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14. Electric Vehicles Concept and Implementation in India

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Abstract:

This paper gives a brief overview of electric vehicles with its types. Many different approaches have been proposed to enhance our understanding of the fundamental vehicle system and challenges of implementing it in India. Master plans for most cities in India target 60-80 per cent public transport ridership by 2025-2030.

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 lead to increase in peak load of already stressed distribution network. This paper represents a road map for the implementation of electric vehicles in India.

Keywords: Electric Vehicles, BEV, HEV, PHEV, Challenges in India

14.1 Introduction:

In India, presently, most of the motorized vehicles used for the transportation purpose are fuelled by petrol, diesel, and natural gas. These vehicles are considered to be the major source of air pollution because of high carbon emission by them. Further, the petroleum products, which are being used in the vehicles, are depleting at a very fast rate. We have petroleum resources available for next few years only.

Therefore, there is a need to find an alternate way to run the motorized vehicles. Recently, the National Electric Mobility Mission Plan 2020[1] was notified by the Department of Heavy Industry, Ministry of Heavy Industries and Public Enterprises, Government of India, to address the environmental challenges due to conventional motor vehicles and boost the production of reliable, affordable, and efficient electric vehicles (EVs).

Recent breakthrough in the electric vehicle (EV) technology and affordable battery storage have shown a hope of mass level adoption of EVs.

Accordingly, the Government of India has also taken various initiatives, such as FAME (Faster Adoption and Manufacturing of Hybrid& Electric Vehicles) India Scheme [2] to support hybrid/electric vehicles market development and Manufacturing eco-system.

14.2 Types of Electric Vehicles:

Mainly, there are three main types of electric vehicles;

A. BEV:

The Battery Electric Vehicle (BEV) are full electric vehicles which uses high-capacity batteries and electric motor for propulsion but have no conventional Internal Combustion Engine (ICE) and fuel tank. It batteries can only be recharge its batteries by plugging in the vehicle to a charging point [3].

B. HEV:

Hybrid Electric Vehicle (HEV) that uses a combination of Electric Motor in low speeds for city traffic and a conventional Internal Combustion Engine (ICE) for outside urban areas [4] .When ICE mode is activated, the EM stops and batteries start charging using an alternator driven by the same equipped ICE. It also generate electricity from regenerative braking.

C. PHEV:

Plug-in Hybrid Electric Vehicle (PHEV), it includes both an internal combustion engine and electric motor. These vehicles are powered by an alternative fuel or a conventional fuel such as gasoline (petrol) and battery which can be charged up with electricity by plugging into an electrical outlet or charging station. The combustion engine works as a backup when the batteries are depleted and the driver cannot have a break for charging.

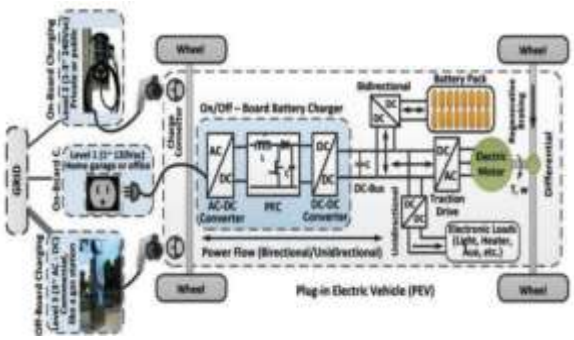

Fig. 14.1 Electric Vehicle

D. SEV:

Solar electric vehicle (SEV) is an electric vehicle powered completely by direct solar arrays installed on top of the vehicle by photovoltaic cells; solar energy is converted directly into electric energy. Since converted solar energy is the only source, it powers all part of SEV's. These are also equipped with a battery pack to ensure continuous driving during cloudy days or night use giving an extended range of autonomy to the users.

EVs can go beyond the above mentioned technology based classification, and can be classified on the basis of their attributes such as i) charging time, ii) driving range, and iii) the maximum load it can carry[5]. Of these attributes, the two most important characteristics of an electric vehicle of concern to the consumer are:

a. Driving range (i.e. the maximum distance an EV can run when fully charged)
b. Charging time of batteries (i.e. the time required to fully charge the battery) and charging time depends on the input power characteristics (i.e. input voltage and current), battery type, and battery capacity [6].

14.3 Drivers for Growth of Electric Vehicles in India

While many countries have included EVs as an element of transportation policy, their responses have varied according to their stage of economic development, energy resource endowments, technological capabilities, and political prioritization of responses to climate change. In India, a particular set of circumstances which are conducive to a sustainable mobility paradigm have created an opportunity for accelerated adoption of EVs over ICE vehicles. These are:

a. A relative abundance of exploitable renewable energy resources.
b. High availability of skilled manpower and technology in manufacturing and IT software.
c. An infrastructure and consumer transition that affords opportunities to apply technologies to leapfrog stages of development.
d. A universal culture that accepts and promotes sharing of assets and resources for the overall common good [7].

These circumstances position India to pursue an EV policy which systematically ensures that India's EV program keeps pace with the global scale since large economies seem to take significant steps towards electrification of vehicles. India's growth prospects create potential for developing leadership in EV in certain segments. In that sense, the policy will encourage a path which starts with India-specific characteristics and initiatives for its auto sector, building towards global relevance and applications [7].

A. The key objectives of the EV policy are:

a. Reduce primary oil consumption in transportation.
b. Facilitate customer adoption of electric and clean energy vehicles.
c. Encourage cutting edge technology in India through adoption, adaptation, and research and development.
d. Improve transportation used by the common man for personal and goods transportation.
e. Reduce pollution in cities.
f. Create EV manufacturing capacity that is of global scale and competitiveness.
g. Facilitate employment growth in a sun-rise sector [7].

14.4 Challenges For Electric Vehicles's In India:

A. Government Regulation Challenges:

a. The Indian Government in 2013 announced the National Electric Mobility Mission Plan to create demand for all electric vehicles, [9] but has not created a separate program or business model for the potential two-wheeler and three wheeler market exclusively.
b. More policy tools need to be put in place to increase research and development capacity and incentives in battery technologies [10].

c. There is no sustainable transportation policy intervention to integrate electric buses to slowly phase out diesel buses [10].
d. Promotion of public-private partnerships through car sharing programs will increase greater utilization of EVs [11].
e. Promotion of pilot programs in public transportation in various cities should be implemented to understand feasibility for the Indian market and thereby allow data sharing for charging stations to be installed [12].

B. Technology and Infrastructure Challenges:

a. There needs to be an extensive layout and tariff plans for public charging stations that are run by public-private partnerships to promote private investment into this sector [13].
b. There needs to be a common standard that is adopted by all players in the EV market in the charging and battery infrastructure to increase flexibility and ease of access.
c. Parking spots exclusively for EVs will address range anxiety issues [11].
d. As the number of EVs increase, the grid must increase its capacity to cater to the same, and this cannot be done without altering the energy mix to include more renewables and nuclear [14].
e. Setting up regions to eliminate emissions in highly polluted cities like New Delhi and Agra by limiting access to conventional vehicles will promote e-rickshaws and electric buses [10].
f. India's lithium reserves are not sufficient to cater to the increasing demand from the EV market.
g. There is a need to invest in research in development to design battery technology that is convenient and adaptable for domestic needs [13].
h. There are insufficient regulations on recycling battery and material recovery, which in itself could be a whole new industry [15].
i. Smart City programs the Smart City Mission should be expanded to more cities to develop existing infrastructure to make the transition to EVs easier [10].
j. There is a need for manufacturers to start designing EV components to meet the local requirements through proper research and development to reduce imports and motivate players to enter the manufacturing sector [15].

C. Transportation and Consumer Acceptance Challenges:

a. The number of buses that run on combustion engines is not sufficient to cater to the needs of the people (currently only one-tenth of the population). Expanding public transportation provides opportunities for EV markets to increase as well by deploying more electric buses [14].
b. There needs to be an effective transportation system specifically for high population density regions to reduce travel time for EVs to be deployed [10].
c. The National Urban Transport Policy promotes public transportation but however less emphasis is given to introduce more bus fleets [10].
d. There is an inhibition for consumers to purchase EVs due to ignorance of subsidies, lack of access of public transportation and high costs [11].
e. Programs and agencies like the Bureau of Energy Efficiencies, National Green Tribunal, FAME, Jawaharlal Nehru National Urban Renewal Mission, etc., should create educational programs to remove any stigma and skepticism associated with EVs [10].

f. Incentives like prioritizing EVs in traffic by allowing them to use separate lanes will reduce congestion and increase public acceptance of EVs.
g. Charging stations at points of high access like malls, hospitals, stadiums, etc., should be implemented [12].
h. Intelligent Transportation Systems are needed to understand consumer use of conventional vehicles and land use to develop better activity based modeling, to create travel information and to develop user opinions and attitudes [16].

14.5 Conclusions:

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) .We should work on framing good policies and Adequate capacity addition primarily through Renewables in distribution grid in order to meet additional demand created by high penetration of EVs. Use of dynamic pricing model and smart grid tools for charging stations to encourage charging at non-peak timings hence aiding to Peak Load Management. Investment in R&D for future battery technologies resulting in batteries with much higher specific energy, environment friendly and lower costs. As batteries constitutes 50% cost of EV's. Other initiatives that may help scale up EV in cities include local plans for electric vehicles, subsidies, dedicated parking and related incentives, use of information technology (IT) to locate charging stations, collaboration with private companies, as well as public car share and lease.

14.6 Acknowledgment:

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A. Abbreviations Nomenclature:

- EPDS- Electric Power Distribution System.
- FAME-Faster Adoption and Manufacturing of Hybrid& Electric Vehicles
- EV Electric Vehicle
- BEV Battery Electric Vehicle
- HEV Hybrid Electric Vehicle
- PHEV Plug-in Hybrid Electric Vehicle
- SEV Solar Electric Vehicle