

The Charge of the EVs: An Overview of the Indian E-Mobility Roadmap

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Abstract

The electric mobility sector is the most developing sector currently and is the only solution to resolve the environmental problems looming upon the globe. The adoption of EVs from the global perspective can help in understanding India's current position and potential. A comparative analysis of the global leaders in EV adoption and electrification of the transportation sector provides an outline for India's EV adoption roadmap. Based on current levels of EV adoption certain future projections and assessments can also be made. Various government initiatives and policies provide support for development of the Electric Vehicles ecosystem. The government policies for e-mobility adoption have evolved in the past five years and the current Phased Manufacturing Programmes and FAME II policy are pursuing adoption of e-mobility very progressively. The economic downturn will have considerable impact on EV adoption and will push the inflection points for various vehicle segments further by few years. There is a pressing need to adopt EVs in the backdrop of the ongoing global warming and the consistent environmental and ecological damage due to human activities. The development process can be made sustainable only by adoption of clean energy. A conscious recognition and adoption of a positive environmental conservation role by everyone will help in averting a climate pandemic, which can now be a fast-approaching reality. Reduction in carbon footprints made while moving from one place to another is one of the long-term solutions to the climate problem.

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I. INTRODUCTION

A consistent transition is taking place in the mobility sector with an increasing adoption of Electric Vehicles (EV's). Environmental concerns and a need to cut down emissions of greenhouse gases have led countries to formulate and adopt EV policies. In the coming decade, the world will see a massive change in the mobility sector. Electric vehicles in comparison to their fossil fuel counterparts are the transportation modes which the future is looking at.

Electric mobility cuts down on carbon emissions per km and has a clean and green image. EV's as an alternate to the petrol/diesel vehicles to cut down on environmental pollution as well as noise pollution in big cities. Various research studies have shown that electric vehicles are better for the environment as they have no tailpipe pollutants like oxides of nitrogen.

Besides environmental benefits EV's have a much lower running costs, though the initial purchase cost in comparison to the fossil fuel vehicles is little higher. The EVs have fewer moving parts and hence they have less overall maintenance costs. Auto companies like Ford (Focus Electric), Nissan (Leaf) are making the interiors of some of their electric vehicle variants from ecofriendly and recycled materials. Recycled plastic water bottles, plastic bags, old car parts and even secondhand home appliances are being used for designing the interiors of these EV's.

Electric vehicles use one or more powered motors which are charged by Lithium-ion batteries. these are the same batteries which are used in smartphones and laptops. Lithium-ion batteries have a life span of 8-10 years. Manufacturing process of the batteries do have carbon footprints; but with gradual improvements in technology, these footprints are being reduced. Electric vehicles are powered by renewable energy hence they have lower or neutral carbon footprints indefinitely.

One important observation regarding electric vehicles and their future sustainability is that; nearly half of the world's known reserves of lithium are in Bolivia. Argentina, Chile, Bolivia together forms the Lithium triangle of South America. China, US, Australia, and Brazil are some other countries where Lithium reserves can be found. This concentration of Lithium reserves in certain areas of the world can have geo-political

consequences when demand for this resource will rise in the future due to progressive adoption of electric vehicles. The extraction of lithium reserves involves water and air pollution and at times there are chemical leakages also.

Currently the technologies used for processing lithium along with manganese and cobalt for use in electric vehicles; are very energy consuming; they require almost double the amount of energy as required for manufacturing of conventional vehicles.

Despite these constraints and drawbacks, the coming decade is going to witness an exponential progression in adoption of electric vehicles globally.

Overview of the Global Scenario in EV Adoption

Due to excessive global warming and the resultant climate changes, the past decade has seen a tremendous growth globally, towards use and adoption of electric vehicles. Switching from fossil fuels to electricity is an important solution which is needed to stall the climate changes. Conventional vehicles are a significant source of global warming and emissions. In countries like Sweden, France where electricity comes from renewal resources the average lifetime emission from electric vehicles is up to 70% lower than fossil fuel vehicles, for UK the figure is 30%.

According to a study by Radboud University, in 95% of the world driving an electric car is better for climate than the conventional petrol car. Only in countries where electricity is produced by coal (e.g., Poland, China, South Korea, India etc.) same conclusion cannot be drawn.

The researchers of this study calculated the greenhouse gas emissions and emissions through the entire production chain and waste processing. The study divided the world into 59 regions. 53 of these regions included most of Europe, US and China which represents 95% of the global mobility sector.

In 2019 global electric cars sales crossed 2.1 million mark. in terms of active use and adoption of EV's China is the global leader with 2.3 million electric vehicles. Europe has 1.2 million and US has 1.1 million electric vehicles in active use.

But if we look at relative terms, situation in Europe is far more promising. Norway is leading the world with 56% of its vehicles running on electricity. In Iceland and Netherland this figure is 25.5% and 15% respectively. China on the other hand has only 5.2% of vehicles running on electricity. Government incentives are increasing globally for adoption of EV's. Share of EV's to total vehicles globally is likely to increase from 2% in 2016 to 22% in 2030.

The Radboud University study projected that in the coming years electricity will be less carbon intensive than today. Though there has been a tremendous growth in the electric mobility sector, but it is just a scratch on the surface. A lot of effort by governments and innovations by industry are required to speed up the adoption process. The impending dangers of the environmental degradation are seeming very real now. Short term and long-term targets are being fixed. According to estimates, by 2030 the global electric vehicle stock would be 7% of the global vehicle fleet. Another more optimistic scenario known as EV30@30, nearly 30% of all vehicles would be electric. By the year 2050, every second car on the road could be electric, which could reduce global CO2 emissions by up to 1.5 gigatons per year.

In the electric car segment China is leading the world. Low share of Europe and US is evident from the above graph. UK is aggressively pursuing the EV adoption. Sale of purely fossil fuel cars will end in 2030 and hybrids in 2035. although the existing cars will be allowed for some time.

China is leading in electrification of buses, two wheelers and three wheelers also. In the two-wheeler category e-bikes, e-scooters and e-mopeds are fast emerging options in populous countries like India and China. Light commercial electrical vehicles, electric buses are also gaining ground in the city of Santiago de Chile. Finland, China, India, Chile are some countries which are fast electrifying the public transportation. There were 460,000 electric buses on road in 2018.

Electrification of heavy-duty trucks, shipping operations at ports, ground operations in airports (like electric taxiing) are fast expanding in many countries.

In 2017 for the first time the global sale of EV's crossed a million units. Following this trajectory, the annual passenger sales is expected to go up to 10 million by 2025, 28 million by 2030, and 56 million by 2050.

India and EV adoption

Highly populated cities and need for curtailment of carbon emissions makes India a country in much need for adoption of EV's. 14 out of 20 of the worlds most polluted cities are in India. In 2017, 1,2 million deaths in India were linked to air pollution. According to an estimate around 3% of India's GDP goes towards addressing serious health consequences resulting from air pollution. EV's can reduce India's CO2 emissions by upto 37%.

Another factor which favors India's adoption of EV's is the prospective curtailment of heavy oil import bill which India faces. India is relying fully on oil imports for its fuel needs. The oil import bill was around USD

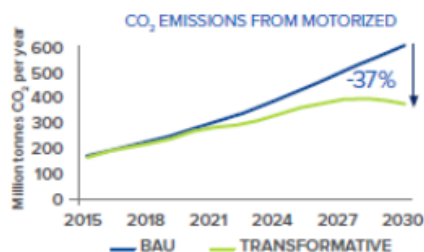
101 billion in the fiscal year 2020. If India adopts electric solutions it can bring down its fuel energy consumption by up to 64%.

There is excess capacity in the power generation sector which is undermining the viability of the power sector. Consistent power demand from the EV sector with paying capacities will lead to regeneration of the power sector.

India has 3 key Strategic Imperatives to look at EVs

Higher Carbon Emissions

One of India's major development goals is the urgent need to reduce our carbon emissions and meet our climate obligations. *EVs could reduce our CO2 emissions by 37%.*



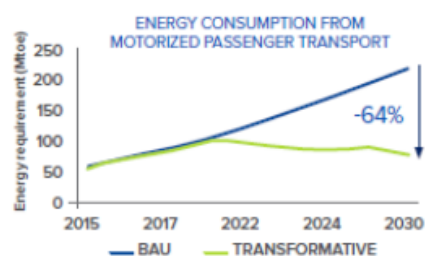
Lower Power Demand

Demand for power has not risen in sync with power generation capacities, leading to non-viability of the sector. Rise in EVs could help grid stability going forward.

A new source of power demand in the form of Electric Vehicles will be beneficial for the power sector and may lead to stable demand and a 'paying customer segment'

Fuel Security Risks

India currently depends on large scale imports of crude to meet most of its mobility fuel needs. *India can save 64% of passenger mobility-related energy demand in 2030 by pursuing a shared, electric & connected solution. This could result in a reduction of 156 Mtoe (~US \$ 60 Bn.) in diesel & petrol consumption for that year.*



Source: NitiAyog/RMI Report on Transformative Mobility Solutions for All

The dynamics of the Indian automobile industry are different and present a tremendous potential for EV adoption. India has the world's 4th largest automobile industry with around 32 million people employed in it. FDI in the Indian automobile industry between 2015 to 2018 was around \$8.6 billion. India registered a growth of 14.78% in the number automobiles produced during the period April to March 2018 over the same period last year. The Indian automotive industry is divided into 4 segments: two wheelers 81% (79% scooters and 2% motorcycles), three wheelers 3%, passenger vehicles 13% and commercial vehicles 3%. The current levels of EV penetration are only 1% of the total automobile sector. An average of 1.5 lakh electric vehicles are sold annually in India. Industry and government both have recognized the growth prospects in e-mobility and are working to attain a transition towards adoption of clean energy. A study estimates that EV market in India is growing very fast, it would be around \$2 billion by 2025.

The focus in India is on the electrification of small vehicles and public transportation. It is economically viable and possible to have a unique impact and scale with two wheelers and three wheelers in India. Priority should also be given to large scale electrification of buses and government cars fleet.

Policy support provided by the Government to promote Electric Vehicles:

In India, the government has taken many initiatives for manufacturing and adoption of electric vehicles. A push towards EV's and alternate fuels is very evident. The EV policies prioritize two and three wheelers, public transportation, and job creation. Emphasis is on moving towards a 'shared mobility era'. The government wants to significantly reduce the carbon footprints in the mobility sector by 2030. For a smooth transition of mobility sector towards electrification policies are there at both center and the state level.

- National Electric Mobility Mission policy (NEMMP) 2020, was launched in the year 2012 with an aim of improving fuel security and air quality through adoption of electric and hybrid vehicles. The target was to achieve 6-7 million sales of electric and hybrid vehicles by the year 2020. This mission provided demand side incentives for acquisition of EV's and supply side incentives through promotion of R&D in battery technology, motors, systems integration, testing infrastructure to ensure industry participation.

- FAME I, faster adoption and manufacturing of electric vehicles was launched under NEMMP in 2015 to promote domestic manufacturing capabilities in EVs. Steps were taken by the government for faster transition of mobility sector to adopt EVs.

A tax cut on loan amount taken for purchase of EVs was announced.

GST on electric vehicles was slashed from 28% to 12% with no cess.

Sale of electricity was allowed as a service for charging of Electric Vehicles.

Ministry of Road Transport Highways exempted the EVs from permit requirement.

All vehicle segments were incentivized under FAME I, around 2.78 lakh EVs were supported with demand incentives of 343 crore rupees. In addition, 465 buses were sanctioned to different cities under this scheme.

- FAME II was notified by the Department of Heavy Industries in March 2019, with an outlay of 10,000 crore rupees and for a period of three years. Under this policy emphasis is on creation of demand for Electric Vehicles with focus on two wheelers and three wheelers. A target of generating demand of 10 lakh two wheelers and 5 lakh three wheelers has been set. 7000 buses will also be supported by the scheme. Creation of a robust charging infrastructure has also been planned in the scheme; 2700 charging stations will be set up in tier-1 cities. Charging stations will also be set up on highways connecting city clusters. The scheme aims at providing affordable and environment friendly public transportation for the masses. In the e-three-wheeler and e-four wheelers and e-buses category the scheme will be applicable to vehicles used for public transport, but in the two wheelers segment privately owned vehicles will also be covered.

- National Mission on Transformative Mobility & Battery Storage has been formulated to provide cohesiveness in policy framework for e-mobility and battery storage in the country. Under this policy an integrated program has been formulated to facilitate Advance Chemistry Cells (ACC) and battery storage manufacturing in the country. Cost effective options of advance battery storage are essential for bringing down the cost of EV's. Niti Ayog is the key steering agency of this programme.

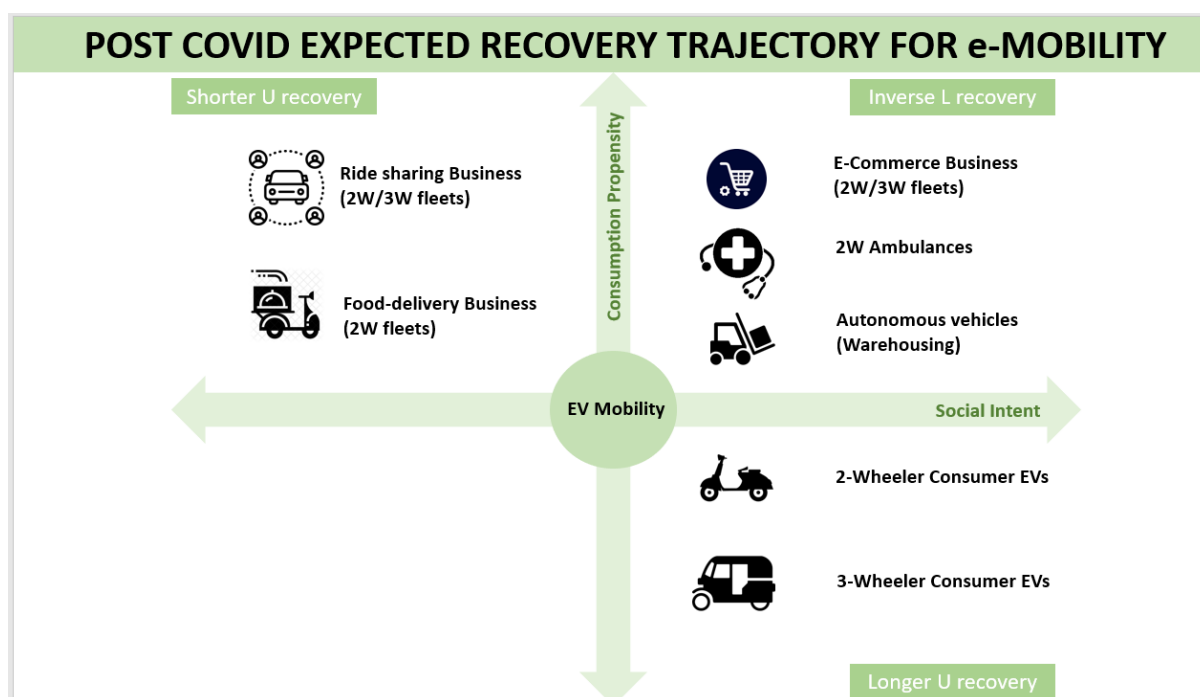
Two Phased Manufacturing Programmes (PMP) valid till 2024 will be effectively implemented by the National Mission on Transformative Mobility and Battery Storage. These PMPs are to support setting up of battery and cell manufacturing giga plants in India and to localize production across the entire Electric Vehicle value chain. There has been a slashing of GST on EV's to 5% (as against 25% for combustion engines). A tax exemption of 1.5 lakh rupees will be given on loans to buy electric vehicles. Proposed custom duty exemption on certain EV parts including electric drive assembly, onboard charger, e-compressor, and a charging gun to cut down costs.

- Over ten states in India have final or draft EV policies. Tamil Nadu, Kerala, Telangana, Andhra Pradesh, Madhya Pradesh, Uttar Pradesh, Uttarakhand, Maharashtra, Karnataka, and Delhi have approved electric vehicles policy and Bihar, Gujarat, Himachal Pradesh, and Punjab have already drafted EV policies. Nearly all state policies have maximum incentives for two wheelers, three wheelers and buses. The central government electric mobility plans will be strengthened only if states effectively implement their plans to develop local EV markets.

The government is making active policies for charging swapping stations which will provide energy to EV's. Both long term and short-term tax incentives are being provided to EO's (Energy Operators, who provide charging and swapping). The pace of government support has been accelerated recently with FAME II and industry is also seeing an opportunity in the EV sector.

Post Covid Electric Mobility scenario in India

The COVID-19 pandemic has led to an economic downturn and the related stimulus needed to rebuild India present an opportunity to support the automobile industry through investment in electric mobility. Due to the Covid-19 pandemic there were many social and behavioral changes, which have impacted EV adoption in India. In the year 2020 the economic activity in India has witnessed negative growth rates, all efforts are being made for the revival of the economy. In the electric vehicles market certain changes in terms of future market potential have been witnessed. Post COVID-19 recovery path will be different for various segments of the electric mobility market.



There has been a considerable decline in ride sharing and food delivery business, mainly due to social distancing norms and health concerns. These two segments are impacted mainly due to behavioral changes and the resulting low social intent. As the pandemic subsides, a slow recovery will be seen in these two segments. Hence a shorter U recovery is predicted for these segments. E-commerce business has picked up momentum during the pandemic. In e-commerce segment is two and three wheelers fleet have a high consumption propensity and high social intent is also there. Requirement of warehousing facilities will also go up with exponential increase in the e-commerce business in India. Vehicles used in warehousing sector also have a great potential for electrification. The requirement of ambulance services has also increased in the COVID-19 scenario and their electrification also has high economic and social intent and hence a high market potential. An inverse L shaped can be expected for e-commerce and warehousing vehicles and ambulances.

The economic downturn and resultant fall in income levels have impacted the two and three wheelers demand in the personal consumer's segment. Already a lagging sector, it has high social intent but has low consumption propensity. This sector requires a lot of effort and government support and will witness a slow U-shaped recovery.

India is a middle-income country, so the EV adoption has begun to enable the first and last mile connectivity through e-rickshaws, three wheelers, and buses. A public transit infrastructure is being created. The increasing demand to cater to the online orders has resulted in adoption of e-mobility by various e-commerce giants. Following table depicts the short- & long-term adoption of EV's by various users and vehicle segments.

User Segment	Vehicle Segment	Consideration Point	Inflection Point
Public Transportation	3W-L3, 4W	2018	2023
E-Commerce / Delivery	3W-L3,3W-L5,2W	2019	2022
Personally Owned	2W	2021	2024

Personally Owned	4W	2022	2026

The consideration point occurs when consumers start considering or evaluating an EV to make a purchase decision. At this stage, the overall EV penetration may be low but consideration regarding performance and total cost of ownership increases.

Inflection point occurs when various factors like EV technology, performance, enabling ecosystem gets established. Faster growth of the market occurs after the inflection point,

The consideration points in terms of establishing the proof of concept, technical due diligence and sorting the supply chain for last mile connectivity services have already progressed for public transportation and e-commerce delivery. At this pace, the above segments will have the large-scale adoption of EV's in the next 2-3 years' time frame.

The 2W & 4W passenger segments are actively perusing and exploring the e-mobility space. The progress is a bit slow looking into their commitment to invest in BSVI technology and finding alternates to their existing large service network. The full-scale adoption may happen in next 4-5 years' time frame.

Challenges for EV adoption in India

Prior to the pandemic also the EV sales were only 1% of total vehicle sales in India and of that 95% of sales were electric two wheelers. Only 1500 electric cars were sold for personal use between April and December 2019. The Indian mobility market is dominated by two wheelers. 79% of all vehicles sold in India during 2018 were scooters. The primary focus should be a shift towards EV's in the two wheelers segment, which is more viable and will lead to an impetus for shift in the cars segment.

Low level market penetration of EV's can also be attributed to skepticism of consumers towards adoption of EV's. Consumers as well as fleet managers are adopting a wait and watch approach. Price of EV's is a great consideration for the consumers. The Green Premium attached with EV's is a bit too high for consumers in a middle-income country like India. Other factors like range and duration of charging are also hindering fast adaptability of EV's in India.

Developing adequate charging infrastructure, increasing the range per charge, and managing pricing and affordability by bringing down the production costs; will be the key factors enabling quick and smooth transition towards EV adoption in India. Investments in the e-mobility sector by both government and private investors will help India achieve goals of job creation and reduction in pollution levels to combat climate changes.

EV-revolution, one of the solutions to the Environmental Pandemic

EV revolution is catching a fast pace across the globe now. Nearly 16% of the environmental damaging emissions come from the transportation sector. Partial or full replacement of fossil fuel vehicles involves huge green premiums; but research and gradual development of efficient technologies will bring down these huge green premiums. Rising temperatures are indicating a slow and creeping climate pandemic approaching mankind, which perhaps will be much larger than this unprecedented COVID-19 pandemic. Electrification of the mobility sector will be a huge leap to curb the damaging emissions. The preceding discussion and the presented facts show that globally fast paced efforts are being undertaken and in India also the electrification is happening in the small vehicle segment and in providing last mile connectivity to millions of people using public transportation.

The main hindrance in adoption of EV's in the developing country like India is the pricing or the green premiums associated with these vehicles. Gradual development of technologies, expansion of scale of manufacturing and strong government push and support is imperative for removal of the various roadblocks.

According to Bill Gates in his book titled 'How to Avoid A Climate Disaster', the environmental problem is slower and deadlier than the current pandemic, it will kill five times more people than the peak time mortality of the pandemic. The world has goals, but concrete plans are required. The green premium which is \$5 trillion per year must be brought down to \$250 billion per year. Danger warnings combined with incentives will work towards attaining positive outcomes. The pressing need to adopt EV's has now been identified and acknowledged by planners and environmentalists and various initiatives are being taken to follow the road to electrification of the mobility sector.

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