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Electric Vehicles in India: Future and Challenges

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Abstract

Vehicle electrification is a game changer for the transportation industry because of the significant energy and environmental effects caused by high vehicle efficiency (EVs are about three to four times more efficient than comparable internal combustion engine vehicles, or ICEV), zero tailpipe emissions, and decreased reliance on petroleum due to the wide variety and flexibility of fuels available for electricity production. The power industry and the larger energy system are both significantly impacted by the integration of vehicles into the grid. Additionally, the Indian government intends to expand the use of electric vehicles in the automotive sector. This essay discusses the prospects and difficulties facing the Indian market for electric automobiles.

Introduction

With over 40 crore consumers in need of mobility solutions by 2030, India is currently the world's fifth-largest automobile market and might rise to among the top three in the near future. But according to the Paris Agreement, a growing number of car owners does not always mean that conventional fuel use would rise. India has to undergo a transport revolution that would improve "walkability," public transit, roads, trains, and automobiles in order to guarantee a positive growth rate towards reaching Net Zero Emissions by 2070. Electric vehicles are probably the answer to "better cars."

. TAXONOMY OF ELECTRIC VEHICLES

Generally speaking, EVs are divided into five categories based on the technology of their engines (see Figure 1).

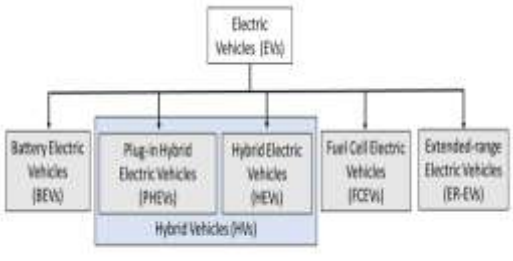

Figure 1. Classification of Electric vehicles according to their engine technologies and settings

Battery Electric Vehicles (BEVs): vehicles 100% are propelled by electric power. BEVs do not have an internal combustion engine and they do not use any kind of liquid fuel. In order to give the vehicle an acceptable autonomy, BEVs normally use large packs of batteries. A typical BEV will reach from 160 to 250 km, although some of them can travel as far as 500 km with just one charge. An example of this type of vehicle is the Nissan Leaf [1], which is 100% electric and it currently provides a 62 kWh battery that allows users to have an autonomy of 360 km.

Plug-in hybrid electric vehicles, or PHEVs, are powered by both an electric engine that is charged by an external plug and a traditional combustible engine. Under normal driving circumstances, PHEVs can store enough electricity from the grid to drastically cut down on fuel use. With its 12 kWh battery, the Mitsubishi Outlander PHEV [2] can travel about 50 km only on electricity. Nevertheless, it is also important to know that PHEVs use more fuel than the automakers claim [3].

Hybrid electric vehicles, or HEVs, are powered by both an electric engine and a traditional internal combustion engine. In contrast to PHEVs, HEVs are not able to be connected to the grid. In actuality, the power produced by the vehicle's combustion engine charges the battery that powers the electric engine. In more recent models, the energy produced while braking can also be used to charge the batteries, converting the kinetic energy into electrical energy.

The Toyota Prius, in its hybrid model (4th generation), provided a 1.3 kWh battery that theoretically allowed it an autonomy as far as 25 km in its all-electric mode [4]. Fuel Cell Electric Vehicles (FCEVs): these vehicles are provided with an electric engine that uses a mix of compressed hydrogen and oxygen obtained from the air, having water as the only waste resulting from this process. Although these kinds of vehicles are considered to present “zero emissions”, it is worth highlighting that, although there is green hydrogen, most of the used hydrogen is extracted from natural gas. The Hyundai Nexo FCEV [5] is an example of this type of

vehicles, being able to travel 650 km without refuelling.

Extended-range EVs (ER-EVs): these vehicles are very similar to those ones in the BEV category. However, the ER-EVs are also provided with a supplementary combustion engine, which charges the batteries of the vehicle if needed. This type of engine, unlike those provided by PHEVs and HEVs, is only used for charging, so that it is not connected to the wheels of the vehicle. An example of this type of vehicles is the BMW i3 [6], which has a 42.2 kWh battery that results in a 260 km autonomy in electric mode, and users can benefit an additional 130 km from the extended range mode.

1. III. OVERVIEW OF THE MARKET

Following the Ministry of Heavy Industry and Public Enterprises' 2015 adoption of the FAME (Faster Adoption and Manufacture of Hybrid and Electric Vehicles) program, the EV market is expanding even further. The electric vehicle market in India was estimated to be worth USD 5.47 billion in 2020 and is projected to increase at a compound annual growth rate (CAGR) of 23.47% from 2021 to 2026, reaching USD 17.01 billion [7]. In order to minimise emissions in accordance with international conventions, encourage the production and use of electric vehicles in India, and advance e-mobility in the wake of rising urbanisation, the Indian government has launched a number of measures [7].

2. The Indian government has provided tax exemptions and subsidies to the EV manufacturers and consumers to promote the domestic electric vehicle industry

3. The Ministry of Power issued a clarification stating that no license is required to operate EV charging stations in India. The reason behind for making it license-free is that the government considers EV charging station as a service and not the sale of electricity.

4. The Ministry of Road Transport and Highways also announced that all battery-operated, ethanol-powered, and methanol-powered transport vehicles would be exempted from the requirement of permits.

5. The government has imposed 15% customs duty on parts that are used to manufacture electric vehicles and 10% on imported lithium-ion cells as per the phased manufacturing proposal.

The Indian Electric Vehicle Market is classified as Vehicle Type and Power Source. By Vehicle Type, the market is classified into Passenger Cars, Commercial Vehicles, Two-Wheelers, and Three-wheelers. By Power Source Type, the market is classified into Battery Electric Vehicle, Plug-in Electric Vehicle, and Hybrid Electric Vehicle.

1. IV. INDIA AND ELECTRIC VEHICLES

1. Origin and Expanding Purview: The Paris Agreement's global climate agenda, which aims to limit global warming by reducing carbon emissions, is what is driving the push for electric vehicles, or EVs. Today, the rapid increase in the use of electric vehicles (EVs) defines the worldwide electric mobility revolution. Approximately two out of every 100 cars produced now are electric, with 2.1 million EVs expected to be sold in 2020 [8]. In 2020, there were 8.0 million EVs worldwide, making up 2.6% of all automobile sales and 1% of the world's vehicle stock [8]. Global demand for EVs is also being fuelled by declining battery costs and increasing performance efficiencies.

2. *Need for Electric Vehicles:* India is in need of a transportation revolution. The current trajectory of adding ever more cars running on expensive imported fuel and cluttering up already overcrowded cities suffering from infrastructure bottlenecks and intense air pollution is unfeasible. The transition to electric mobility is a promising global strategy for decarbonising the transport sector.

3. *India's Support to EVs:* India is among a handful of countries that support the global EV30@30 campaign, which aims for at least 30% new vehicle sales to be electric by 2030. Various ideas were espoused by India at the Glasgow summit, such as, renewable energy catering to 50% of India's energy needs, reducing carbon emission by 1 billion tonnes by 2030 and achieving net zero by 2070 [8].

The government of India has taken various measures to develop and promote the EV ecosystem in the country such as:

- The remodelled Faster Adoption and Manufacturing of Electric Vehicles (FAME II) scheme
- Production Linked Incentive (PLI) scheme for Advanced Chemistry Cell (ACC) for the supplier side
- The recently launched PLI scheme for Auto and Automotive Components for manufacturers of electric vehicles.

4. EV Sales Trends

The overall EV sales in January 2022 clocked 49,672 units [9].

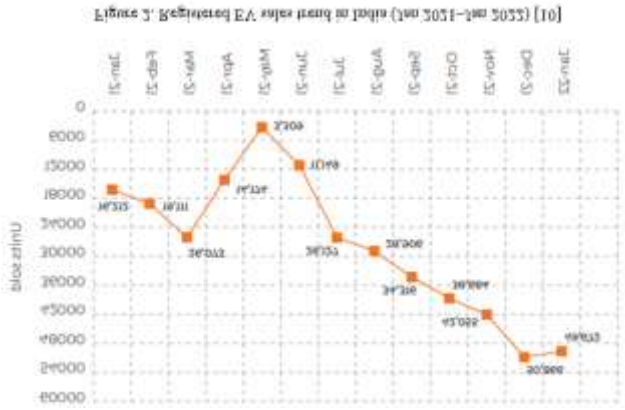

Figure 2: Registered EV sales trend in India (Jan 2021–Jan 2022) [10]

Electric two-wheelers and passenger-type electric three-wheelers drove EV registrations in January 2022, accounting for 89.8% of all registrations for the month, as shown in figure (3) below. E-cars (6.1%), cargo-type electric three-wheelers (3.8%), and so forth were the next most common groups [10].

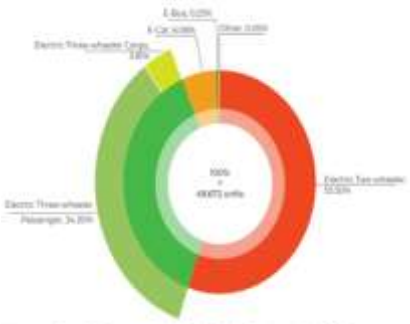

Figure 3. Category-wise EV sales in January 2022 [10]

Uttar Pradesh maintained its highest monthly registered EV sales among all states and Union Territories, accounting for 20% of India's total sales in January 2022. At 12% of the total sales, Maharashtra came in second, followed by Karnataka (10%), Tamil Nadu (9%), Delhi (7%), and Rajasthan (7%), in that order [9].

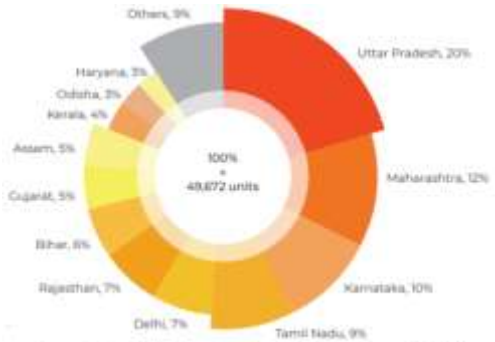

Figure 4. (State/ UT) Region-wise registered EV sales – January 2022 [10]

in the battery manufacturing sector.

VI. OPPORTUNITIES IN EV

1. *Electric Vehicle as Way Forward:* EVs will contribute to improving the overall energy security situation as the country imports over 80% of its overall crude oil requirements, amounting to approximately $100 billion. The push for EVs is also expected to play an important role in the local EV manufacturing industry for job creation. Additionally, through several grid support services, EVs are expected to strengthen the grid and help accommodate higher renewable energy penetration while maintaining secure and stable grid operation.

2. *Opportunities for Battery Manufacturing and Storage:* With recent technology disruptions, battery storage has great opportunity in promoting sustainable development in the country, considering government initiatives to promote e-mobility and renewable power (450 GW energy capacity target by 2030 [11]).With rising levels of per capita income, there has been a tremendous demand for consumer electronics in the areas of mobile phones, UPS, laptops, power banks etc. that require advanced chemistry batteries. This makes manufacturing of advanced batteries one of the largest economic opportunities of the 21st century.

3. *EV Charging Infrastructure:* An EV charging infrastructure that draws power from local electricity supply can be set up at private residences, public utilities such as petrol and CNG pumps, and in the parking facilities of commercial establishments like malls, railway stations, and bus depots. The Ministry of Power has prescribed at least one charging station to be present in a grid of 3 km and at every 25 kms on both sides of the highways. The Ministry of Housing and Urban Affairs under the Model Building Bye-laws, 2016 (MBBL) has mandated setting aside 20% of the parking space for EV charging facilities in residential and commercial buildings [12]. Giving effect to the MBBL will also require the state

governments to introduce necessary amendments to their respective building bye-laws [12].

4. *Increasing R&D in EVs:* The Indian market needs encouragement for indigenous technologies that are suited for India from both strategic and economic standpoint. Since investment in local research and development is necessary to bring prices down, it makes sense to leverage local universities and existing industrial hubs. India should work with countries like the UK and synergise EV development.

Conclusion

EVs hold great promise to replace ICEVs for a number of on-road applications. EVs can provide a number of benefits, including addressing reliance on petroleum, improving local air quality, reducing GHG emissions, and improving driving experience. Vehicle electrification aligns with broader electrification and decarbonization trends and integrates synergistically with mobility changes, including urban micro-mobility, automation, and mobility-as-a-service solutions. The effective integration of EVs into power systems presents numerous opportunities for synergistic improvement of the efficiency and economics of electromobility and electric power systems, with EVs capable of supporting power-system planning and operations in several ways.

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