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Impact and Challenges to Adopting Electric Vehicles in developing countries – a case study in India

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Abstract

Climate change is one of the current threats the world is facing. Pollution is the primary factor causing climate change in which air pollution plays a major part. Almost all developed and developing countries emit a lot of greenhouse gases (GHG). The transportation sector is responsible for the majority of GHG emissions. Nowadays, almost all nations make an effort to lower CO2 emissions from transportation. India also has a strategy to achieve zero emissions through several programmes. When considering ways to lower GHG emissions from the transportation sector, electric vehicles (EVs) are the first choice that comes to mind. The main goal of this case study is to identify why and how India is having trouble launching EVs. India faces significant obstacles in the areas of infrastructure, electricity, battery technology, and consumer behaviour. India already has the infrastructure necessary for the general usage of fuel-powered automobiles. Suddenly changing to another technology and expecting to complete the requirement is a little problematic in emerging nations like India. The majority of electric vehicles (EVs) use lithium-ion batteries, and India is in a position to buy these batteries from other nations. As a result, the battery is a little expensive in India. Nothing is difficult to overcome the barriers compared to the benefits of EVs. In conclusion, this study makes several recommendations for eliminating the barriers to India's EV adoption.

Keywords: Electric Vehicles (EVs), Benefits of Electric Vehicles, Challenges to adopting Electric vehicles, Future of EVs in India, EV Case study, Transport

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1. Introduction

India is the world's second most populated country and the world's leading consumer of goods and real estate. India can provide vast amounts of resources for the world because it is a developing country with huge workforce. Transport is critical in the manufacturing and production of goods to meet the needs of people all over the world. In the last four financial years (2019-2022), 149,875,389 new vehicles were registered [1] among 1,406,199,041 (1.4) billion persons, resulting in a 10:1 vehicle registration ratio. Details of registered automobiles in the past four financial years are provided in Fig. 1. All of these vehicles run on fossil fuels, which results in CO2 emissions of 2.63 billion tons in 2019 and 2.44 billion tons in 2020 [2]. Because of the pandemic's full lockdown, CO2 emissions in 2021 and 2022 cannot be addressed in this study. In 2017, 12 lakh people perished in India as a result of high levels of air pollution [3]. The government has taken several initiatives to reduce pollution. One notable example is the Karnataka state government's "Less Traffic Day" programme [4], which encourages people to take public transportation on the second Sunday of the month to minimise CO2 emissions. Another example is the Delhi government's "odd-even scheme," which regulates the use of motor vehicles. The driver who disobeys the scheme is subjected to a heavy fine of Rs.20,000 [5].

A hundred initiatives announced by the Indian government have also failed to reduce pollution. However, technology is bringing positive changes to the automobile industry. The introduction of electric vehicles (EVs) gradually reduces air pollution and increases the benefits for society. In general, adopting new technology is difficult for developing countries compared to developed countries. The purpose of this paper is to examine how India, a developing nation, struggles to adopt modern technology, namely electric vehicles. Electric vehicle advantages outweigh their adoption struggles on a par. In order to address the difficulties, certain

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recommendations are made in this paper. The reasons why buying an EV in India at this moment are explained in the next section.

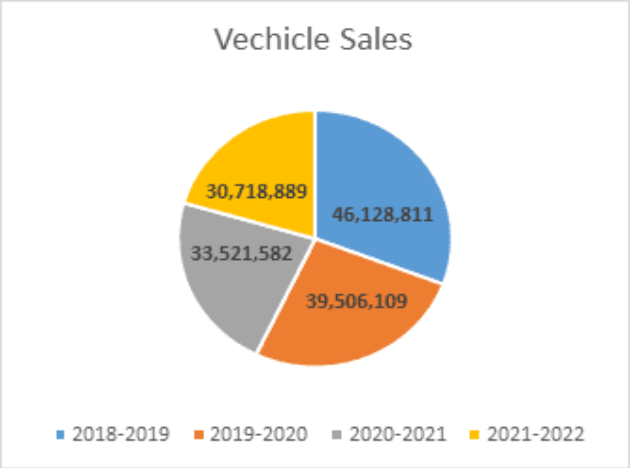

Figure 1. Registered Vehicles in India

2. Is it the Perfect Moment to Buy an Electric Vehicle in India?

Yes, now is the time to buy an electric vehicle. Let's look at some of the advantages of using Electric vehicles India.

2.1. Budget-friendly

For petroleum imports, India is heavily reliant on foreign countries (such as Iraq, the United Arab Emirates, the United States, Nigeria, and Saudi Arabia). Importing it from other nations necessitates paying a significant sum in import taxes. Fuel prices have risen as a result of these factors. The rise in fuel prices is the key motivator for owning an electric vehicle. The recent all-time high in fuel prices has given motorists the impression that change is required. Table 1 shows fuel prices for the past 12 years. Because of the different percentages of VAT charged by the states and the federal government, one country must purchase fuel at different rates in each state (i.e., the petrol price in Chennai is Rs.102.63 and Rs.111.35 in Mumbai on 13, June 2022) [6]. The price of gasoline has increased by 101.5%, and diesel by 135.2%, while the average person's income has increased by only 32.04%. As a result of these statistics, a fuel vehicle is out of reach for most middle-class and lower-income people. In India, the government has different tariffs on electricity bills and offers many concessions to domestic users. When the increase in electricity costs per unit is calculated, it is only 40.8% in the past 12 years [7]. Fig. 2 depicts the percentage of increase in the cost of petrol, diesel, electricity, and the Indian average income [8]. As a result of all of this, purchasing an EV is now more advantageous for commoners in India than purchasing a fuel vehicle.

Table 1. History of fuel price

S.No.	Month & Year	Petrol/Liter (in rupees)	Diesel/Litre (in rupees)
1	April - 2010	48	38.1
2	April - 2011	58.5	37.75
3	April - 2012	65.6	40.91
4	April - 2013	66.09	48.63
5	April - 2014	72.26	55.48
6	April - 2015	60.49	49.71
7	April - 2016	59.68	48.33
8	July - 2016	62.51	54.28
9	July - 2017	63.09	53.33
10	July - 2018	75.55	67.38
11	July - 2019	72.96	66.69
12	June - 2020	79.76	79.88
13	July - 2021	99.86	89.36
14	April - 2022	105.41	96.67
15	May - 2022	96.72	89.62

Aside from the low running cost, the main advantage of investing in EVs is the low maintenance cost. The majority of vehicle components are immovable. This feature automatically reduces the vehicle's depreciation. There is no need to spend a lot of money on fuel vehicles. In comparison to gasoline vehicles, EVs are completely exempt from road tax and registration fees. The capital subsidy is the next notable benefit. With various policies, state governments encourage EV buyers. The state-level subsidy policies [9] are listed in Table 2. In Delhi, the capital of India, the EV charging startup ElectriVa [10] operates 35 charging stations and offers free service from midday to 3 p.m. They also have plans to build 100 additional charging stations.

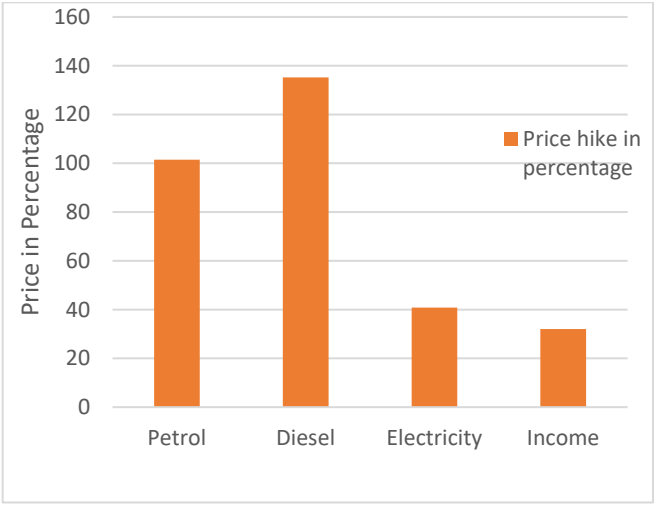

Figure 2. Average price hike of petrol, diesel, electricity, and income in percentage

Table 2. The state level subsidy for EVs (Source: e-amrit.niti.gov.in)

State	Two-wheeler	Three-wheeler	Four-wheeler	Others
Assam	Rs. 10,000/kWh	Rs. 10,000/kWh	Rs.10,000/kWh	No
Delhi	Demand Generation Incentive: Up to INR 30,000 Purchase Incentive: INR 5,000/kWh up to INR 30,000"	Purchase Incentive of Rs. 30,000 Interest subvention of 5% on loans and/or hire purchase scheme for the purchase	Purchase Incentive of INR 10,000/kWh up to Rs. 1.5 lakhs for the first 1000 e-cars	Purchase Incentive of 30,000 for the first 10,000 e-carriers. Interest subvention of 5% on loans and/or hire purchase scheme for the purchase
Gujarat	Rs. 10,000/kWh	Rs. 10,000/kWh	Rs.10,000/kWh	No
Kerala	No	25% of the EV up to Rs. 30,000	No	No
Maharashtra	Rs 5,000/kWh up to Rs. 10,000 for the first 1 lakh electric 2-wheelers	Rs.5,000/kWh up to Rs. 30,000 for the first 15,000 autos Rs.5,000/kWh up to Rs. 30,000 for the first 10,000 electric 3-wheelers goods carrier	Rs. 5,000/kWh up to Rs. 1,50,000 for the first 10,000 cars Rs. 5,000/kWh up to Rs. 1,00,000 for the first 10,000 electric 4-wheelers goods carrier	10% of the ex-factory cost up to Rs. 20,00,000 for the first 1000 e-buses
Manipur	Rs. 10,000/kWh up to Rs. 1.5 lakhs for the first 3,500 electric 2-wheelers	Rs. 4,000/kWh up to Rs. 5 lakhs for the first 200 electric 3-wheelers	Rs. 4,000/kWh up to Rs. 15 lakhs for the first 2500 electric 4-wheelers	Rs. 4,000/kWh up to Rs. 2 crores for the first 30 electric buses
Odisha	15% up to Rs. 5000	15% up to Rs. 12,000	15% up to Rs. 1,00,000	e-buses: 10% up to Rs. 20 lakhs. Goods carriers: Purchase incentive of Rs. 30,000 for the first 5000 electric goods carriers

2.2. Pollution Free

The most dangerous things in a developing country are air and noise pollution. Everyone is aware of global warming. The massive amount of CO2 and other greenhouse gases is one of the primary causes of global warming. Those who live in a healthy and stable environment are responsible for passing it on to the next generation. Almost everyone is aware that gasoline vehicles emitted the majority of CO2. Moving to electric vehicle is a much better choice as a responsible citizen of our country and the next generation. Electric vehicles are environmentally friendly and emit no CO2 [11, 12]. The next advantage of investing in an EV is the reduction of noise pollution [11, 12]. The smooth operation of an EV on the road reduces noise pollution and those who ride inside.

2.3. Safety

EVs are as safe [12] as gasoline cars because they have been tested for fitness and safety. It is more stable than fuel vehicles due to its low centre of gravity. Life on the road is unpredictable; in the event of an accident, the EV's power supply is disconnected from the battery, preventing the vehicle from exploding. Electric vehicles have a simple propulsion mechanism that makes them simple to operate [12].

While there are numerous advantages of driving electric vehicles, there are also a lot of downsides. Let's look at some of the obstacles to making the switch from fuel to electric automobiles.

3. Challenges to the Adoption of EVs in India

There are many obstacles preventing EV adoption in India. In this section, let's look at a few of the obstacles, including the need for electricity, the availability of charging stations, problems with batteries, the cost of the vehicles, lack of service providers and anxieties.

3.1. Shortage in power supply

EVs are a surprising element of transportation, but they also use electricity for their power. India's daily demand is rising and there is a shortage of electricity unfolding. According to data from the Power Ministry, India's latest maximum power consumption on April 26, 2022, was 201.06 gigawatts (GW), this was discussed on an international level [13]. According to the Power Ministry's estimate, the demand might rise by 215–220 GW. The states of Punjab, Haryana, Rajasthan, Uttar Pradesh, Kerala, and Bihar are most impacted by the shortage of electricity. The chief minister of Rajasthan apologised to the people and asked that everyone in the house and office turn off any non-essential electrical devices. It was determined that there were 192 million units of overall electricity shortfall. Several states, including West Bengal, Maharashtra, and Andhra Pradesh, have surpluses of energy at the same time. Table 3 displays India's energy use and requirement over the last five years in Million Units (MU) [14].

The introduction of EVs onto the road would increase the electricity demand. In 2030, the demand is anticipated to be 69.6 Terawatt-hours (TWh) [15]. According to energy expert Vibhuti Garg's prediction, India is now unable to install a 30GW grid annually [16]. It will take two to three years to do this. One of the main obstacles preventing Indian consumers from adopting EVs is a lack of power.

3.2. Lack of charging infrastructure

Public charging stations are necessary for EVs, just like they are for gasoline vehicles. Due to insufficient charging stations [17, 18], finding one in public is a challenging task. Even when one is found the charging station, getting a charging point at that moment can be challenging. Pictured in Figure 3 (a & b) are two public charging stations located in Chennai. They don't have the appearance of a charging station, making it difficult for EV owners to identify the location of the charging station [18].

Figure 3.a. EV Charging station at Kattankulathur

Figure 3.b. EV Charging station at Urappakkam

According to a Union Minister's response from the Lok Sabha on March 25, 2022, 1,742 public charging stations and 10,76,420 electric vehicles (EVs) are currently operating in India. These statistics show very few charging stations for the overall number of electric automobiles. The number of charging stations in the top six Indian cities is still insufficient. According to data from the e-Vahan portal, the national capital of Delhi has 1,32,302 EVs but only 597 public charging stations. To meet the goal of 25% EVs by 2024, 100 more charging stations will be installed by July 2022. If the situation in metropolitan cities were this, there would be no need to discuss urban and semi-urban areas. The busiest highway in the country, the Mumbai-Pune Expressway, has just one charging station, installed by Magenta Group at HP station in 2021 with three charging points [20]. Figure 4 shows the look of the Magenta Charge Grid for this highway.

Figure 4. Magenta group's charging station at Mumbai – Pune Expressway (Source: rushlane.com)

Table 3. Power supply position of India (Source: Ministry of Power)

Year	Energy				Peak			
	Requirement (MU)	Availability (MU)	Surplus(+) / Deficits(-) (MU)	(%)	Peak Demand (MU)	Peak Met (MU)	Surplus(+) / Deficits(-) (MU)	(%)
2018-19	12,74,595	12,67,526	-7,070	-0.6	1,77,022	1,75,528	-1,494	-0.8
2019-20	12,91,010	12,84,444	-6,566	-0.5	1,83,804	1,82,533	-1,271	-0.7
2020-21	12,75,534	12,70,663	-4,871	-0.4	1,90,198	1,89,395	-802	-0.4
2021-22	13,79,812	13,74,024	-5,787	-0.4	2,03,014	2,00,539	-2,475	-1.2
2022-23 until June	4,04,761	4,00,654	-4,107	-1.0	2,15,888	2,07,231	-8,657	-4.0

3.3. Range anxiety

The battery capacity of EVs eventually diminishes, as is the case with other products; this is a universal phenomenon. It initially travels almost the distance that the EV manufacturers had specified. It would start to give less range after a few months [17]. The owner of an EV bases their travel plans on the book format and believes the initial facts. The diminished distance coverage has a significant impact on the EV owner's disposition [17, 18]. It causes a lot of headaches when motorists check the battery backup in the dashboard. Despite the owner's best efforts to travel a shorter distance, sometimes it is necessary to make numerous left and right turns to reach the destination, which adds a few extra kilometers to the journey. Even for owners, looking for a charging station is a difficult chore that causes anxiety. Even though they are in front of the station, they cannot be seen to identify it as a charging station due to India's weak electric vehicle supply equipment (EVSE) infrastructure. They must drive far because there aren't many public charging stations. Another factor that makes EV owners more anxious is the fact that they won't be able to travel the anticipated distance if they have a billionaire traveler, and their weight also matters in this situation.

3.4. Time anxiety/charging time

The majority of owners in India charge vehicles at home. When utilizing a public EVSE to charge an emergency [18], they must wait at least 30 minutes. The speedy charging options are available at the majority of car charging stations, but the situation for two-wheelers is rather unfortunate. Most middle-class people live lives that are mainly based upon seconds. They do not have the luxury of waiting around at a public charging station for several hours.

3.5. The high cost of EVs compared to fuel vehicles

EVs are cost-effective in terms of gasoline and maintenance, but their initial cost is rather high. The average price of a battery-powered car in India is close to 13 lakh, whereas the price of a gasoline car is 4 lakh. The price differential for electric vehicles in the beta testing stage is roughly three times greater than for a fuel-powered vehicle. When considering big vehicles like trucks and buses, the 10-year total costs for gasoline and electric vehicles are practically the same. To enjoy the benefits of an EV, the owner must wait 10 years. For a businessperson, however, this waiting period is excessive. Prices for the two and three-wheelers on both types of vehicles are the same.

3.6. Lack of service providers

There are only fewer qualified individuals and service facilities because EVs are a new product. More than 90% of electric circuits threaten the fuel vehicle service personnel trying to work on EVs. The main issue for EV owners is that they must wait until a service provider arrives at their doorstep and pay a hefty fee if anything goes wrong with their vehicle, whether it be a minor issue or a significant one [17].

3.7. Battery lifetime

It is a well-known fact that any product's life span listed by the manufacturer is not its maximum range. It depends on how the owner maintained or used the item. The battery in an EV operates in the same way. The battery comes with a predefined timeframe or kilometers (KM) of warranty from the EV manufacturer. However, the truth is very different. Many factors affect the Li-ion battery. They are easily impacted by heat, which is one of the main causes. Heat is produced via power fluctuations. Thermal runways and fire catches can result from it occasionally. The major factor is the battery ageing problem, which occurs when a battery loses capacity and frequency after a short period or a limited number of charges. The owners of EVs should be well-prepared in advance for battery replacement.

3.8. Battery price

EVs are mostly powered by lithium-ion batteries. Graphite, lithium manganese oxide, lithium iron phosphate, and lithium cobalt oxide are the main ingredients of these Li-ion batteries. Lithium cells are currently imported into India from China or Taiwan [21] and used to make batteries. Additionally, the imported packs are used to build Li-ion batteries. Li-ion batteries, like other imported goods, are expensive. In India, a 1Wh lithium-ion cell costs between 15 and 20 rupees [21]

for sale. The average cost of the battery is roughly Rs.45,000 when it comes to two-wheelers that use 3kWh batteries. The Tata Nexon has a 31kWh battery; the battery's lowest price is Rs.4.5 lakh, while the car's on-road price is Rs.14.79 lakh. Nearly 1/3 of an electric vehicle's cost goes toward the battery. An EV owner's wallet truly takes a down hit when a battery needs to be replaced.

3.9. Recent fire catch

In India, some electric two-wheelers have caught fire in recent months while charging, and occasionally while driving as well. Recently, on June 22, 2022, electric four-wheeler giant Tata's Nexon caught fire in Mumbai [22]. One of the reasons for reconsidering the transition to battery-powered vehicles is the media's news coverage of EV fire incidents.

4. A Few Recommendations for EVs Adoption in India

- India is having a difficult time promoting electric vehicles. Although there are many obstacles to overcome, the world is currently in a position to reduce GHG emissions to prevent calamities. In 2070, India similarly intended to achieve zero emissions. Some steps must be taken to accomplish that goal. For that, some of the significant recommendations include:
- The Indian government has taken the first step through the Faster Adoption and Manufacturing of Hybrid and Electric vehicles (FAME). People are not yet familiar with the FAME scheme. It is necessary to spread the word about the programme until every Indian has heard it.
- In India, one of the main issues is electricity. The worst-case scenario is that India produces 75% of its electricity from fossil fuels. Roadside CO2 emissions will decline because of EVs. However, energy generating plants' CO2 emissions will rise. Consequently, it is necessary to establish the production of non-fossil fuels.
- The Indian government should encourage its citizens to research cutting-edge renewable energy generation methods.
- Infrastructure for public charging should be expanded, especially on national highways. A power station will soon be installed through FAME every three kilometres, as announced by the Minister in the parliament. The government should take into account the villagers before granting permission for installing charging stations to large corporations. Already, the highways that have been built on their properties have had an impact on their lives. If the government can persuade people to build a power plant on their property, there will be one every kilometre, making India the world's largest producer of power plants. The advantages for the locals will increase as a result.
- Expected to offer greater subsidies to those who are ready to set up recharging stations. Because there are currently fewer automobiles on the road and only one EV vehicle is charged on a business day, it is a new business and people are not willing to put substantial sums of money into it.
- India is currently planning to build charging stations close to the toll booth. Instead, people should be encouraged to produce solar-powered electricity through the FAME scheme. Most of India's states enjoy year-round sunshine. Nowadays, people sell their own farm products on the highways. They will transform their location into solar-powered EV charging stations if the government provides them with plenty of subsidies and incentives. This supports generating extra electricity and setting up a significant number of EV charging stations.
- There should be reserved parking spaces for EVs at workplaces, public areas, and institutions. Emergency charging ports should also be available.
- Since EVs produce relatively little noise, it is necessary to allocate distinct lanes on the road in accordance with developed countries' road lane norms.
- The hearts of EVs are lithium-ion batteries. Lithium is still not mined in India. Lithium was formerly imported from China and Taiwan. The first lithium reserves were discovered recently, (i.e.) in 2021, by India's Department of Atomic Energy at Mandya, Karnataka. Do not yet have the technology to mine the lithium, despite finding the basins. Those who are willing to focus on finding and mining lithium basins need to be given independence and financial support. The major firms are still being sought after by the government to mine lithium. Why not invite start-up companies?
- Since lithium mining is entirely new to Indians, it is imperative to either quickly acquire foreign technology or train the local workforce to dig and collect lithium from mines.
- Lithium mining is difficult, costly, and runs the risk of causing water shortage issues because it requires 5,000 gallons of water to extract one ton of lithium. India should consider seriousness from the start, since South America is already experiencing a water constraint.
- Making the battery and mining the lithium from the mine are both challenging tasks. The Indian government should direct educational institutions to launch specialised courses focused on energy generation and storage to make things simpler.
- E-waste from EVs is the next significant problem. Finding a better way to manage e-waste without harming the environment, particularly soil and water, is necessary. The focus should be placed on

recycling or reusing the e-garbage from electric vehicles.

- Universities in India should offer doctoral and postdoctoral opportunities to model, estimate, and optimise energy storage in lithium-ion batteries, much like the National University of Singapore (NUS) does.
- Contemporary Amperex Technology Co. Limited (CATL), a leading lithium battery producer with headquarters in China, currently manufactures first-generation Sodium-ion batteries and supplies batteries to Tesla. India is also able to advance in this field of technology. Reliance is the only company currently using this technique. A few more companies have to be encouraged to join this league.
- Researchers at the Indian Institute of Technology (IIT), Kharagpur, created supercapacitors and sodium-ion batteries. The Department of Science and Technology has provided funding for this project (DST). The commercialization of this invention is required.
- While sodium-ion batteries are fire-free, lithium-ion fire catches are the most dangerous issue with these batteries. Since lithium-ion battery technology in India still has a lot of issues, switching to sodium-ion technology is advised.
- Batteries in bad condition are the main cause of EV fires. Government involvement in safety measurements is necessary. Applications for monitoring the health of EV batteries or regular manufacturer inspections are needed.
- Compared to lithium-ion batteries, sodium-ion batteries used in electric vehicles have a shorter range. Another crucial element in the current situation is research into extending the range of sodium-ion batteries.
- Only 6 states and one union territory offer subsidies for the purchase of electric vehicles out of the 28 states and 8 union territories, according to statistics from the e-amrit.niti.gov. on website. In order to encourage the use of EVs, the central government should advise the states to offer subsidies to consumers.
- There aren't many EV service providers because the technology is so new. To lower zero emissions, people in India should have a greater awareness of EVs. Therefore, there is a significant need for EV-related conferences, workshops, and hands-on training. The government should set aside a considerable sum of money for this. In India, the registration of EVs is not governed by any proper rules. India needs to abide by certain rules for EV registration. If the rules are regulated, calculating the necessary electricity, electric networks, and charging stations in the surrounding locations is simple.
- The road tax for EVs is not generally collected by governments. That is a plus for EV owners, and EVs also benefit from road upkeep, which is important.
- Lithium-ion batteries and fuel-efficient hybrid vehicles are the current focus of the automobile industry in India. However, only a small number of developed nations focus on vehicles with lithium-ion and sodium-ion batteries. To participate in the emerging technological environment, research in this field is also vital.
- Smartphone lithium batteries allow for wireless charging because chargers and batteries are in close proximity to one another. Due to the receiver and transmitter's location issues, the same technology cannot be used in EVs. This problem needs to be solved in order to improve the efficiency of electricity transmission.
- Battery monitoring powered by the Internet of Things (IoT) may extend the life of the batteries, allow for smarter battery recycling decisions, and support better load management of energy consumption and generation.

5. Conclusions

This paper provides a detailed examination of why India currently needs to adopt electric vehicles as well as a list of the advantages of doing so. For developing nations like India, adopting new technology is never simple because there are so many obstacles to overcome. Infrastructure is the most significant of many challenges to the adoption of EVs in India. India currently has adequate infrastructure, but it is not enough for India's long-term objectives. The barriers that are being mentioned here are primarily focused on the zero-emission future goal. A few suggestions are made in order to help India reach its goal of having no emissions by 2070. Those suggestions must be seriously taken into account in order to remove the obstacles to EV adoption and help India establish itself as a responsible global influence. Most of the research needed relates to technical development. India would overcome the obstacles and accomplish its goal ahead of schedule based on confidence in Indians' intelligence and government assistance.

References

[1] Seshan Vijayraghvan, India's Total Vehicle Sales Fell 19% In FY 2022 Against Pre-COVID FY 2020, But PV Sales Grew 11%, https://www.carandbike.com/news/indias-total-vehicle-sales-fell-19-in-fy-2022-against-pre-covid-fy-2020-but-pv-sales-grew-11-2884906, April 13, 2022.

[2] Hannah Ritchie and Max Roser, India: CO2 Country Profile, https://ourworldindata.org/co2/country/india.

[3] Atanu Biswas, Free public transport to combat air pollution: lessons from Europe, https://www.telegraphindia.com/opinion/free-public-transport-to-combat-air-pollution-lessons-from-europe/cid/1682936, January 19, 2019.
[4] Government plans 'Less Traffic Day' to cut Bengaluru's pollution, https://www.deccanchronicle.com/nation/current-affairs/050218/government-plans-less-traffic-day-to-cut-bengalurus-pollution.html, February 5, 2018.
[5] Motorists in Delhi may have to pay Rs 20,000 for violation of odd-even scheme, https://economictimes.indiatimes.com//news/politics-and-nation/delhi-rs-20000-fine-likely-for-odd-even-plan-violation/articleshow/71196494.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst, September 19, 2019.
[6] Gagan Modi, Historic Petrol and Diesel Fuel Prices of 20 Years in India. 2003 to 2022 Record, https://www.mycarhelpline.com/index.php?option=com_easyblog&view=entry&id=808&Itemid=91, May 22, 2022.
[7] Madhumitha Jaganmohan, Average cost of state electricity supply in India from financial year 2009 to 2020, https://www.statista.com/statistics/808201/india-cost-of-state-electricity-supply/, May 30, 2022.
[8] India's per capita income remains below pre-Covid level in 2021-22, https://www.business-standard.com/article/economy-policy/india-s-per-capita-income-remains-below-pre-covid-level-in-2021-22-122053101435_1.html#:~:text=India's%20annual%20per%20capita%20income,FY22%20over%20the%20previous%20year, June 1, 2022.
[9] Niti Aayog, Government of India, State Level Policies, https://e-amrit.niti.gov.in/state-level-policies
[10] Free EV Charging in Delhi to Start from June. But there is a catch, https://auto.hindustantimes.com/auto/news/free-ev-charging-in-delhi-to-start-from-june-but-there-is-a-catch-41649217548928.html, April 6, 2022.
[11] Vishal Khanna, 10 Benefits of Buying an EV (Electric Car) in India right now!, https://gomechanic.in/blog/benefits-of-buying-an-ev/, August 18, 2020.
[12] Rinkesh, Various Advantages and Disadvantages of Electric Cars, https://www.conserve-energy-future.com/advantages-and-disadvantages-of-electric-cars.php
[13] Girish Madan, India to Face Supply Challenges, Rising Electricity Demand, https://www.fitchratings.com/research/corporate-finance/india-to-face-supply-challenges-rising-electricity-demand-07-04-2022#:~:text=We%20expect%20monthly%20electricity%20demand,average%20monthly%20demand%20in%201Q21., April 7, 2022.
[14] National Information Centre, Power Sector at a Glance ALL INDIA, https://powermin.gov.in/en/content/power-sector-glance-all-india, August 16, 2022.
[15] India's electricity demand from EVs may reach 69.6 TWh by 2030: Study, https://auto.economictimes.indiatimes.com/news/passenger-vehicle/cars/indias-electricity-demand-from-evs-may-reach-69-6-twh-by-2030-study/64584576, June 14, 2018.
[16] Prerna Lidhoo, Electric Vehicles: Will Challenges Outweigh Opportunities in the Long Run? https://www.businesstoday.in/magazine/30th-anniversary-special/story/electric-vehicles-will-challenges-outweigh-opportunities-in-the-long-run-321696-2022-02-07, February 20, 2022.
[17] Mainak Das, Owning an EV in India, these are the challenges I face, https://auto.hindustantimes.com/auto/two-wheelers/owning-an-ev-in-india-these-are-the-challenges-i-face-41639369301985.html, December 13, 2021.
[18] Garg, Exclusive - Challenges faced by Electric Vehicles to become the next big thing in India, https://zeenews.india.com/electric-vehicles/exclusive-challenges-faced-by-electric-vehicles-to-become-the-next-big-thing-in-india-2443191.html, March 08, 2022.
[19] India has over 1 million EVs, 1,742 public charging stations: Gadkari, https://www.business-standard.com/article/economy-policy/india-has-over-1-million-evs-1-742-public-charging-stations-gadkari-122040100303_1.html#:~:text=India%20has%20over%201%20million%20EVs%2C%201%2C742%20public%20charging%20stations%3A%20Gadkari,-As%20per%20Vahan, April 1, 2022.
[20] Satya Singh, Electric Car Charging Station Inaugurated On Mumbai Pune Expressway, https://www.rushlane.com/electric-car-charging-station-mumbai-pune-expressway-12396284.html., March 12, 2021.
[21] Lithium-ion Battery Manufacturers in India 2022, https://inverted.in/blog/lithium-ion-battery-manufacturers-in-india-2022.
[22] IANS, "Now Tata Nexon EV catches fire in Mumbai, probe on, https://economictimes.indiatimes.com/industry/renewables/now-tata-nexon-ev-catches-fire-in-mumbai-probe-on/articleshow/92405220.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst, June 23, 2022