Energy Sources and Electric Vehicles in INDIA.

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Abstract- Battery powered electric vehicles, need of society were commercially available in the 1890s and available throughout the first decade of 20th century. EV's are popular due to its cleanliness, simplicity of operation and reliability. Gradually performance and reliability of internal combustion (IC) engine is improved and inherent limitations of EV's became obvious to go off-road in the race of sustenance. Major limitation of acceptance of EV's lies in the moderate performance of the battery. Still EV's have continued where pollution and noise at its unacceptable stage. A renaissance of interest in road EV's began in 1970s as a result of oil crises. People realized long term feasibility of internal combustion vehicles NOT possible with limited fossil fuels. Internal Combustion Engined Vehicle (ICEV) had established its supremacy in road transportation, concern over both increasing atmospheric pollution and diminishing petroleum supplies has led to renewed activity in Electric Vehicle (EV) development.

Kewords- ELECTRIC VEHICLE (EV), INTERNAL COMBUSTION (IC), BATTERY ETC.

I. INTRODUCTION

World is facing major crisis of Energy. This is mainly due to environmental imbalances caused by artificial factors like excessive use of fossil fuels. Energy consumption is increasing every year and main resources of Non-renewable energy are petroleum products, particularly petrol and diesel. Most important reasons of energy crisis are limited reserves of fossil fuels, growing environment pollution and unpredictability of crude oil prices. Also vehicular pollution has a serious impact on the environment, which leads to severe health issues and hampers quality of life. Even though development of Internal Combustion (IC) Engine vehicle, is one of the greatest achievements of modern technology caused and continues to cause serious problems for environment and human life. Air pollution, global warming and rapid depletion of the Earths petroleum resources are now problems of paramount concerns. At present all vehicles rely on the combustion of hydrocarbon fuels to derive energy necessary for their propulsion.

Pollution free or zero emission is possible in transportation by electric vehicles, fuel cells and hybrid vehicles. There are six types of vehicle are available for transportation i.e. Bio-Fuel, Flex-Fuel, Battery Electric, Hybrid Electric, Hydrogen gas and Natural gas.

II. HISTORY AND PATH

The first EV was built by Frenchman Gustave Trouve in 1881. It was a tricycle powered by 0.1 hp DC motor fed by Lead-acid batteries. Among the most significant EVs to reach 100km was "La Jamais Contente" built by Frenchman Camille Jenatzy.

Electric Vehicle (EV) uses one or more electric motors or traction motors for propulsion. There are mainly three types of electric vehicles, they are

1. Hybrid Electric Vehicle (HEV)
2. Plug-In Hybrid Electric Vehicle (PHEV)
3. Single fuel all-Electric Vehicle (EV)

Electric powered motor vehicles were first introduced in 19th century. Negligible availability of required infrastructure is a major setback in Electric Vehicles. During 1970's production of EV's resumed because of growing air pollution caused by fossil fuel vehicles. Important stakeholders in EV industries include Consumers, car dealers and garages, fuel or gas or charging stations, charging infrastructure manufacturers, battery manufacturers, automobile industry, finance and insurance companies and government.

At certain levels risk is associated in adaptation of electric vehicles, which include

1. Charging infrastructures or charging station adoption risk.
2. Consumer adoption risk.
3. Utility infrastructure adoption risk
4. Co-innovation risk.

As gasoline automobiles became more powerful, more flexible and above all easier to handle, EV's started to disappear. EV's limited driving range and performance that really impaired them versus their gasoline counterparts. In 1966, General Motors built the Electro-van, which was propelled by induction motors that were fed by inverters built with thyristors. The most significant EV of that era was the Lunar Roving Vehicle, which the Apollo astronauts used on the Moon.

III. ARCHITECTURE OF ELECTRIC VEHICLE SYSTEM

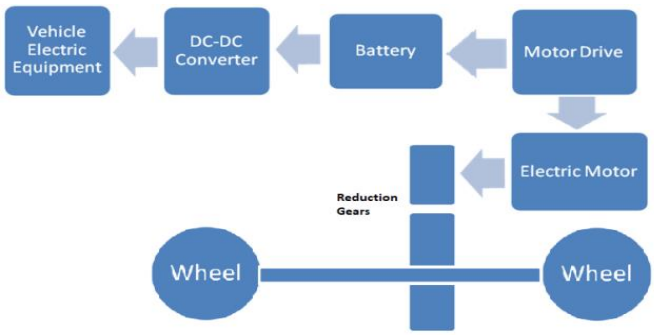

Fig.1: Schematic of electric vehicle.

In EVs, the battery is the original energy source and provides electric power to electric motor drives and other equipments, such as lighting devices. As shown in Fig.01, Control system

of Electric vehicle consists of five electric control units which controls the drive torque of Electric Vehicle.

The modern EV era evolved during 1980's and 90's with release of few realistic vehicles. Although these vehicles represented a real achievement, it become clear that electric automobiles could never compete with gasoline for range and performance. The reason is that, in batteries energy is stored in metal of the electrodes, especially energy storage capacity per unit weight and volume. In the context of development of EV's, it is the battery technology that is the weakest, blocking the way of EV's to the market. Thus in recent years, advanced vehicle technology research has turned to HEVs and Fuel Cell vehicles.

Indian government launched NEMMP-2020 to promote electric vehicles in Indian market. After successful implementation, Indian government able to save 9500 million tons of fossil fuel which approximately worth Rs. 62,000 Crores (National Electric 2015).

Almost all electric scooters in India run on lead batteries to keep price low. Battery failure and low life are two major limiting factors for high speed vehicles. Electric Vehicles models available in India are

1. Mahindra e2o
2. Toyota Prius
3. Toyota Camry Hybrid
4. BMW i8
5. Maruti Suzuki Ciaz Hybrid

The Indian Automobile Industry is currently ranked 5th largest in the world and is set to be the 3rd Largest by 2030. Indian government launched National Electric Mobility Mission Plan (NEMMP) 2020, which target of deploying 5 to 7 million electric vehicles in the country by 2020 (3).

Passenger Vehicles	2 Wheelers	3 wheelers	Commercial Vehicles	Tractors
Number of OEMs				
15	13	7	12	17
No. of Manufacturing units				
29	22	7	34	20
Maruti Suzuki	Hero Moto Corp	TVS	Tata Motors	Mahindra
Hyundai	Honda Motors	Bajaj	Ashok Leyland	Escorts
Tata Motors	Bajaj	Piaggio	Force Motors	TAFE
Fiat	TVS	Atul Auto	Hindustan Motors	John Deere
Ford	Suzuki Motorcycles	Scooters India	Isuzu Motors	New Holland Tractors
Honda	Yamaha	Mahindra	Mahindra	International Tractors
General Motors	Mahindra	Force Motors	AMW Motors	Force Motors
Mahindra	Royal-Enfield		Piaggio Vehicles	Indofarm Tractors
Nissan	Piaggio Vehicles		SML Isuzu Ltd	SAS Motors
Toyota	LML		Eicher	HMT Tractors
Volkswagen Group	Harley Davidson		Volvo	CNH Industrial
Renault	Triumph		Man Force	ACE
Premier Auto	Kawasaki			Preet Tractors
Mercedes Benz				SAME DEUTZ – FAHR INDIA
BMW				Standard Tractors
				Captain Tractors
				Trishul Tractors

Table. 1 Key players in Automobile industry in INDIA.

IV. ENERGY SOURCE AND ELECTRIC VEHICLES

The practicality of electric transportation awaited the discovery of batteries which gave higher electrical output and could be recharged effectively, light in weight and less in cost. Gaston Planté invented the 1st lead acid battery in March, 1860. After few years later rechargeable alkaline systems of nickel/cadmium and nickel/iron entered into market. By 1912, several battery operated vehicles were in service throughout the world. The performance of EV power source still could not match that of heat engines using combustible fuels. For example, one liter of lead acid battery weighs 2.4kg, contains 0.07kwh and will propel a passenger car only few hundred meters. Commercialization of lithium-ion battery by Sony (Japan) in 1991 served purpose up to certain extent. As everyone knows Ideal battery does not exist, below graph shows relationship of Rechargeable and Non-rechargeable batteries with watt hour / kilogram (Wh/Kg).

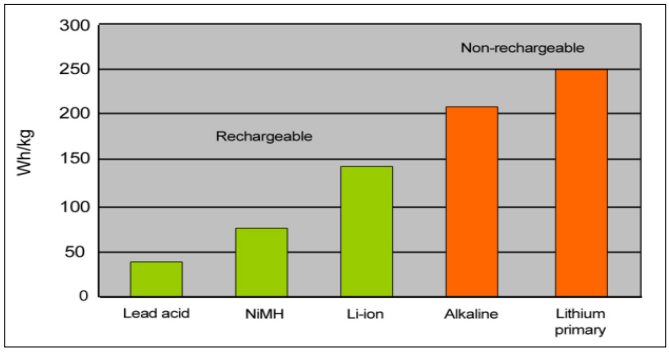

Fig.2: Relationship of Rechargeable and Non-rechargeable batteries with watt hour / kilogram (Wh/Kg)

Above graph of Watt hour / kilogram (Wh/Kg) ratio shows that Non-Rechargeable batteries have more watt hour / kilogram (Wh/Kg) ratio than rechargeable batteries, but rechargeable batteries is need of Electric vehicles. Hence more emphasis is needed on rechargeable batteries. Lithium-Ion batteries capturing market rapidly due to its features offered but still not able to overcome combustion engines yet.

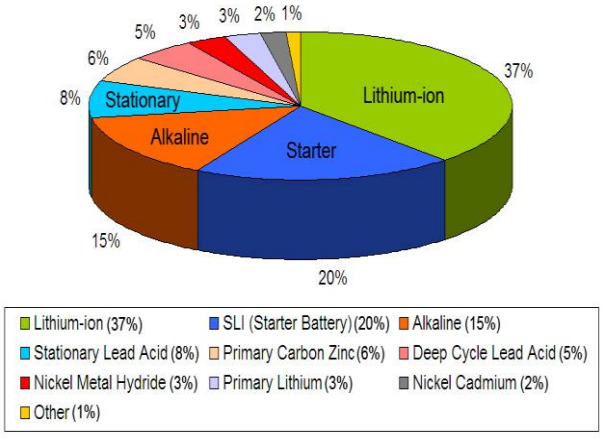

Fig.3: Revenue contributions by different

I. **battery chemistries. Courtesy:**
https://batteryuniversity.com/
Energy storage devices stores energy, deliver energy (discharge) and accept energy (charge) from external resources. Different energy sources for electric vehicle are chemical batteries, ultra-capacitors or super-capacitors, ultra high speed flywheels and fuel cells.

II. **Electrochemical batteries**:
convert electric energy into potential chemical energy during charging and vice versa during discharging. A cell is an independent and complete unit that possesses all the electro-chemical properties whereas a battery is composed of cells stacked together. Examples include Lead-Acid, Nickel based, Lithium based etc

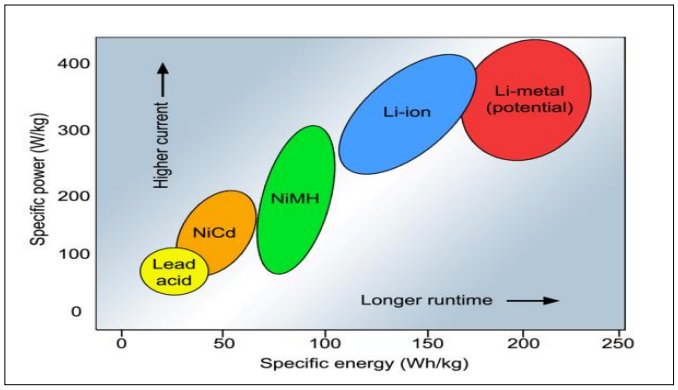

Fig.4: Energy-Power ratio of Electro-Chemical Batteries.

A. Ultra-capacitors or super-capacitors, In electric vehicles, peak power capacity is more important than its energy capacity, ratio of peak power to average power required is 10:1. The energy source, mainly batteries and fuel cells, has high specific energy, where as power source has high specific power. The ultimate power source is ultra-capacitor or super-capacitors. Power sources can be recharged from energy sources through regenerative braking. The stored energy, E_{cap}, is expressed as

$$E_{cap} = \frac{1}{2}CV^2.$$

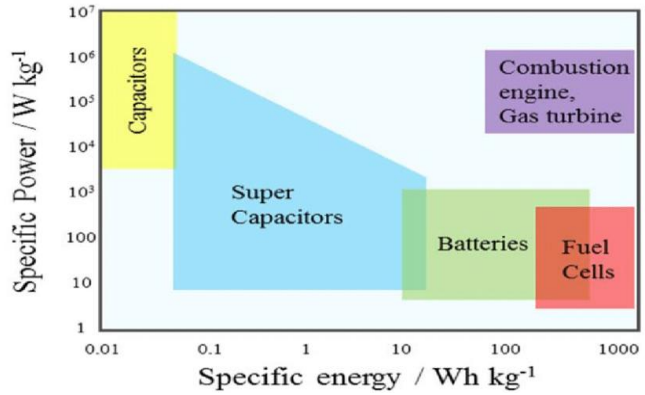

Fig.5: Energy-Power ratio of super-capacitor

B. Ultra High speed Flywheels, are used to store energy in mechanical form. The concept of ultra high speed flywheels appears to be feasible means for fulfilling stringent energy storage requirements for EV and HEV applications, namely high specific energy, high specific power, long life cycle, high energy efficiency, quick recharge, maintenance free characteristics, cost effectiveness and environment friendly. A rotating flywheel stores energy in kinetic form as,

$$E_f = \frac{1}{2} J_f \omega_f^2$$

C. Fuel Cell is a galvanic cell in which chemical energy of fuel is converted directly into electric energy by means of electrochemical processes. In contrast to chemical battery, fuel cell generates electric energy rather than storing it and continues to do so as long as a fuel supply is maintained. Fuel cell powered vehicle has longer driving range without long battery charging time, high energy efficiency and much lower emission due to direct conversion of free energy in the fuel into electric energy, without undergoing combustion. Due to Non-combustion it is more environment friendly, a major concern of today's era.

V. REQUIREMENTS OF EFFICIENT CHARGING SYSTEM

In transportation, key player is availability of fuel / charging stations. Even though electricity supply is readily available everywhere, but lack of safe charging stations of Electric Vehicles is still a far away from reality. Major need of inception of EV's in India is availability of charging station. Below is the status of charging stations in India.

	Installed base 2016-17	Additions in the last 4 months	Total installed base as of August 2017
EV Charging stations	100	30	**130**
Average Norms of EV Chargers	1.5	4	
Total EV Chargers installed	150	120	**270**
% of AC Slow chargers	100%	80%	
% of DC Fast Chargers	0%	20%	
No of AC Slow chargers installed	150	96	**246**
No of DC Fast Chargers installed	0	24	**24**

Table 02 Charging stations in INDIA till 2017.

Based on Census of India 2011 data, there are nine metros – Greater Mumbai, Delhi-NCR, Kolkata, Chennai, Bengaluru, Hyderabad, Ahmedabad, Pune, and Surat – with population over four million. It is proposed to install at least one high-capacity charging station at every 3-5 km in these cities. The largest of these, Delhi-NCR, covers approximately 3,603 square kilometers (sq. km.), thereby requiring 401 charging stations, the maximum amongst all cities.

For select highways connecting metros, two sets of charging stations are proposed on either side of the road, every 25 km. These highways are – the Mumbai-Pune Expressway, Ahmedabad-Vadodara Expressway, Yamuna Expressway (Delhi to Agra), Delhi-Jaipur, Bengaluru-Mysore, Bengaluru-Chennai, and Surat-Mumbai expressways. The last of these, at 250 km, is the longest and requires 40 charging stations, the most amongst these highways.

The proposed charging stations would consist of -

- One fast DC high-power charging point (50 kW) to comply with the Combined Charging System (CCS), which is an open and universal standard
- One CHAdeMO connector (50 kW), which is a Japanese standard for high-power DC charging
- Two Type-2 AC charging points (22 and 43 kW)
- One AC-001 (3.3 kW, slow charging) and DC-001 (15 kW) charging point as per Bharat EV charger specifications (which are currently being implemented by EESL)

To achieve standardisation of charging infrastructure in the country, the government has proposed that Energy Efficiency Services Limited (EESL) be designated as the aggregator for bulk procurement of public chargers, and other entities act as nodal agencies responsible for setting up and maintaining them using a capital grant by the Union government, available under FAME-II.

Tata Power has signed MoU with state-run oil marketing company Hindustan Petroleum for setting up commercial-scale electric vehicle (EV) charging stations at latter's retail outlets and other locations across the country.

VI. DISCUSSION AND CONCLUSION

India is the land of opportunity for any kind of new technology. Electric Vehicles is one of the future technology, which has entered India very recently. "Electric vehicles are costlier than conventional ones, but they are the need of the hour as they reduce pollution". Any technology needs some time to strengthen its roots. Indian government took some great steps for the future of Electric Vehicles. Many Automobile manufacturers taking part in electrifying the EV mission 2030.

The beauty of an electric vehicle is that any home / business / hotel can install EV charging stations. Hence Community charging stations concept introduced by Plug-In-India forum. Total Number of Community Charging Stations installed by them in India are **274(4).**

Despite all the talk, the total number of electric vehicles at present is only one percent. Once that cost of battery falls, the cost of electric car would be equivalent to (that of) an internal combustion car. So the challenge lies in making a breakthrough in battery (technology).

a. Developments from around the World and in INDIA

- BMW forecasts jump in sales of Electric Vehicles in 2018
- Jaguar Land Rover to electrify all it's vehicles by 2020
- Morris Garages (MG) Motor India Pvt. Ltd is testing EVs in India
- Micromax to foray into EV space
- Mahindra Electric, Meru tie up to deploy EV cabs in Hyderabad
- Sweden opens new road that charges EVs
- Ferrari Quietly tests Electric Cars
- Chinese Government to offer Tax rebate on Electric Vehicles.

VII. ACKNOWLEDGMENT

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VIII. REFERENCES

[1]. Selection of Electric Motor Drives for Electric Vehicles, X. D. Xue, K. W. E. Cheng, and N. C. Cheung, Department of Electrical Engineering, the Hong Kong Polytechnic University, Hung Hom, Kowloon, Hong Kong, China. 2008 Australasian Universities Power Engineering Conference (AUPEC'08).
[2]. https://www.ipcc.ch/pdf/assessment-report/ar5/wg3/ipcc_wg3_ar5_chapter8.pdf
[3]. https://electricvehicles.in/what-is-the-future-of-electric-vehicles-in-india-by-2030/
[4]. http://www.pluginindia.com/charging.html
[5]. https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data
[6]. http://www.teriin.org/article/creating-charging-infrastructure-power-evs-india
[7]. Batteries in a portable world – A handbook on rechargeable batteries for Non engineers, Isidor Buchmann, CADEX Electronic Inc.
[8]. The future of electric vehicles in India – A consumer preference survey By Nirupama prakase et. al.
[9]. Batteries for Electric vehicles By DAJ Rand, R. Woods, RM Dell. Research studies press ltd.
[10]. Modern Electric, Hybrid Electric and Fuel Cell vehicles – Fundamental, Theory and Design by Mehrdad Ehsani, Yimin Gao, Ali Emadi, CRC Press.

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