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A Review of Pros and Cons of Electric Vehicles in Smart Power System

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Abstract

With the awareness about the environment and greenhouse effect, researches are going on non-polluting alternatives of the energy. Petroleum, natural gas, coal etc. are main source of energy and public transport. But now advancement of technology main stress is on renewable source of energy, and with deployment of natural resources electric vehicles technology is new alternative to petroleum transport. But the excess use of electric vehicles has some ill effect on the power system. In this work, an analysis of electric vehicle on the power system is presented. Various problems related to these and their solutions are given in literature. Presently, electric vehicles are in developing stage and are the future of the transport system.

Keywords:

Power System;
Distribution Network;
Electric Vehicle;
Charging Stations.

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1. Introduction

Due to the ample consummation of fuel and exhaust of the greenhouse gases, some environmental problems, such as global warming and non-renewable resources have become a serious problem which has attracted much attention from the whole world. Regarding transportation, vehicles not only consumed huge fossil fuel, but also released frequent greenhouse gases to the atmosphere. For this truth, a number of research institutions and automobile company have regularly devoted their interests on researching and increasing alternative energy source to change or control the fuel consumption in conventional vehicles.

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Hence, from the past few years electric vehicles being a substitute of conventional vehicles.
In 2012, more than 1,00,000 electrical and hybrid vehicles was sold across the world and the sale is nearly doubled each year [1]. As the market of electric vehicles is growing, many automobile companies developing their electric models which are technically viable, affordable and pollution free.

With the increased popularity of these vehicles, there are some challenges in the development phase like long distance travelling, power and efficiency, charging at fast rate and low cost [2]. The main concern with the EVs is the driving range, which is approximately 100 to 500 km for recent models with a fully charged battery backup. And other concern is recharging time of the batteries which is nearly 30 minutes to 10 hours depends upon the vehicle. By use of electrical energy these vehicles helps in reduction of petrol and greenhouse gases [3]. The EVs will remain parked approximately 90%, and plug in the supply whether charging is not necessary this will provide a virtual storage system [4]. This will helpful in supporting and managing the smart grid like smoothing the demand curve.

2. Literature Review

The increasing load demand overloads the distribution equipments. Further, with new emerging technologies different types of electrical devices are common need of human beings. To deal with these challenges different parameters like electricity reforms [5-7], distribution losses [8-11], customer satisfaction [12,13], service quality [14-18], voltage profiles [19-20], smart distribution system [21-23] have been presented. But due to nonlinear devices there is distortion in supply voltage which results in poor power quality which affects the equipments. For this a number of techniques applied for analysis of power quality as given in [24-28]. Similar power system disturbances are also due to electric vehicles. This may cause unitability in the power system [29-35]. For a healthy power system these disturbances must be in tolerable limits so detection and mitigation of power quality disturbances is important [36-39].
The literature survey is carried out about the analysis, design and evaluation of EVs in the smart grid and their impact on the distribution transformer or on the grid when they are plugged for charging to the already installed grid. The impact of EVs on the distribution network depends on electric vehicles battery & its charging and discharging characteristics and also coordination of its charging with other loads.

Zhipeng, L et al. [40], explains that with continuous extraction of fossil fuels and awareness about the polluted environment, EVs getting more attention in present scenario. But the improper size and location of charging station gives adverse effect by increasing losses and degrade voltage. To overcome these effects authors propose a technique for optimal location of EV charging station on the basis of environmental factors and service range. A mathematical model has been developed by minimizing the cost function for charging station. The proposed model has been tested in IEEE 123 test feeder.

Authors in [3], present a model for flattening the load curve by considering the charging profile of a family's plug-in hybrid electric vehicles (PHEVs), in a household microgrid. By using this model different factors like variance of load, losses and performance of charging on capacity of battery has been studied.

A vehicle-to-grid (V2G) algorithm has been presented by the authors, which gives financial support to the owners of EVs and operational advantage to the utilities. The proposed algorithm gives provision of electrical energy for load regulation and ancillary services to grid from EVs [41].
In [42], authors proposed a decimalized charging scheme for EVs. In this scheme the charging schedule of EV is considered as optimal control problem with objective to valley filling and charging profile. The utility iteratively send a control signal and each EV updates their charging profile irrespective of charging time and deadline.

A modeling and analysis technique is presented by the authors for load demand due to battery charging load of EVs. This technique includes dissimilar battery charging start time and

initial charging status of the individual batteries of various EVs [43].

Geng, B. et al. [44], presents a charging control problem of PEVs with V2G function and its effect on local transformer. A two-stage charging control (TSCC) is adopted which shifts the load from transformer and gives better charging profile for grid connected PEVs. Simulation results are presented to authenticate the performance of the TSCC.

In [2], authors present an approach of demand side management for PHEVs. The proposed approach has three parts i.e., aggregation, optimization, and control. The presented result shows the optimal charging with improved scalability.

An EV charging schedule problem is presented in [45], by considering the aggregator's returns and customers' demand and charge. Two battery charging schedules, static and dynamic are there. In static schedule aggregator know the charging demand in advance and in dynamic the EV can be plugged any time. A linear programing based optimum technique is used for static schedules while for dynamic schedule a heuristic algorithm is proposed.

In [46], another problem of EV charging schedule is presented with energy storage with day ahead and real time energy trading. A mixed integer linear programing model is presented to provide an optimal solution.

Authors in [47] address that PHEVs are the way to reduce the dependency on the oil transport vehicles, but the large quantity of EVs can increase the peak load if used without control. For the solution of this problem authors proposed two algorithms.In [48], authors presented a load management technique for charging of multiple PEVs. Due to this utilities are subject to stress, degradation in performance and overload conditions in distribution system. To deal with these problems a real-time smart load management (RT-SLM) control technique is provided. Modified IEEE 23 kV distribution system simulation is performed with several low voltage residential networks populated with PEVs to validate the performance of the SLM.

3. Conclusion

In the current scenario, the use of plug in electric vehicle is increasing. As these vehicles are environment friendly but these have some drawbacks like slow charging rate of batteries, short travelling range, cost and other utilities related issues like increased in peak load, degradation of voltage, overloading and power quality problems. With the smart management the grid connected vehicles are also helpful for some ancillary services. At present all the automobile companies presenting their electric vehicle with improved designs and other researches are going on this field to short out these problems. With the advantages of non-polluting nature these vehicles replace the other fuel transport system in near future.

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