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Essential Need for Electric Vehicles and Infrastructure Advancement: Challenges in India

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Abstract

This paper analyses the essential need for EVs in Indian transport, need for advanced charging infrastructure and techno-economic comparative analysis of EVs and ICE engine vehicle. India is depending on oil imports largely for the energy needs. The share of oil imported by India was 57% at 1957, and it'll be 97% for 2020. The escalating price of oil poses a severe problem in Indian energy segment in future. An emission from the transport sector is the key source of air pollution next to power sector in India. 13/ 20 cities in the world with highest air pollution are positioned in India. Transport and power sector have a significant effect in worsening air quality. As for these reasons the exploration of a different kind of transportation is required. Electric Vehicles (EV) are proving to be an absolutely new way to store and consume mass amounts of energy from the power grid. Battery Electric Vehicles (EV) and Plug-in Hybrid-Electric Vehicle (PHEV) offers beneficial rewards compared to the conventional ICE vehicle. Power generation from renewable sources, transmission, distribution, and allocation of energy and energy mix are developed with improved efficiency and consistency. A prearranged analysis is done for the business-related scopes of electric vehicles Indian energy sector. Data aggregator provides supplementary grid services as well as controls the electric vehicles charging.

Keywords: Aggregator, Charging Station, Electric Vehicle, Pollution

1. Introduction

1.1 Present Scenario of Electric Vehicles in India

India ranks the third position in the World's largest auto markets. The motorized traffic volume in India will touch 13000 billion passenger-km in next decade, out of which 91% will be provided by the roads and the rest by Railways[1]. According to International Energy Agency (IEA), the transportation sector consumes 30% of world-wide energy consumption and second largest cause of the emission of CO2 which is contributing 20% to GHG.13/ 20 cities in the world with highest air pollution are in India[2]. Increases in oil price and environmental issues have made the Electric vehicles as an alternate for IC engine vehicles[3]. The passenger vehicle in India has shown significant growth over the past decade. In the year 2000, a pair of electric two-wheelers was on the hands in the Indian market. Now, the market has been expanded to thousands in the market at present. These include low-speed vehicles with a minimum speed of 20km/hr to high-speed vehicles with a maximum speed up to 60km/hr. The range of driving can be varied from 20km to 100km. According to a survey conducted in Ludhiana (Punjab), city resulted that 36% existing car and two-wheeler owners were interested to shift their conventional vehicles to electric vehicles due to the increasing cost of fuel and environmental concern[4]. The Electric Vehicles have inwards in urban transport, and the incursions of electric vehicles in some of the metropolitan cities are significant. Day-by-day the statistics of electric vehicles are escalating[5]. So it became obligatory to do an investigation for the power grid, traffic intensity, GHG emission, availability of charging station.

1. 2 Comparative Analyses of Different

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Fuel Expenditure, co_2 Emission and Total Ownership Cost

Expenses of different fuel are calculated for Mahindra e2o, Petrol and Diesel Variants of Hyundai Grand i10 for the comparative analysis. Let us consider the transportation cost as a constant, i.e., Rs.6000. With the sum of six thousand rupees 100 liters of petrol, 133 liters of diesel, and 909kWh of electric power can be consumed. The distance which can be reached by different types of fuel is given in the Table1.

Table 1. Comparison of different fuel expenditure

Fuel	Electricity	Petrol	Diesel
Cost per unit kWh/Litre(Rs)	6.6	60	45
Consumption	909kWh	100 litre	133 litre
Mileage (kWh-Per Litre)	5	16	22
Range/Day	120	53	97.5
Range/Month	3600	1590	2926
Range/Year	43600	19345	35600

By considering, diesel range, i.e., 20000 km/year as the reference, petrol does not reach the reference range. When compared with electricity a superfluous range of 23600 km can be sheltered which is equivalent to saving 1475 liters of petrol worth Rs.88500 per year. The magnitude of CO_2 exhausted by flaming one gallon of fuel depends on the quantity of carbon in the fuel. 99% of the carbon in fuel is emitted as CO_2, when the fuel is burned. Remaining of one percent is emitted as hydrocarbons and carbon monoxide, which can be rehabilitated as CO_2 in the ambiance. The carbon content differs for the different type of fuel. A gallon of diesel can engender 15% more CO_2 than a gallon of petrol does. A gallon of petrol emits 8,887 grams of CO_2. A gallon of diesel emits 10180 grams of CO_2.Taking into an account, a diesel car releases 0.312 ton CO2/year, and a petrol car releases 0.296 ton/year.

Table 2. Comparison of CO^2 emissions for different fuel

Vehicle type	Electricity	Petrol	Diesel
CO^2 emission(Kg/year)	0	296	312

When comparing the total ownership cost of Electric, Diesel and petrol car, the electric car leads top to the table. The Table gives the total ownership cost of Electric, Diesel and petrol car. Let we consider an average of 40 km drive per day. Per month it will be 1200 km per year it is 14600 km.

Table 3. Total ownership cost for six years

Data	Electricity	Petrol vehicle	Diesel vehicle
On- road Price(lakhs)	6.7	7.3	7.8
Cost per km(Rs)	0.75	3.75	2.04
Service cost per year(Rs)	2000	10000	8000
Battery cost for 4th year(Rs)	200000	0	0
Total ownership cost(Rs)			
End of 1st Year (Rs)	682950	794750	817376
End of 2nd Year(Rs)	695900	859500	854752
End of 3rd Year(Rs)	708850	924250	892128
End of 4th Year(including new battery) (Rs)	921800	989000	929504
End of 5th Year(Rs)	934750	1053750	966880
End of 6th Year(Rs)	947700	1118500	1004256

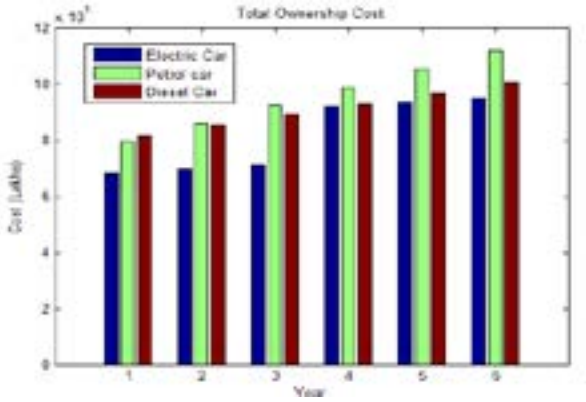

Figure 1. Total ownership cost for six years

From the Figure1, it is clearly understood that the total ownership cost of the electric vehicle costs lesser than the petrol and diesel cars.

2. Charging Station

2.1 Necessity of Charging Station Infrastructure

The responsibility of Electric vehicle charging station is important to deploy the EVs. The Charging stations for

electric vehicles require new infrastructure like IT security, encrypted information exchanging, and protection. The foremost concern of charging station is different chargers for different locations like a house, campus and commercial places[6]. Given the fact that the tariff is diverse for different locations, it will lead to illegitimate prices. The charging point requires the different type of Chargers (Normal Charger, Fast charger and DC Fast Charger) depend on the locations. Fast chargers at public charging point reduce the charging time. At home, many EV owners are charging at night time when the grid is off-peak. Different tariff for different location can improve the grid stability. i.e., Different tariffs for charging at malls, cinema theater complex and residence. So the designing of Charging point location, size and time must be opting to the Indian grid. With the present power distribution system, the adoption of a huge number of EVs is not achievable. Independent charging stations have to be encouraged to reduce the time to find a public charging station. Providing subsidies for private charging station can help the production of electricity from renewable sources. Electric Vehicle Supply Equipment protocol could be used for an optimum charging scheme.

3. Smart Grid with EVs

3.1 Necessity of Smart Grid

The enlargement and function of EV could bring positive feedback by reduced Fuel cost for transport network and zero emission of CO2 to the environment. But a considerable number of Charging of Electric vehicles could carry negative feedback to the power grid. The effect of many irrepressible small loads on the power system can affect the grid balancing. It can bring power losses[7], current and voltage limit violation[8]. So monitoring the power system is important while charging a large number of EVs. The present Indian power system is a like a mechanical system. The usage of digital devices and controllers are limited to monitor and security of the power system operation and control. So adequate number controllers and digital devices are needed for a smoother operation. In general, a smarter grid could adopt a large number of electric vehicles to charge. Smart grid is capable of two-way information interchange between the utility and its clients. Demand response enables to change the customer's usual expenditure pattern according to the price signal which is used to reduce the peak load while charging the EVs. Demand side management enables the smart grid to integrate with other renewable sources. The most important objective of demand side management is to decrease the peak demand and to support the energy efficient devices. The energy efficient devices could regulate the running time and adjust the power demand on the grid.

4. Grid to Vehicle Technology (V2g)

4.1 Impact on the Distribution System

Location, time and the state of charging of the battery decides the impact level due to the penetration of EVs in the distribution system[9]. Penetration level is also depending on the attribute of the grid. Smart metering system and uneven tariff plan can be done by demand response and demand side management. The function of Demand response and demand side management are used to reduce the grid reinforcement cost and the emissions associated with the power plant (i.e. emission from thermal power plant). Considering a residential apartment with 500 houses, the peak demand of a single house is 6kwh at midnight. So, the total load will be 3000kwh and 3100kwh with other amenities. The required rating of the transformer with 20% the safety level will be 4.65MVA (2*2500KVA).If 250 houses have EVs and charging with 3.5kwh at a time, then the load comes up to 4750kwh. Considering 20% as the safety level the required capacity of the transformer will become 7.2MVA(3*2500) and, the additional investment cost will be Rs.58,13,900.

Role of Smart Charger

The increasing number of electric vehicles in Indian market needs sufficient infrastructure. According to the National Electric Mobility Mission Plan 2020, six to seven million hybrid and electric vehicles sales year on year from 2020 onwards is fixed as the target[10]. The implementations of a large number of electric vehicles need a plenty of smart charging points to reduce the stand in time. The charging networks are providing Electric Vehicle chargers with the capability to identify the users and take the cost for public charging. Smart chargers can amputate the power once it reaches the charging level to 75% for high power battery vehicle and it can be transferred to other

cars for charging to avoid peak load charging. Apart from implementing individual charging point common charging point can be installed with the smart meter at places like Special Economic Zone (SEZ).

5. Results and Discussions

Table 1 to 3 and Figure 1 extrapolates that the Electric vehicle is comparatively better than Petrol and Diesel vehicles in all aspects. But the lagging of charging infrastructure makes the customers to pushes back. So it has to be developed. The public cognizance by publicity, Contributing subsidies and warranty can be offered to attract the customers. Encouraging local based Original Equipment Manufacturer (OEM) companies and foreign investments can make a faster, better service and green environment.

6. Conclusion

Investing and encourage to produce the power from renewable sources has to be done to control the load issue instead of investing to produce power from non -renewable resources. Off-peak charging can be encouraged for grid balancing. Before implementing charging infrastructure necessary parameters, i.e., Population, Traffic volume, no of the electric vehicle has to be taken into consideration. The Power system has to be enhanced for the integrated operation of the power and transport sector. Electrical, energy and automobile companies can initiate projects together for commercial charging points as well as faster charging terminals.

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