Review Article: Concepts of Electric Vehicles

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Abstract **- Electric Vehicles (EVs) enable to avoid local nuisances (atmospheric pollutant emissions and noise) together with a possible decrease in greenhouse gases (GHG) and fossil primary energy use. However, a widespread diffusion of EVs in the market is still difficult due to their high price, limited range and high sensitivity of this range to the operating conditions such as driving schedule and auxiliaries use. This review article gives an overview of the concepts of electric vehicles, market demand of electric vehicles, types of charging of electric vehicles and their benefits.**

Index Terms **- Electric Cars, Consumption of energy, Benefits of electric car, Types of Electric Vehicle charging.**

INTRODUCTION

Electric Vehicles (EVs) enable to avoid local nuisances (atmospheric pollutant emissions and noise) together with a possible decrease in greenhouse gases (GHG) and fossil primary energy use. However, a widespread diffusion of EVs in the market is still difficult due to their high price, limited range and high sensitivity of this range to the operating conditions such as driving schedule and auxiliaries use.1

Due to the limited quantity of energy embedded in the battery, EVs are very sensitive to parameters which can influence their energy consumption and then can induce huge variations in their actual range. Among all these factors, driving conditions, auxiliaries' impact, driver's aggressiveness and braking energy recovery strategy are to be considered as the main factors influencing the EV energy consumption.1

This review article will give overview of how the concept of electric cars came in force. The market survey of electric car, its type of charging and energy consumptions.

CONCEPTS OF ELECTRIC CARS

History

At the beginning of the automobile's history, two main competing approaches to engine-driven vehicles existed: one with internal combustion engine (ICE) and another one with an electric drivetrain. Already in 1834, the American inventor Thomas Davenport built the first electric car. The first ICEV was developed in 1886 by Benz and Daimler in Germany. Around the year 1900, electric cars had a significant share of all engine-driven cars. At the same time, F. Porsche already invented a hybrid electric car equipped with an ICE range extender and wheel hub electric engines. The two different drive trains were competing until Henry Ford, in 1908, chose an ICEV for the first mass production of a car in history. This way, ICEV won the race early in the twentieth century and displaced the battery electric vehicles (BEV). From an environmental perspective, this may have been one of the biggest mistakes in the history of technology.

Concluding, the BEV does not represent recent ‘high tech’, but a comparatively simple technical concept, meanwhile available as a series product for more than 110 years. Accordingly, e-conversion, which is the conversion of new or used ICEV to electric cars, can easily be implemented by experienced personnel. In contrast, the modern lithium-ion battery technology, prerequisite for the everyday life practicability of most BEV, is related to very recent technical improvements.2

Market Overview

The global electric vehicles market is estimated to exhibit stellar growth by the end of 2030. The rise in the promotion of electric vehicles by different governing authorities plays a huge role in driving this growth. The growing awareness regarding the impact on the environment from the emission of conventional vehicles bolsters the growth of the market. The global efforts towards encouraging electric vehicles for mass transit plays a vital role in the growth of the landscape. Developed and rapidly developing economies are generating a plethora of revenue prospects for the manufacturer owing to favorable government

regulations and initiatives. Regions including North America, Asia Pacific, and Europe are expected to stay at the forefront in the market by the end of the forecast period.

Manufacturers are exploring opportunities in different types of vehicles including hybrid and plug-in hybrid types of electric vehicles. Major automobile manufacturers are heavily investing in the market to strengthen their position.3

FACTORS INFLUENCING MARKET GROWTH OF ELECTRIC VEHICLES

The growth of electric vehicles market is attributed to the ever-increasing production and sales of automobiles. Vehicles are becoming an increasingly affordable commodity owing to the growing disposable incomes across the world. Though the percentage share of electric vehicles market in the automotive industry is extremely small in the current scenario, it is highly likely to expand at a faster rate than expected due to rise in fuel prices owing to higher current usage and growing rate of depletion, the government regulations to reduce the amount of greenhouse gases emitted by vehicles, high fuel efficiency offered by the electric vehicles and soundless operation of the electric vehicles.

Another important factor which is pushing the surge of electric vehicles market is the attractive incentives provided by the governments of various countries with a motive to push the sale of electric vehicles. Customers are offered benefits such as tax exemption, reduced selling prices, and free charging of electric vehicles at various charging points.

Though electric vehicles have proven to be advantageous over conventional vehicles, the market is not without restraints hindering the growth of the market over the forecast period. Electric vehicles come along with a high price tag which might evoke customer apathy towards this market.

Scarcity of charging points within major cities is a massive hurdle in the growth of the global electric vehicles market. The electric vehicles lack alternate source of fuel which often put the schedule of the commute in jeopardy. The complete drainage of the battery can stall the car and can put the traveler at risk. These loopholes in the electric vehicles are a major drawback for the market.

Electric vehicles provide excellent torque at low speeds but its performance drops at higher speed in comparison with conventional vehicles, this difference in performance can also act as a restraint to the growth of the global electric vehicles market.3

TECHNICAL COMPONENTS OF AN ELECTRIC CAR

According to Larminie and Lowry, the main components of a BEV can be divided into the electric battery, the electric motor, and a motor controller. The technical structure of a BEV is simpler compared to ICEV since no starting, exhaust or lubrication system, mostly no gearbox, and sometimes, not even a cooling system are needed.

The battery charges with electricity either when plugged in the electricity grid via a charging device or during braking through recuperation. The charger is a crucial component since its efficiency can vary today between 60% and 97%, wasting 3% to 40% of the grid energy as heat. The motor controller supplies the electric motor with variable power depending on the load situation. The electric motor converts the electric energy into mechanical energy and, when used within a drivetrain, to torque. In series BEV produced so far, central engines have been used; however, hub wheel electric engines are also possible and would be available for mass production.2

TYPES OF ELECTRIC VEHICLE CHARGING AND ITS ADVANTAGES AND DISADVANTAGES

Level 1 EV charging: Level 1 electric vehicle charging is rated at 120 volts. The hardware required for this, which is a cord with an attached control-box, is supplied as standard with every electric vehicle. One has to simply plug-in to a three-prin (grounded) wall socket. Using this charging technique usually takes 16 to 20 hours to fully charge the vehicle's batteries depending upon its capacity. The advantage of using this charging type is that it does not require the installation of additional hardware. One simply needs to the park near a three-pin wall socket and plug-in the charging cable. The drawback of this technique is that it takes a lot of time to juice up the batteries.

Advantages

- No installation cost if you already have an outlet near where your electric car is parked
- Low impact on electric utility peak demand charges (often applied to commercial accounts)

Disadvantages

- Slow charging, typically 3-5 miles of range per hour5

Level 2 EV charging: Level 2 charging for electric vehicles is rated at 240 volts. Additional hardware is required for this type of charging. On the purchase of an electric vehicles, some manufacturers will install an AC wall-box charger at the customer's home and in some cases the place of work as well, either free of cost or otherwise, in order to enable level 2 charging. With the use of this, an electric vehicle can be fully charged in as early as 6 hours or a little over, depending upon the battery capacity. Level 2 charging is considerably faster in comparison to Level 1 charging. Not only this, but it is said to be more energy efficient as well. However, this charging technique is expensive because of the use of more sophisticated hardware.

Advantages

- Faster charge time - typically 10 – 20 miles of range per hour of charge
- More energy efficient than Level 1 - about 3% gain in efficiency
- Variety of EV charging manufacturers provides differentiated products for distinct markets and requirements, including networked systems that can schedule charging, track use, and collect fees

Disadvantages

- More expensive than Level 1.
- Potentially higher impact on peak kilowatt demand charges for businesses.5

Level 3 EV charging: The level 3 charging for electric vehicles is what one will find at public charging stations. Called as DC fast charging, it converts the AC current, into DC current for direct storage in electric vehicle batteries. It is usually rated at 480 volts. With the use of a DC fast charger, an electric vehicle can be charged to 80 per cent in less than an hour. Tesla superchargers are able to reach the same charging capacity within half an hour. The hardware required for the same is quite expensive and is usually found at public charging stations. In order to use them, one needs to pay a certain amount to the service provider.3

Advantages

- Charge time is reduced drastically--it's nearly as fast as refueling a gasoline vehicle.
- Variety of charging equipment manufacturers provides differentiated products for distinct markets and requirements.

Disadvantages

- Significantly more expensive than Level 1 or Level 2 equipment and high voltage 3 phase power connections to utilities further increases installation costs.
- Potentially increased peak demand charges for commercial locations.
- Different plug types are confusing to potential EV buyers and charging station operators.
- Depending on the vehicle and charging equipment, fast charging can be slowed during cold weather.5

FACTORS AFFECTING ENERGY CONSUMPTION OF ELECTRIC VEHICLE

The cost of running an electric car is directly related to its energy consumption, but what exactly does this entail? Defined in terms of kilowatt hours per one hundred kilometers, consumption is crucial when calculating the range of a vehicle based on its use. Just as with traditional combustion-powered vehicles, the driver's behavior affects the energy consumption of an electric vehicle. A driving style that anticipates both the traffic and the road conditions will reduce the energy required to power the electric car and, ultimately, optimize your electricity consumption. On the highway, as speed increases, so does energy consumption. Increased road surface friction and air resistance mean that the motor has to use more watts to maintain speed. Lastly, consumption also depends on interior temperature regulation: both heating and air conditioning significantly reduce the range of an electric car battery.6

ELECTRIC VEHICLE BENEFITS AND CONSIDERATIONS

Energy Security

Using more energy efficient vehicles like hybrid and plug-in electric vehicles is an important part of continuing this successful trend of minimizing imported petroleum. Additionally, using an energy source such as electricity for transportation creates a resiliency benefit. The multiple fuel sources used in the generation of electricity results in a more secure and domestically generated energy source for the electrified portion of the transportation sector. All of this adds to our nation's energy security. Hybrid electric vehicles (HEVs) typically use less fuel than similar conventional vehicles because they employ electric-drive technologies to boost vehicle efficiency through regenerative braking—recapturing energy otherwise lost during braking. Plug-in hybrid electric vehicles (PHEVs) and all-electric vehicles (EVs), also referred to as battery electric vehicles, are both capable of being powered solely by electricity

Costs

Although energy costs for hybrid and plug-in electric vehicles are generally lower than for similar conventional vehicles, purchase prices can be significantly higher. Prices are likely to equalize with conventional vehicles, as production volumes increase and battery technologies continue to mature.

Fuel Economy

HEVs typically achieve better fuel economy and have lower fuel costs than similar conventional vehicles. HEVs, PHEVs, and EVs can reduce fuel costs dramatically because of the high efficiency of electric-drive components. Because PHEVs and EVs rely in whole or part on electric power, their fuel economy is measured differently than that of conventional vehicles. The fuel economy of medium- and heavy-duty PHEVs and EVs is highly dependent on the load carried and the duty cycle, but in the right applications, PEVs maintain a strong fuel-to-cost advantage over their conventional counterparts.

Infrastructure Availability

PHEVs and EVs have the benefit of flexible charging. Since the electric grid is in close proximity to most locations where people park, they can charge overnight at a residence, as well as at a workplace or public charging station when available. PHEVs have added flexibility because they can also refuel with gasoline or diesel (or possibly other fuels in the future) when necessary.

Public charging stations, or electric vehicle supply equipment, are not as ubiquitous as gas stations. Charging equipment manufacturers, automakers, utilities, Clean Cities coalitions, municipalities, and government agencies are rapidly establishing a national network of public charging stations.

Emissions

Hybrid and plug-in electric vehicles can have significant emissions benefits over conventional vehicles. HEV emissions benefits vary by vehicle model and type of hybrid power system. EVs produce zero tailpipe emissions, and PHEVs produce no tailpipe emissions when in all-electric mode.

The life cycle emissions of an EV or PHEV depend on the sources of electricity used to charge it, which vary by region. In geographic areas that use relatively low-polluting energy sources for electricity production, plug-in vehicles typically have a life cycle emissions advantage over similar conventional vehicles running on gasoline or diesel. In regions that depend heavily on conventional electricity generation, PHEVs and EVs may not demonstrate a strong life cycle emissions benefit. Use the Electricity Sources and Emissions tool to compare life cycle emissions of individual vehicle models in a given location.7

CONCLUSION

The major benefit of electric cars is the contribution that they can make towards improving air quality in towns and cities. With no tailpipe, pure electric cars produce no carbon dioxide emissions when driving. This reduces air pollution considerably.

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