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Electric Vehicle Scenario in India: Evolution, Challenges and Opportunities

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ABSTRACT: Electric vehicles (EV) has recently been getting interest worldwide as they result in very less climate pollution, less dependence on oil imports than the gas powered vehicles. The automotive industry could benefit by viewing it not as a threat, but an opportunity. The policymakers are also considering it seriously and the social circle across the nation is making EV a buzzword. This paper mainly focuses on providing an overall picture of modern Electric vehicle scenerario, main challenges while its adoption and areas for further growth.

KEYWORDS: Battery Electric Vehicles (BEVs), Hybrid Electric Vehicles(HEVs), FAME, NEMMP, Regenerative Braking.

I. INTRODUCTION

The Indian automobile industry is all-set to embrace vehicles without IC engines and a hydrocarbon fuel. The need for a cleaner environment along with dependency upon fossil-fuels are ready to create a major disruption. EVs make less noise, involves simpler operation and reduced fuel costs. It doesn't produce smog and air pollution. It provides financial benefit to customer through bidirectional charging while integrating with smart grid via Vehicle to grid (V2G).Major challenges while adoption of EVs are the high cost of batteries and fuel cells, limited range due to battery capacity and speed, long charging period depending on battery type and charger and insufficient charging stations[1]. Future developments are aimed at designing better batteries and charging technologies that reduce charging time and increases flexibility.

II. REVIEW OF ELECTRIC VEHICLE TECHNOLOGY

Working of an e-vehicle

All electric vehicles (EVs) have an electric motor instead of an internal combustion engine. The vehicle uses a large traction battery pack to power the electric motor and must be plugged in to a charging station or wall outlet to charge. Because it runs on electricity, the vehicle emits no exhaust from a tailpipe and does not contain the typical liquid fuel components, such as fuel pump, fuel line, or fuel tank.

Key components of an electric vehicle

Battery (all electric auxiliary): In an electric drive vehicle, the auxiliary battery provides electricity to power vehicle accessories.

Charge Port: The charge port allows the vehicle to connect to an external power supply in order to charge the traction battery pack.

DC/DC Converter: This device converts higher-voltage DC power from the traction battery pack to the lower-voltage DC power needed to run vehicle accessories and recharge the auxiliary battery.

Electric traction motor: Using power from the traction battery pack, this motor drives the vehicle's wheels. Some vehicles use motor generators that perform both the drive and regeneration functions.

Onboard charger: Takes the incoming AC electricity supplied via the charge port and converts it to DC power for charging the traction battery. It monitors the battery characteristics such as voltage, current, temperature, and state of charge while charging the pack.

Power Electronics Controller: This unit manages the flow of electrical energy delivered by the traction battery, controlling the speed of the electric traction motor and the torque it produces.

Thermal system (cooling): This system maintains a proper operating range of the engine, electric motor, power electronics, and other components.

Traction battery pack: Stores electricity for use by the electric traction motor.

Transmission(electric): The transmission transfers mechanical power from the electric traction motor to drive the wheels.

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Advantages of an e-vehicle

There are many environmental benefits and personal benefits for having an electric vehicle.

- Most electric motors can travel upto 150-180 km before they need to be charged
- No tail pipe exhaust meansnogreenhouse gases such as CO_2,and NO_2 etc.
- No oil consumption means less reliance on fuel
- Cars can be recharged whenever is convenient to the user
- More cost-effective than regular cars because of long-lasting battery use
- Cheaper to maintain because they have fewer moving parts
- Creates less noise pollution because the engine is silent

III. BATTERY TECHNOLOGY

Lithium-ion batteries

Lithium-ion batteries are currently used in most portable consumer electronics such as cell phones and laptops because of their high energy per unit mass relative to other electrical energy storage systems. They also have a high power-to-weight ratio, high energy efficiency, good high-temperature performance, and low self-discharge. Most components of lithium-ion batteries can be recycled, but the cost of material recovery remains a challenge for the industry. Most of today's EVs use lithium-ion batteries. Research and development are ongoing to reduce cost and extend their useful life.

Nickel-metal hydride batteries

Nickel-metal Hydride batteries, used routinely in computer and medical equipment, offer reasonable specific energy and specific power capabilities. Nickel-metal hydride batteries have a much longer life cycle than lead-acid batteries and are safe and abuse tolerant. These batteries have been widely used in EVs. The main challenges with nickel-metal hydride batteries are their high cost, high self-discharge and heat generation at high temperatures, and the need to control hydrogen loss.

Lead-acid batteries

Lead-acid batteries can be designed to be high power and are inexpensive, safe, and reliable. However, low specific energy, poor cold-temperature performance, and short calendar and cycle life impede their use. Advanced high-power lead-acid batteries are being developed, but these batteries are only used in commercially available electric-drive vehicles for ancillary loads.

Ultra-capacitors

Ultra-capacitors store energy in a polarized liquid between an electrode and an electrolyte. Energy storage capacity increases as the liquid's surface area increases. Ultra-capacitors can provide vehicles additional power during acceleration and hill climbing and help recover braking energy. They may also be useful as secondary energy-storage devices in electric-drive vehicles because they help electrochemical batteries level load power.

IV. TYPES OF ELECTRIC VEHICLES

Battery electric vehicles

Battery electric vehicles (BEVs) are complete electric vehicles that are powered by only electricity and do not include a petrol/diesel engine, fuel storage or exhaust pipe. They use electric motors and motor controllers for propulsion. They do not have an internal combustion engine. They charge the battery through external charging outlet and hence also known as " Plug-in Electric Vehicles (PEVs)". There are various types of BEVs such as electric cars, buses, bikes, scooters, trucks and trains. They even include fewer parts than those used for vehicles based on internal combustion engines. They even produce fewer noises compared to their counterparts.

Hybridelectric vehicles

Hybrid electric vehicles (HEVs) are not pure electric vehicles since they use a combination of internal combustion engine and electric propulsion systems. These mainly includes cars, buses and trucks. The latest models use technologies focusing on improving efficiencies such as regenerative brakes, which convert kinetic energy of vehicle into electric energy to charge the battery and other systems such as start-stop system, which switches off the engine at idle and restarts when needed to reduce idle emissions and motor-generator. A hybrid electric vehicle produces much less emission than those produced by pure gasoline based hybrids improving fuel economy functioning at maximum efficiency. These are also Plug-in hybrid vehicles (PHEVs). They even produce fewer noises than pure hybrid vehicle

Extended range electric vehicles

In extended range electric vehicles (EREV or REEV), the propulsion is driven only by an electric motor powered by high capacity batteries. These batteries are maintained charged by a small engine-generator unit. Its small consumption, less

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than two litres of fuel at 100 km, offers an extended range of autonomy and distance to be reached.

Fuel cell electric vehicle

Fuel cell electric vehicles (FCEV) have been introduced to perform long distances. It uses a fuel cell system to power its on-board electric motor. Proton Exchange Membrane fuel cells generally called Polymer Electrolyte Membrane (PEM) fuel Battery electric vehicles are complete electric vehicles that are powered by only electricity and do not include a petrol/diesel engine, fuel storage or exhaust pipe. They use electric motors and motor controllers for propulsion. They do not have an internal combustion engine. They charge the battery through external charging outlet and cells used in FCEVs use hydrogen fuel stored onboard and oxygen from the air to produce electricity. As long as a fuel is supplied FCs continue to generate electricity, similar to conventional ICEs. However, fuel cells are much cleaner; they convert fuels directly into electricity via an electrochemical process that does not need combustion.

Solar electric vehicle

Solar Electric Vehicle (SEV) is an electric vehicle powered by direct solar energy. Through solar arrays installed on top of vehicle, often photovoltaic (PV) cells, solar energy is converted directly into electric energy.Since converted solar energy is the only source, it powers all or part of SEV's propulsion, electronics, communication, navigation, security and other auxiliary features. Sensors provide assistance to the driver similar to conventional vehicles. Here, gathered informations allows monitoring the car's energy consumption, solar energy capture and other parameters. SEVs can be equipped with a battery pack assistance to ensure continuous driving during shaded days or night use giving an extended range of autonomy to the users.

V. ELECTRIC VEHICLES ADOPTION CHALLENGES

Despite the effectiveness of the electric vehicles, their adoption has always been challenging due to battery defects, range anxiety of the EV driver, auxiliary loads such as AC, battery cost, lack of charging infrastructure, etc. This section explains the risks and challenges associated with the widespread adoption of EVs.

Range anxiety

Range anxiety is the term used to describe the fear experienced by drivers that the electric vehicle may not have sufficient charge to reach the final destination. Range anxiety and recharging time are the main barriers which prevent electric vehicles from becoming a part of mainstream transportation fleets.

Auxiliary loads

Auxiliary loads significantly affect the energy consumption of electric vehicles, thereby reducing their range. First, in city driving conditions high auxiliary loads cause battery drain, which leads to a reduced EV driving range [15]. In summer, when the AC is used, the driving range drops by 17.2–37.1% (under simulation conditions). Similarly, due to heating requirements in winter, the range varies from 17.1 to 54.1% (under simulation conditions) since EVs uses PTC (Positive Temperature Coefficient) heaters.

EV battery and charger issues

Battery type

EV battery technology needs much improvement, and it has to come a long way to achieve this goal. A suitable EV battery should have high energy density, high power density, should be lightweight, inexpensive, safe, and durable.

Battery cost

The high cost of batteries is another EV issue, which prevents it from becoming a market success. Limited driving range, high battery cost, lengthy battery charging time, uncertain battery life, heavy weight of EV batteries, and battery safety are some of the major limitations of EV battery technology.

EV chargers

Most common EV chargers are unidirectional which makes it difficult to integrate them into the smart grid. However, a bidirectional EV charger can solve this problem.

Lack of charging infrastructure

Insufficient recharging stations are another factor related to EV adoption since customers will be frustrated if they cannot find a convenient recharging station when driving. In addition, it can also lead to range anxiety.

High price of electric vehicles

Due to the high cost of EV batteriesand lack of an EV charging infrastructure, electric vehicles are expensive at the moment. Consequently, the high upfront cost of EVs is one

of the significant economic barriers preventing their large-scale adoption.

Customer mindset

Customer mindset or preferences play a significant role in the adoption or rejection of a new technology. Automobile manufacturers have stated that it is challenging task to make this "transition" because customers still do not desire to use fully electric vehicles.

VI. GOVERNMENT POLICIES AND REGULATIONS

The government of India has embarked on a mission to create revolution in renewable energy in the country by planning a movement involving transformation to Electric vehicles by 2030.It is expected to cut its oil purchases by some $60 billion, reducing emissions by 37% and curb demand for road infrastructure within next 12 years.

FAME India scheme (faster adoption and manufacturing of electric vehicles)

Government Of India has notified FAME India Scheme for Hybrid and Electric Vehicles in India for implementation with effect from 1st April, 2015 with the objective to support hybrid/electric vehicles market development and manufacturing eco-system. The scheme has four areas i.e. Technology development, Demand Creation, Pilot Projects and Charging Infrastructure. The phase-I of the scheme is being implemented for a period of 2 years i.e. FY 2015-16 and FY 2016-17 commencing from 1st April, 2015.This scheme is aimed at incentivizing all vehicle segments i.e. 2 Wheeler, 3 Wheeler Auto, Passenger 4 Wheeler Vehicle, Light Commercial Vehicles and Buses. The scheme covers Hybrid and Electric technologies like Mild hybrid, Plug-in Hybrid and battery electric Vehicles.Under this scheme, about 99000 hybrid/electric vehicles (xEVs) have been given direct support by way of demand incentives.Department has also approved pilot projects, charging infrastructure projects and technological development projects aggregating to nearly Rs.155 crores.

NEMMP 2020 (National electric mobility mission plan)

The NEMMP 2020, the mission document for NMEM (National Mission For Electric Mobility) approved by the National Council For Electric Mobility(NCEM) on 29th August 2012, sets the vision, lays the targets and provides the joint Government-Industry vision for realizing the huge potential that exists for full range of efficient and environment friendly electric vehicle technologies by 2020. As per these projections, 6-7 million units of new vehicle sales of the full range of electric vehicles, along with resultant liquid fuel savings of 2.2-2.5 million tons can be achieved in 2020.This will result in substantial lowering of vehicular emissions and decrease in carbon-dioxide emissions by 1.3% to 1.5% in 2020 as compared to a staus quo scenario.Government aims to provide fiscal and monetary incentives to kickstart this nascent technology.The government plans to incentivize buyers while purchasing these hybrid and electric vehicles by providing monetary support.

Regulations for local manufacturing and import

In order to promote Electric Vehicles, there has to be lenient regulation for import of these vehicles and local manufacturing. As importing these vehicles or parts cannot be a lifetime solution, there has to be regulation for regulating local manufacturing of these vehicles especially batteries (NITI Aayog, 2017). The strong regulation and incentives scheme for battery manufacturer with assistance from research bodies, industry partners and foreign collaborations has to be achieved. There has to be supportive ecosystem which will regulate both direct and indirect factor for adoption of E-vehicles. There has to be a regulation on indirect factors like emission standards of vehicles, regulating oil demand, etc

Incentives for encouragement and adoption

Most of the countries that are leading the mass deployment of electric vehicles have provided various types of incentives to different stakeholder to promote electric vehicle adoption.Similar incentives as shown below can be adopted for Indian cities along with already existing incentives.

- Registration tax
- Road tax
- Insurance benefits
- Income tax benefits
- Free parking
- Toll benefits

Support research, development and demonstration activities

Policy actions supporting research and development aim to encourage research by providing funding and subsidies to businesses and appropriate government agencies and by creating working groups and hosting technical events where stakeholders can discuss market barriers and ways to find innovative solutions. Policy actions

supporting research, development, and demonstration can be viewed as supply-focused policies aimed at expanding industry growth and building the country's future research and industrial capabilities. These policies are essential in encouraging early adoption of electric vehicle technologies. Also, if properly structured, they could support market creation and cost reduction of segments that receive less attention globally and are more relevant to the Indian context.

VII. SCOPE OF ELECTRIC VEHICLES IN INDIA

The market of electric vehicles in India is very less compared to ICE vehicles due to various factors. India has only sold 1% of EVs in the world over last decade. Its mainly due to service lags and high cost issues. People in India are more concerned about the mileage, maintenance free, and durability, immediately accessible and service oriented vehicles in the market. Moreover high daily usage of vehicle by the people has caused EV a failure. It has more charging time, less top speed and less speed per charge made the consumers to avoid EV in our country. Also there is lack of government schemes implementation for the motivation of the consumers. And above all the power crises is one of the major reasons which make these chargeable electric vehicles non-usable in our country.

VIII. CONCLUSIONS

India has a huge challenge in shifting the transportation sector from ICE engines to EVs. This requires a lot of planning, research and development. Government policies like FAME, NEMMP and few other policies needs to be updated on regular basis to keep in pace with the development throughout the world. India should focus on improving the energy-efficiency of EVs. The power electronics, electric motors and charging stations should be planned according to Indian conditions. Charging infrastructure needs to be adequately build to address range anxiety. It is also very important to create demand generation by making all government buses electric and offering tax exemptions for private EV owners.Various steps are required to be taken by the government and private sector for the research and development for various infrastructures, technology and power source. Concept of EV can flourish in India only after the betterment of these problems, motivation and awareness among the people. This concept needs to be developed and researched in India with various projects, case study and research work by government as well as private manufacturers as India has good future scope and potential market in vehicle industry.

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