

# Performance Analysis of Hybrid Charging Station for Electric Vehicles

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## Abstract:

This paper depicts the solar and wind energy based charging mechanism (SWCM) to create the power for charging the battery packs of electric vehicles (EVs). The sustainable charging station comprises of both the solar photovoltaic (PV) modules and a wind generator. The SWCM tremendously lessen the necessity of non-renewable energy sources to create power which brings about enormously decreased CO<sub>2</sub> and CO related discharges. The sustainable sources, for example, wind and solar has been demonstrated utilizing single diode model and a logical displaying has been done for wind energy generation.

**Keywords** – Electric vehicle, Solar Power, Wind energy, SWCM, DC-DC converters, MPPT, MATLAB-Simulink.

## 1. INTRODUCTION

Since electric vehicles have been utilized in the 1990s, their dispersion into the vehicle market has not been up to the mark because of the reason that it is less cost effective and these vehicles need to recharge once in 60 to 70 km drive. The hybrid vehicles play a major role in the present market and it obtains their energy from the combustion engine. However, in order to alleviate the utilization of gasoline, the plug-in electric vehicles (PHEVs) entered into the market and it takes the energy from the grid for driving. To increase the life of storage system, cost reduction, and the flexible grid connectivity, the PHEVs are still under research. Nowadays, the park stations, roadside units, and the standard home outlets are used to charge the battery packs of EVs. The storage system present in the EV takes a prolonged period for recharging the battery packs and it will vary depending upon the capacity. A new charging method is introduced by Chellaswamy et al for recharging the EVs. The control system present in this mechanism automatically charges the battery packs without the contribution of the driver. The performance analysis has been done and the result is compared with other EVs [1]. The plug-in EVs are used to reduce the green house gas emissions. The high-frequency ac-dc converter is used to charge the traction battery packs and an electromagnetic interference (EMI) filter is connected with the high-frequency transformer to suppress the EMI noise has been studied in [2]. A high sampling rate camera with a sensor is used to estimate the slip angle measurement of EV. The performance of this model based estimator has been studied by Yafei Wang, with the help of multi-rate Kalman filtering [3]. A linear programming is used to estimate the operating cost, optimal scheduling, and CO<sub>2</sub> emission of a hybrid EV under European regulation. This mechanism also controls the electricity consumption of EVs [4]. A control algorithm has been developed to equally maintain the state of charge (SOC) of all the NiMH battery packs which are present in the EVs. The SOC variation for different temperature and the percentage of improvement has been studied by Man Ho Au et al [5, 6]. To limit the rate of charge and the cost a smart algorithm has been developed and the performance is studied by Mosaddek Hossian. An experimental setup has been implemented and electrifying the plug in EVs by parking garage standard outlet. A comparative analysis has been performed for SOC under different temperature conditions [7]. Hybrid renewable energy (RE) based power generation become popular because of anxiety over the atmosphere. To eliminate the transmission loss and grid connectivity problems, RE based power generation is carried out in [8]. The wind power generation system has a less harmful impact compared to fossil fuels. The wind energy potential and electricity generation for recharging the storage system present in the EV has been studied in [9, 10]. Among different wind generators, the permanent magnet synchronous generator (PMSG) is more popular because of its generation capacity. The power quality is improved by Geng and Xu with the support of power electronics [11]. The maximum power tracking and control system has been introduced for increasing the amount of power generation of the wind turbine has been studied in [12]. The possibilities of providing electricity through a renewable hybrid energy system to a remotely located community, Bekele and Palm [13] and a renewable source for recharging the EV is discussed by Chellaswamy and Ramesh [14].

## 2. DESIGN

The recreation model has been created in MATLABSimulink for the proposed SWCM. The I-V and PV attributes of the solar panel have been examined under different irradiance levels and various boundaries of wind turbine has been contemplated under two different stacking (1 kW and 3 kW) conditions. There are two unidirectional direct current DC to DC converters are associated with the PV modules and the wind turbine and six bidirectional DC-DC converters are associated with ten charging points which gives charging to the electric vehicle. To adjust the load demand, the proposed framework is associated with the grid through a three phase bidirectional DC-AC (alternating current) inverter. The acquired outcomes show that the proposed renewable charging mechanism is suitable for EV charging thus creating pollution free environment.

### 3. PROPOSED METHODOLOGY

The renewable charging station is constructed with the solar PV module of 10m×20m of SPM050-P and a vertical axis wind turbine (WKV-10000) with the rated wind speed of 12 m/h. The weather report has been analysed for the last five years and the extracted statistical data shows that there are 276 sunny days are available during the year. The solar PV can generate full power during these days and it is very less in the remaining days, the power requirement can be managed by both the solar and wind power and the balance energy needed for charging EVs can be taken from the grid. The total power generated by the charging station from the solar PV modules and the wind turbine has to be estimated. The generated power should be managed the daily power demand. So that a statistical analysis has to be performed for the average number of PEVs and EVs charged per day around the vicinity of the charging station. The number of EVs charging hour by hour per day is shown in Fig. 1. The proposed SWCM consists of a wind energy conversion system, PV array, maximum power point tracking (MPPT) controller, unidirectional DC/DC converters for PV array, DC-AC inverter connected to grid, and bidirectional DC-DC converter for providing charging to EVs. In this study, the charging station is constructed in such a way that it can handle 10 EVs charging points. tracking (MPPT) controller, unidirectional DC/DC converters for PV array, DC-AC inverter connected to grid, and bidirectional DC-DC converter for providing charging to EVs. In this study, the charging station is constructed in such a way that it can handle 10 EVs charging points. It is noted that the proposed charging stations can switch vehicle-to-grid (V2G) connection. An automatic system is incorporated to manage the charging of EVs and discharge the electric energy through the grid when the load demand of the grid is high. The wind Energy conversion system and the solar module have been connected through the two similar DC-DC converters to the DC bus and the PV array is continuously monitor and track by controller and the DC -Link taken as a reference for the controller. The implementation of proposed charging mechanism for EVs is shown in fig 1.

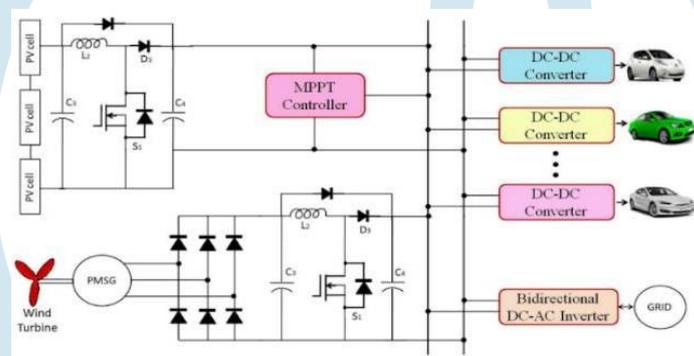


Fig.1 Implementation of the proposed charging station for

### 4. CONCLUSION

In this paper, a new recharging mechanism for electric vehicles is proposed using solar and wind energy. The usage of EV is directly affected by the present charging technique. charging stations are necessary for longer drive vehicles and it is commonly used in few countries. The traveling distance depends on the capacity of energy storage present in the vehicle. The recharging stations are needed for long distance travel. In this paper, we have introduced a new hybrid renewable charging mechanism for EVs. A simulation model has been developed using MATLAB-Simulink and the performance of solar and wind energy has been studied. Various parameters of the solar module have been verified under different irradiation level. The SG has been studied under different loading condition. Finally, the hourly load of EV versus generated electricity has been analysed. From the output generated by the hybrid system, we strongly say that the proposed SWCM provides enough power for recharging the electric vehicle and the time taken for charging can be avoided by battery swapping method. At last, we are concluding that this approach reduces the pollution and increase the usage of EVs as a result creating pollution free environment.

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