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Future renewable energy option for recharging full electric vehicles

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ABSTRACT

In this paper, an overview of future energy option for charging mechanism associated with the full electric vehicle (FEV) is carried out. This review emphasizes the basic types of electric vehicles (EVs), various factors affecting to increase the number of FEVs to use, the CO_2 emission and fuel economy, and a new charging mechanism for increasing the usage of FEVs. The EVs such as plug-in hybrid electric vehicles (PHEVs), the hybrid electric vehicles (HEVs), and the FEVs are recharged externally. The HEVs are the one will cover longer traveling distance compared to PHEVs and FEVs because of internal combustion engine. The PHEVs provides on-board charging and an option for sustaining mode of operation. On the other hand, FEVs run only with the help of batteries and the electricity required for recharging the batteries is generated from the conventional power plants which produces more greenhouse gas emission. In order to overcome this problem, a new recharging mechanism is proposed, which has both the renewable sources (wind and solar) moreover it automatically recharges the battery banks present in the FEVs. A wind duct is incorporated for increasing the velocity of the wind and the model of both the wind and the photovoltaic (PV) system have been studied. Furthermore, the streamline plot of wind duct is simulated at various values of Reynolds number and the PV array is modeled using Simscape. The performance and comparison results indicate that the proposed system can be used for charging the batteries of EVs.

1. Introduction

Nowadays vehicles have become a part and parcel of human life for both personal use and haulage. Hence, there is a never ending demand for oil today as well as in future and the amount of oil that will be present is crucial. This demand is due to the increase in population and prominent need for vehicles. Therefore, it has turned our concern with the forte towards the excess emission of greenhouse gasses. This motivated for a research on electric vehicles which are much more immaculate and eco-friendly. These vehicles are used to reduce the dependence on fossil fuels thereby decreasing the emission of greenhouse gasses and other pollutants. Though electric vehicles have existed since 1990s, their penetration into the market has not been high because these vehicles are not cost effective and recharging the batteries at 60 km or 70 km depends on the capacity of the EVs. The present market consists of hybrid vehicles deriving their energy from both the batteries and from the combustion engines. However, in order to mitigate the gasoline consumption, the plug-in electric vehicles have been introduced in the market which takes its energy from the grid. These vehicles are still under research for its improvements on battery-life, costs, and grid connection.

An automatic charging mechanism is present in the EVs for reducing the traveling time. The drive train assembly is interfaced with the turbine and the output is given to a converter with fuzzy controller [1]. It consists of two turbines, one is used to charge the main battery packs present in the vehicle and the other is used to charge the auxiliary battery packs. The increasing greenhouse gas emissions can be reduced with the help of FEVs. The renewable energy sources produce fluctuating output power which will be stored in a storage system. A power factor correction method for an integral battery charger for traction drive is implemented by a fixed-point digital signal processor. The battery management system activates the current or voltage controlled charging modes of the battery packs [2].

The future battery technology and its cost for EVs are surveyed by Michela et al. The total battery packs define the overall cost of EVs. The transport sector has caused a serious damage to the quality of air especially in metropolitan areas [3]. The two EV charging scenarios such as the static and the dynamic methods are used for charging and an aggregator is employed to collect the information about the charging. The static problem is solved by using a linear program and the dynamic problem by a heuristic algorithm [4]. EV is a promising technology for the transport sector to reduce the emissions of poison gasses such as carbon dioxide (CO_2), nitrogen oxides (NOx) and other air pollutants. On the other hand, the electric cars and other EVs are not competitive with conventional vehicles that are commercially used. The batteries used in EVs and its technologies are still under development [5,6]. The electricity required for recharging the batteries should be generated through renewable or clean sources to achieve the standpoint of zero emission.

Renewable energy (RE) based hybrid power generation has become popular due to concerns over the environment. To eliminate the grid connection and to reduce transmission loss the RE-based power generation can be used to serve local loads in remote areas [7]. Wind power generation system has less negative impact compared with fossil fuels; studied by Leung and Yang [8]. Among various wind generators, the permanent magnet synchronous generator (PMSG) is more popular because of its generation capability. The output power quality can be improved by the supported power electronics [9,10]. A maximum power tracking and control system for increasing the amount of power is generated by the wind turbine. The efficiency and the life time of the turbine will be reduced if the design is improper and it also creates fatigue to the turbine

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Table 1
Top electric vehicles and its various ratings.

Name of EV	Battery type	Capacity (kWh)	Range (miles)	Charging time (hours)	Charging voltage/current
BMW Mini E	Lithium ion with Air cooled	35	96	26 4.5 3	110 V/12 Amp 240 V/32 Amp 240 V/48 Amp
Chevy Volt	Liquid cooled. Lithium manganese cells from LG Chem.	16	40	10 4	120 V/12 Amp 240 V/24 Amp
Ford Focus EV	Lithium ion tri-metal cells from LG Chem.	23	75	6–8	230 V/32 Amp
Smart FortwoED	Lithium ion	16.5	85	3.5–8	220 V/24 Amp
Tesla Model S	Standard (larger premium batteries optional)	42	160	3–5	220 V/70 Amp
Tesla Roadster	Lithium cobalt Liquid cooled	56	220	3.5	220 V/70 Amp
Think City	Lithium ion batteries	24.5	99	8	110 V/48 Amp
Volvo Electric C30	Lithium ion batteries	24	93	8	230 V/16 Amp
Nissan LEAF	Lithium manganese	24	100	8	230 V/30Amp
Mitsubishi iMiEV	Lithium ion	16	128	7	230 V/20Amp

Table 2
Various types of EVs and used charging system.

Type of electric vehicle	Battery charging	Internal combustion engine
Plug-in Electric Vehicle	Internal (on-board) and /or external charging	Yes
Hybrid Electric Vehicle	Internal (on-board)	Yes
Full Electric Vehicle	External charging	No

Table 3
Comparison of different EVs with speed and maximum range.

Vehicle type	Battery type	Mode of operation	Maximum speed (km/h)	Maximum driving range (km)
HEVs	NiMH	Charge sustaining	170	900–1200
PEVs	NiMH	Charge sustaining	160	20–60
	Li-ion	Charge depleting mixed mode	150	900
FEVs	Li-ion	Charge depleting	80–200	120–390

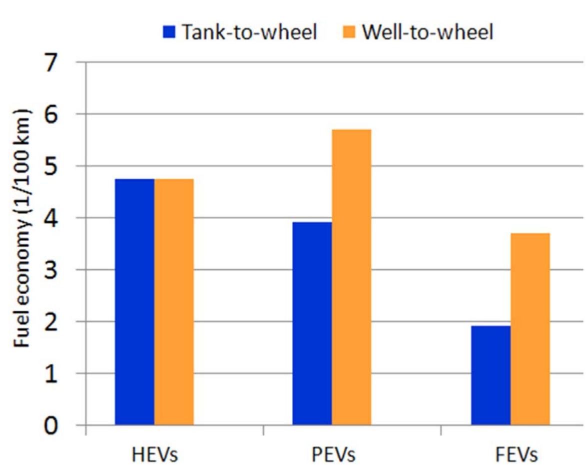

Fig. 1. Comparison of fuel economy of different EVs.

components [11]. In addition, the other parameters such as yaw misalignment, wind shear, turbine imbalance, and turbine shadow decrease the power quality of turbine and the authors have suggested that the fixed speed wind turbines are widely used because of its ruggedness, simplicity and less maintenance [12–14]. The gearbox connected with the turbine creates many problems such as the increase in the size, weight, noise, continuous maintenance; reduction of efficiency and power losses; studied by Saccomando et al. [15]. On the other hand, the variable speed wind turbine has many advantages compared to fixed speed wind turbines such as high energy capturing capacity, better efficiency, operation at the maximum power point, and high power quality.