Swiss Organization, found that 35 of the 50 cities of the world with the severe air quality parameters were in India. This shows a lot about the development route the country is going on for some decades.

In 48% of Indian cities, air pollution levels exceed the limit set by the WHO by 10 times. The report tells us that none of the cities in India met the prescribed air quality standard of 5 micrograms per cubic meter. In fact, Delhi continues to top the global charts for the fourth consecutive year in a row.

With 9 million people globally succumbing to air pollution in 2019, the study estimates that nearly 18 per cent of these deaths occurred in India. Simply put, it means a shocking record 16.7 lakh people have lost their lives from air pollution in India alone, and that too in one year.[1]

In order to combat these concerns, The government promotes the uptake of electric vehicles (EVs), although so far India has only 260,000 – including two-wheelers and hybrids – and, overall, only 0.6% of sales are EVs. The rollout of charging stations remains low.

It also has around 1.5m electric rickshaws, although these are typically used only for short journeys.[2]

In 2011, India set up its National Mission for Electric Mobility, which aimed to promote electric vehicle (EV) and hybrid manufacturing. In 2017, then-power minister Piyush Goyal said petrol and diesel car sales should end by 2030. But the government has since rowed back on this aim, now targeting a 30% share of sales for EVs by 2030. It also aims for all new urban buses to be fully electric by 2030.

In 2015, India launched its FAME scheme to subsidize electric and hybrid cars, mopeds, rickshaws and buses. This was recently extended with a fresh $1.4bn over three years. Of this, $1.2bn is earmarked for subsidies and $140m for charging infrastructure. Several individual states have also rolled out policy initiatives to support EVs.

India finalized its first passenger vehicle fuel efficiency standards in 2014. These entered force in 2017 and will be tightened in 2022, though even then they will be less stringent than current standards in the EU.

Its 2009 national biofuels policy had an "aspirational" target to blend 20% biofuels into the diesel and petrol mix by 2017. However, India has fallen well short of these targets, so far reaching only around 2% bioethanol and 0.1% biodiesel blend in 2018. It updated its biofuels policy in 2018, proposing a 20% blend of bioethanol and 5% of biodiesel by 2030.

India's railway system is the fourth-largest in the world in terms of rail track length. It is second only to China in terms of rail passenger activity, with this set to grow more than any other country, tripling by 2050.

Around half of India's conventional rail tracks are electrified, although its first high-speed line is still under construction. A third of India's land freight is carried by rail, a high proportion by global standards, with coal by far the main commodity.

India plans to increase the share of railways in total land transport from 36% to 45%, its climate pledge says, including through development of dedicated freight corridors.

II. CURRENT TECHNOLOGY USED IN ELECTRIC VEHICLES

A vehicle that runs on one or more electric motor propulsion is commonly refer to as an electric vehicle.

Road Electric Vehicles (EVs) include a large range of vehicles from electric two - wheelers, three - wheelers (rickshaws), cars and electric buses.

In addition, plug - in electric vehicles can be classified into two types: battery electric vehicles (BEVs), and plug - in hybrid electric vehicles (PHEVs). BEVs have an electric motor in place of combustion engine and use electricity from the grid stored in batteries. Plug - in hybrid electric vehicles (PHEV) use batteries to power an electric motor and liquid fuel such as gasoline or diesel to power an internal combustion engine or other propulsion source.

EVs can go beyond the mentioned technology base classification, and can be classified on the basis of their attributes such as charging time, driving range, and the maximum load it can carry.

Of these attributes, the two most important characteristics of an electric vehicle of concern to the consumer are:

- Driving range (the maximum distance an EV can run when fully charged)
- Charging time of batteries (the time required to fully charge the battery) and Charging time depends on the input powercharacteristics (input voltage and current), battery type and battery capacity.

Batteries used in electric vehicle –

The choice of batteries depends on the energy density, weight and costs. Electric cycles and low range mopeds have simple battery units while electric cars deploy a large number of batteries. Traditionally, most electric vehicles have used lead - acid batteries due to their mature technology, easy availability and low cost. However, since the 1990s battery technologies have evolved significantly and several new types of batteries have been developed. More recently, batteries using combinations of lithium ion and its variations are gaining widespread acceptance due to better efficiency, reduced weight, lower charging time, better power output, longer lifetime, and reduced environmental implications from battery disposal.

The following four types of batteries are commonly used today in EVs:

- Lead Acid
- Nickel Cadmium (NiCd)
- Nickel Metal Hydride (NiMH)
- Lithium - ion (Li- ion) - Lithium - ion batteries have higher specific energy relative to the other battery types. In the future, technology innovations with Li -ion and other battery technologies are expected to result in batteries with much higher specific energy and lower costs.

Battery Charging –

In low power applications the power conditioning which includes the AC to DC conversion, the power control unit which delivers a variable DC voltage to the battery, and various filtering functions are all carried out within the charger and can be implemented at a relatively low cost. The Battery Management System (BMS) is tightly integrated with the battery. It monitors the key battery operating parameters of voltage, current and temperature and controls the charging rate to provide the required constant current / constant voltage (CC/CV) charging profile and it triggers the protection circuits if the battery's operating limits are exceeded, isolating the battery if needed.

III. ELECTRIC VEHICLE SCENARIO IN INDIA

India's commitment to the *EV30@30* initiative - to reach a 30 percent sales share for EVs by 2030 - presents a cumulative investment opportunity of as large as INR 19.7 lakh crore ($US266 billion). There has been a recent increase in public budgetary allocations and corporate investment in EVs in order to achieve this.

Central and state governments have approved fiscal incentives for EVs, charging infrastructure, and manufacturing that are helping achieve parity in total cost of ownership with internal combustion engine (ICE) vehicles for several segments and use cases. Original equipment manufacturers (OEMs) and component manufacturers are investing in indigenous manufacturing and supply chains. EV start-ups are attracting significant venture funding due to their product and business model innovation, capturing as well as creating the market opportunity presented by EVs.

Production-Linked Incentive (PLI)

Production-Linked Incentive (PLI) scheme worth INR 18,100 crores (US$2.4 billion) approved for investments in advanced chemistry cell (ACC) battery manufacturing and worth INR 26,058 crore (US$3.5 billion) approved for automotive manufacturing focusing on EVs and hydrogen fuel cell vehicles.

National Electric Mobility Mission Plan (NEMMP) 2020

- Target of deploying 5 to 7 million electric vehicles in the country by 2020
- Emphasizes importance of government incentives and coordination between industry and academia
- Target of 400,000 passenger battery electric cars (BEVs) by 2020 ~ avoiding 120 million barrels of oil and 4 million tons of carbon di oxide.
- Lowering of vehicular emissions by 1.3 percent by 2020
- Total investment required – INR 20,000 – 23,000 crores (approx. 3 billion USD)

E- Rickshaw

•The Government of India announced the Deendayal scheme in June 2014, which would help in the financing and procurement of the battery rickshaws inthe country.

•In March 2015 the Motor Vehicles (Amendment) Bill was cleared establishing battery-powered e-rickshaws as a valid form of commercial transport 3 wheeled vehicles run by battery power of no more than 4,000 Watts

•4 passengers, luggage of 50 kg and with a single trip under 25 km.

•The number of battery-operated E - rickshaws in Delhi has risen from 4,000 in 2010 to more than 1,00,000 in 2014, to as many as 11,000 electric rickshaws are sold every month in the country today, as against the 4,000 electric rickshaws that were sold in all of 2010. While 98% of the electric rickshaws have been sold in the unorganized market, safety and import regulations of the 2010s have created a level playing field for all, evident by the emergence of organized manufacturers such as Kinetic Green, Hero Electric, Mahindra & Mahindra, Bajaj, Piaggio, Lohia, Gayam Motors, and others. and is now an integral part of the transport eco-system in the state.

•In January 2014, Tripura became the first state in India to regulate the functioning of the e-rickshaws, and they came up with the Tripura Battery Operated Rickshaw Rules 2014 for the purpose. Tripura Battery Operated Rickshaw Rules 2014 consists norms / guidelines such as driver age limits, license fee, renewal fee, Road Tax, provision for vehicle fitness certificate, insurance for e-rickshaw and identification of routes for operation of these vehicles.

•The running cost for an electric three-wheeler is only Rs 0.4/km as compared to Rs 2.1-2.3/km for the conventional ICE-based rickshaws. Coupled with purchase incentives from the government, electrification of rickshaws based on diesel, petrol, LPG and CNG is truly a low-hanging fruit for the country. Apart from a high economic impact, e-rickshaws also have a positive environmental benefit with zero tailpipe emissions. Additionally, the average energy consumption of electric rickshaw is 53.76 KJ/passenger/km which is one of the most efficient among all forms of motorized transport.

- **Technical parameters of E-rickshaw**

TECHNICAL PARAMETERS	MEAN VALUE
MOTOR POWER	650W-800W
BATTERY VOLTAGE	48V
MAXIMUM LOAD CAPACITY	380 kg
VEHICLE WEIGH (APPROX)	215 kg (with battery)
CHARGING TIME	8.5 hours
BATTERY CHANGING PERIOD	8-9 months

- **Based on the survey report (in Delhi) on various factors on e-rickshaw followings points can be noted.**

TYPE OF RICKSHAW	INITIAL COST(AVERAGE) (₹)	AVERAGE DAILY EARNING (₹)	DAILY RENT COST (₹)	TOTAL NUMBERS (GOVT, REGISTERED)
AUTO- RICKSHAW	2,25,000	750-1000	500	95,000
E- RICKSHAW	1,00,000	600-800	300	35,000

- The battery-operated e-rickshaws have become an important part of the transport system of the state of Delhi, and there is a need to regularize the operation of these rickshaws.
- The rickshaws have impacted the socio-economic status of a large number of people in the city, and its role in the income generation can be seen as 89% of e-rickshaw drivers saw increase in their salaries from their

previous employment, and 39% of the surveyed rickshaw drivers were either unemployed or cycle rickshaw drivers before turning to the profession. The absence of a regulatory framework and manufacturing policies for the rickshaws have resulted in a lack of safety structure for the rickshaws, and is a hazard for the commuters.

- Most of the e-rickshaw are assembled in India by buying various components from China till 2015 but now by the entry of the different motor industries of India it is sold as a complete product.
- 7% of the e-rickshaw respondents reported a possible toppling of their rickshaws on a turn.

Electric Scooter

Electric scooters and motorbikes are two- or three-wheeled plug-in electric vehicles. The electricity is E-scooters, like their non-powered predecessors, are as basic as personal mobility devices get.

In their most basic form, scooters consist of a thin platform or deck, t-stem handlebars with a throttle and hand brakes, two wheels (although some variants have three or four), and front and rear suspension. Most scooters can be folded, and some versions come with a seat.

Scooters are what they are when it comes to variety. If you change the design too much, you'll end up with a completely different mode of transportation. However, they have a few crucial areas where even minor differences have a substantial impact on performance.

Some of the top electric scooters and their performance in India in 2022:

Model Name	Price (□)	Battery range	Charging Time	Distance travelled per full charge (km)	Top Speed (km/hr)
Bajaj Chetak EV	1,41,500	50000 km	5 hrs	90	70
Ather 450X	1,40,000	2000 cycles	5.45 hrs	70	80
TVS IQube	1,25,000	50000 km	4 hrs 6 min	145	82
OLA Electric S1	85,000-1,25,000	3 years	6.3 hrs	181	115
Okinawa Ridge+	69,000	3 years	2-3 hrs	100	55
Hero Photon	72,500	2-4 years	5 hrs	90	45

(*Data as per companies website)

Benefits of Electrified Bikes and scooters

With more efficient and powerful electric vehicles being released every year, the electric vehicle industry quietly revolutionizes the automobile industry. Electric scooters and bikes have many benefits and drawbacks, but the benefits exceed the disadvantages.

- **Environmentally friendly:**

Among the electric bike benefits and drawbacks, the most compelling selling point for electric two-wheelers is their environmental friendliness. They don't use fossil fuels and don't emit smoke.

- **Lower Operating Costs:**

While electric bikes and scooters are a little more expensive to buy than traditional two-wheelers, the money you'll save on gas, in the long run, makes this a cost-effective option. With growing fuel prices, many people opt for electric vehicles to save money on their daily commute.

Electricity is more than 10 times cheaper than fossil fuels for same power extraction in India because of the hydro-power, wind power, solar power, that is in general renewable power extractions in India is huge and India is also developing its capacity of extraction

- **Maintenance:**

When weighing the benefits and drawbacks of electric scooters, one major advantage is that there are no complicated processes. As a result, compared to traditional vehicles, the cost of maintaining electric motorcycles is lower.

- **Low Noise:**

When most vehicles are driven, they make a lot of noise. You can hear dozens of automobiles contributing to noise pollution as you walk down a crowded street. Another advantage of electric bikes is that they create very little noise.

- **Lightweight:**

Electric scooters are lightweight as they are simple and have fewer parts. As a result, they are compact and easy to park.

- **Political benefits:**

In our country there are no big fossil fuel sources, so we have to import petroleum oils in large scale continuously. As everyone knows in whole world, petrol prices are highest in India itself and scientific research says all the fossil fuels will be exhausted by 35-40 years. India will lose the petroleum supply even much earlier because all the countries will decide some or the other day to preserve the petroleum for their future usage before it is exhausted completely.

Disadvantages of Electric Scooters and Bikes:

After going through the benefits of electric scooters here are a few drawbacks to be aware of:

- **Battery Life:**

When electric batteries are damaged or no longer provide a wide range, they must be changed. They typically last a year and range in price from Rs.13,000 to Rs.20,000, depending on the rating, brand, quality, and warranty.

- **Range:**

The range refers to the distance it can travel on a single charge. The top electric scooter models in India have an average capacity of 100 kilometers. Furthermore, the range diminishes as the battery life declines. It takes about 5 hours to charge the battery fully, so it isn't ideal for long-distance travel.

- **Repair and maintenance:**

Currently, many scooter mechanics do not know how to deal with e-bike problems. The problem can be very simple, such as a wire that has come loose, or a wire that has been chewed by a rat, or a puncture in the front or back wheel, or almost anything.Repair services will become more mainstream and accessible as electric vehicles grow more popular.

- **Mechanical Failure:**

One of the problems currently seen in electric scooter is mechanical failure while riding. Most recent case regarding the mechanical failure is reported in Aurangabad, India where the front suspension of the electric scooter gets detached from the electric scooter while riding. Also, as the battery gets discharge over time the speed of the vehicle decreases notably that causes the owner to recharge battery at frequent basis thus decreasing the battery life.

- **Battery Failure**

One of the most common problems occurring in the E- scooter is the battery defects. Currently many controversies are originating regarding the malfunctioning of the batteries thus causing the vehicle to catch fire either while riding or charging.The main cause of the fire breakout is short circuit, loose wiring or over heating of battery while in use.

GENERAL REASONS OF EVs CATCHING FIRE:

Short Circuit	A short circuit brought about from a wiring fault to even a puncture in cells can cause a rise in temperature and subsequently a fire.
Faulty Charging	Using Incorrect or faulty cables or wall outlets can also trigger a fire with an incorrect amount of electricity.
Cell Quality	Even a single contaminated cell can spark a massive fire, igniting itself and then leading to the dreaded thermal runaway igniting subsequent cells thanks to the temperature rise.
BMS Issues	The key safety task in any battery management system (BMS) is temperature control. This entails carefully managing both charge and discharge speed and cycles, any fault here can raise the battery temperature sufficient enough to combust and high ambient temperatures exacerbate the issue.
Accidental Damage	Though protected very well, a battery getting punctured or even dented in an accident can led to cell ruptures and thus ignition. An accident can also spill oil (used for lubrication and cooling) onto hot electrical components which can ignite and lead to a bigger blaze.

IV. IMPROVEMENT/SOLUTION TO PROBLEMS

One of the ideas which is in practice in several countries to overcome the major problems regarding the EVs is setting up of Battery swapping stations at various locations like petrol and gas stations.

Battery swapping works as these stations will take the discharged battery of the vehicle and replace it with another fully charged battery which will take sufficiently low time as compared to the recharging of the battery after being discharged.

Battery swapping stations

Battery swapping stations are one of the best options for EV charging stations in India and even a solution to the lack of EV charging infrastructure in India. The battery swapping stations take less time to charge your electric vehicle 100%. Just Swap the Drain Lithium-Ion Battery with a new One and be ready for longer drives.

Some benefits of battery swapping stations

- The Battery stations will be responsible to exchange the dried-up battery after battery life is over. Thus, the issue of the customers will be reduced. The cost of the battery exchange must be included in the battery swapping station fees that include the charging fees, replacing fees and their estimated profit.
- The frequent recharging of the battery which take up to 5 hours to completely charge will be done in the battery swapping station which will decrease the nuisance of the customer.
- By increasing the number of outlets for battery swapping the long-distance travel for the EV will be possible.

Additional steps:

- Battery swapping stations should be design preferably with solar generation to minimize the dependency on fossil fuels hence shifting towards clean energy.
- The EV manufacturers should be encouraged to design vehicles with changeable batteries, so it would be easy and time efficient for customers to replace the battery at the stations.
- Battery disposal/recycling process should be strictly enforced to prevent disastrous environmental impacts of battery.
- There should be adequate investment in research and development for future battery technology for manufacturing batteries with much high specific energy, environment friendly and lower costs. As batteries generally contribute to 50% cost of EVs.

Safety points to be checked for avoiding the Fire cause in EV:

- Regular checkups of the battery circuits to ensure that there is no loose wire or scrape that may led to a circuit fire
- To check that there is no overheating caused in battery during charging or while driving.
- The battery cells are not defected or there is no dent or impact on the battery which can cause a series of battery cells to catch fire due to high temperature.Cell shape and chemical type are also important considerations in battery safety. Pouch cells (cell phone battery) bunch closer when bundled together in battery modules that make up a pack and thus offer a better space to energy ratio. However, cylindrical cells (standard AA battery) offer better thermal management thanks to the air gap around them. Thus, cylindrical cells offer a small safety advantage.Either way, Nickel based batteries are well protected and built to extremely high standards and are just as safe in operation. It's clear then that a lot of development and changes are underway in the world of batteries and electric vehicles.
- Avoid fast charger to ensure that it does not cause any defect in the battery.

V. INDIAN GOVERNMENT SCHEMES TO ENHANCE ELECTRIC VEHICLE OPERATIONS IN INDIA

Drivers for growth of electric vehicles in India

- Thirteen out of 20 cities in the world with highest air pollution are in India It is envisaged that Low carbon scenario with 'highest' EV penetration shows 50 percent drop in PM 2.5 by 2035 (UNEP, DTU and IIM-A).
- Master plans for most cities in India target 60 - 80 per cent public transport ridership by 2025 - 2030 (Centre for Science and Environment)
- With the Government of India targeting 100 GW of solar by 2022, electric vehicles can improve reliability and utilization of renewable by acting as storage
- However, there needs to be proper planning with reference to monitoring and control of charging infrastructure as unplanned increase in penetration of EVs in an area can cause an increase in peak load of already stressed distribution network.
- Large scale penetration of EVs will require both demand side incentives (e.g., tax incentives) and improved charging infrastructures as well as integrated planning for distribution Grid management.
- EVs offer the opportunity to act as a distributed storage in the urban energy system which could help in better integration of intermittent renewables like wind and solar and can feed the grid at peak timings if price incentives are designed in terms of dynamic tariff as part of Smart Grid implementation.

FAME India scheme

The Department of Heavy Industry is administering the scheme "Faster Adoption and Manufacturing of Electric and Hybrid Vehicles in India", popularly known as FAME India scheme since 01 April 2015.

FAME Phase I

Under the scheme, subsidy is being given to 11 cities for launching electric buses, taxis and three-wheelers. The cities include Delhi, Ahmedabad, Bangalore, Jaipur, Mumbai, Lucknow, Hyderabad, Indore and Kolkata, plus two cities – Jammu and Guwahati under special category. The nine big cities in the list will be given subsidy for 40 buses each while Jammu and Guwahati will get for 15 buses each. Subsidy for taxis will be given to Ahmedabad (20 taxis), Bangalore (100 taxis), Indore (50 taxis) and Kolkata (200 taxis) – based on their demand. Bangalore will get subsidy for 500 three wheelers, Indore for 200 and Ahmedabad for 20. This comes to a total of 390 buses, 370 taxis and 720 three wheelers.

FAME Phase II

Government has approved Phase-II of FAME Scheme with an outlay of Rs. 10,000 Crore for a period of 3 years commencing from 1st April 2019. Out of total budgetary support, about 86 percent of fund has been allocated for Demand Incentive so as to create demand for EVs in the country. This phase aims to generate demand by way of supporting 7000 e-Buses, 5 lakh e-3 Wheelers, 55000 e-4 Wheeler Passenger Cars (including Strong Hybrid) and 10 lakh e-2 Wheelers.

However, depending upon off-take of different category of EVs, these numbers may vary as the provision has been made for inter as well as intra segment wise fungibility.

Revision of Faster Adoption and Manufacturing of Electric Vehicles Phase II (FAME II) demand incentives for electric 2-wheelers (e-2W) from INR 10,000 per kWh to INR 15,000 per kWh. Incentive cap increased from 20 percent to 40 percent of the capital cost of the e-2W. Energy Efficiency Services Limited (EESL) will be responsible for aggregating and leasing 3 lakh electric 3-wheelers (e-3W) as well as electric buses (e-buses) available under FAME II

Only advanced battery and registered vehicles will be incentivized under the scheme. With greater emphasis on providing affordable & environment friendly public transportation options for the masses, scheme will be applicable mainly to vehicles used for public transport or those registered for commercial purposes in e-3W, e-4W and e-bus segments. However, privately owned registered e-2Ws are also covered under the scheme as a mass segment.

VI. CONCLUSION

Battery swapping stations are going to bring a revolutionizing impact in the Electric vehicle industry as it covers up most of the problems currently faced in them. As India has the high petrol price in the world with high dependency of supply through imports so it should concentrate more on an alternate source of power for road transportation and try to bring it in as soon as possible. Electric vehicle in India is the future of the transportation industry, switching to electric vehicle will be the best solution for increasing environmental concerns and rise in petrol and diesel prices.

Although, there are currently some demerits regarding the EVs but it is possible to rectify them while looking at the major advantage EVs bring not only environmentally but also helping the country politically to stabilize the economy and also to reduce the heavy dependency of our transportation industry on foreign countries.

The electric vehicle era can be simply started by buying electric vehicles, conveying or advertising the benefits and advantages of electric vehicle and persuade the public to move towards a greener future by buying electric vehicles.

Electric vehicle with adequate charging stations and technique will be completely dominating the regular IC engines and will take over them in India.

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