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Simulation analysis of electric vehicle charging station using hybrid sources

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ABSTRACT

This paper described simulation analysis of electric vehicle (EV) charging station using hybrid sources. This paper highlights electric vehicle charging station with photovoltaic panels, batteries, and diesel generator. This study employs a solar, battery, diesel generator set, and grid electric vehicle charging station to provide continuous charging in is landed, grid-linked, and Diesel generator (DG) set connected modes. By utilizing a solar and battery, the charging of battery in electric vehicle application is the primary objective If the storage battery is poor and there is no solar generation, The mode of charging automatically shifted to grid or diesel generator set. Furthermore, the charging station manages the generator voltage and frequency without the need of a mechanical speed governor in conjunction with the storage battery. The demand is nonlinear at unity power factor (UPF). For continuous charging, power used from the grid or the DG set and it is synchronized to the grid/generator voltage by the point of common coupling voltage. To boost charging station operating efficiency, the charging station also performs all power transfer from car to grid, vehicle to house, and vehicle to vehicle.

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1. INTRODUCTION

With zero tailpipe emissions, electric vehicle are the most efficient modes of transportation. Given the benefits of electric vehicles (EVs), there are presently 3 million vehicles on the road, with a total of 100 million expected by 2030. However, the proposed approach needs a vast charging infrastructure as well as massive energy. Furthermore, using fossil fuels to create energy, on the other hand, does not reduce emissions; it only moves them from vehicles to power plants. As a consequence, employing nonconventional energy sources for electricity generation may completely eliminate emissions while simultaneously benefiting the environment. solar production is the most feasible option for electric vehicle charging in all sources because it is available practically anywhere, whether rural or urban [1]–[3]. It is open almost all year on the Indian subcontinent. In contrast to solar PV arrays, wind and hydro energy are site-specific and mostly advantageous in coastal locations and in highland places. Author in emphasized the need of renewable energy for electric vehicle charging station long-term viability. The researchers [4]–[6] charged electric vehicle with a high-power bidirectional electric vehicle charger using solar electricity. However, the planned charger does not support AC charging. Author in presented a three-port converter for connecting a photovoltaic array to an electric vehicle charger. The intended charger, however, does not account for the charger's current distortions in the grid current. The researchers [7]–[9] created a PV and grid-connected electric vehicle charger. The charger, however, is not meant for islanded operation. As a result, it is unable to support EV charging in the absence of a grid. Author provided a hybrid optimization strategy for regulating battery storage with the goal of lowering charging station running costs while increasing solar PV array power utilization. Author in [10]–[12] advocated for employing on-site PV generated power in combination with the EV charging station for maximal solar PV array utilization with little grid affect. The PV array-powered charging station is also well-suited for onsite deployment in order to provide the best service at the lowest feasible cost while minimizing the charging grid effect [13]–[15]. Due to its availability throughout the day and night, wind energy-driven CS is especially helpful for Electric vehicle, and various publications in this subject are available [16]–[18].

Author created a power management approach for a grid-connected and islanded integrated residential PV-storage battery system with multi-mode control. We have described smart household operations in which electric vehicle may be used as storage to offer vehicle, home and grid operations to the benefit of both utilities and customers. The charging station was constructed utilizing renewable energy sources. Furthermore, charging station performance in real-world circumstances is rarely examined [19]–[21]. The previous studies [22], [23] discuss both islanded and grid-connected models. These two modes, however, are controlled independently, and there is no automated mode switching between them. As a result, in the absence of automatic mode switching capabilities, PV array power would be interrupted and EV charging will be intermittent. As a result, our work includes automated mode switching logic, which allows the controller to automatically transition between multiple working modes dependent on the power generation of the PV array and the charging demands of the EV [24], [25].

2. PROPOSED METHODOLOGY

As shown in Figure 1, the charging station charges the EV and load powers associated to the charging station using a solar photovoltaic generator, a storage battery, a DG kit, and grid electricity. A step-up converter connects the solar PV array to the voltage source converter's (VSC) DC connection, while the storage battery is directly connected to the DC link. The power coordinated charging (PCC) ripple filter is used to convert main and generator currents to sinusoidal currents by removing switching harmonics. An excitation capacitor is connected to the self-excited induction generator (SEIG) auxiliary winding. A small capacitor is also connected across the primary coil of the SEIG. To regulate the charging station's connection/disconnection from the DG network/set.

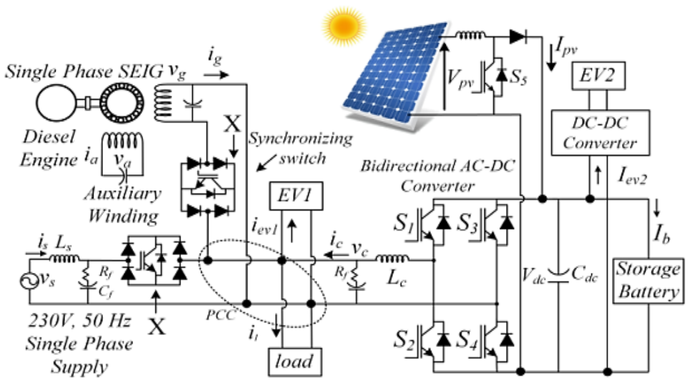

Figure 1. Block diagram of electric vehicle charging by hybrid sources topology

3. SIMULATION RESULTS AND DISCUSSION

3.1. Single phase multilevel inverter

The simulation model of EV charging station using hybrid sources in Figure 2. The electrical vehicle charging using solar PV array in Figure 3. The grid connected EV charging in Figure 4. The diesel generator set connected charging in Figure 5. Following parameters has been selected for simulation. Table 1 shows simulation parameters.

The CS's uninterruptible functioning results demonstrate in Figure 5. Initially in islanded mode, PV array electricity provided the charge to EVs linked at PCC. The excess generation is stored in the energy storage due to exceed charging needs of the EVs. In 0.8 s, sun irradiation decreases from 1000 W/m^2 to 300 W/m^2. So, the PV array output decreases and the storage battery begins to discharge in order to maintain uninterrupted charging. At 1 s, the storage battery empties as the PV array power drops to zero. The controller connects the CS to the grid for synchronization after the battery has been completely discharged. The simulation results indicate the different mode of operation. At 0.8 s phase, grid and storage battery power are unavailable The CS began taking electricity from the grid. The charging station automatically changes modes based on generation and demand is seen in Figure 5.

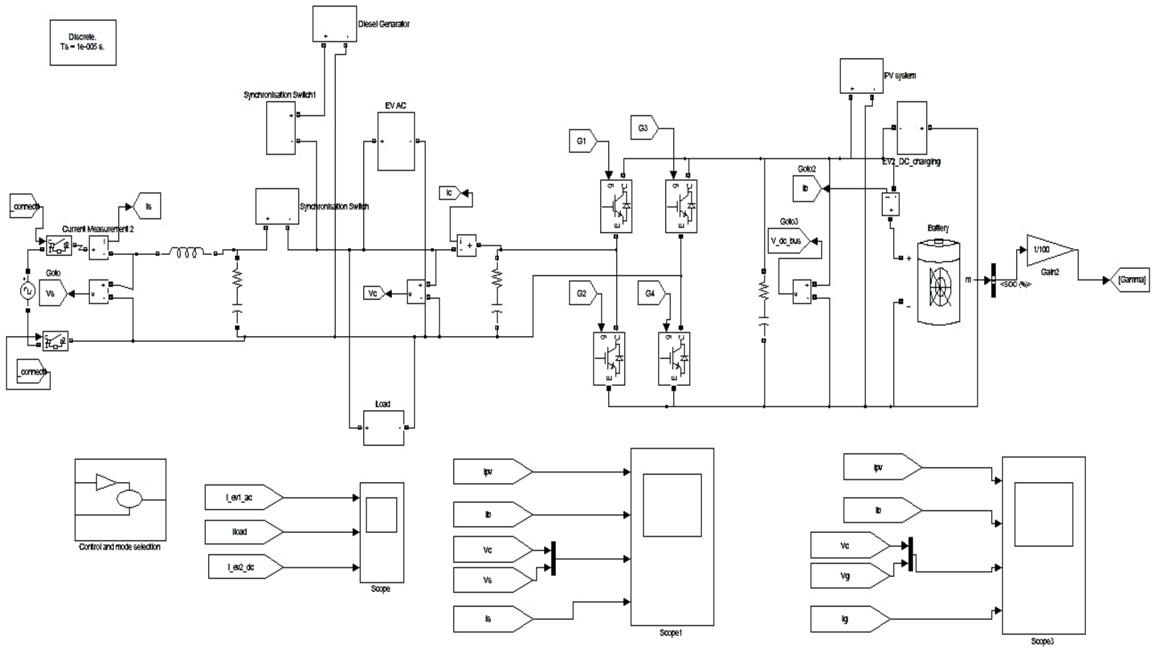

Figure 2. Simulation model of EV charging station using hybrid sources

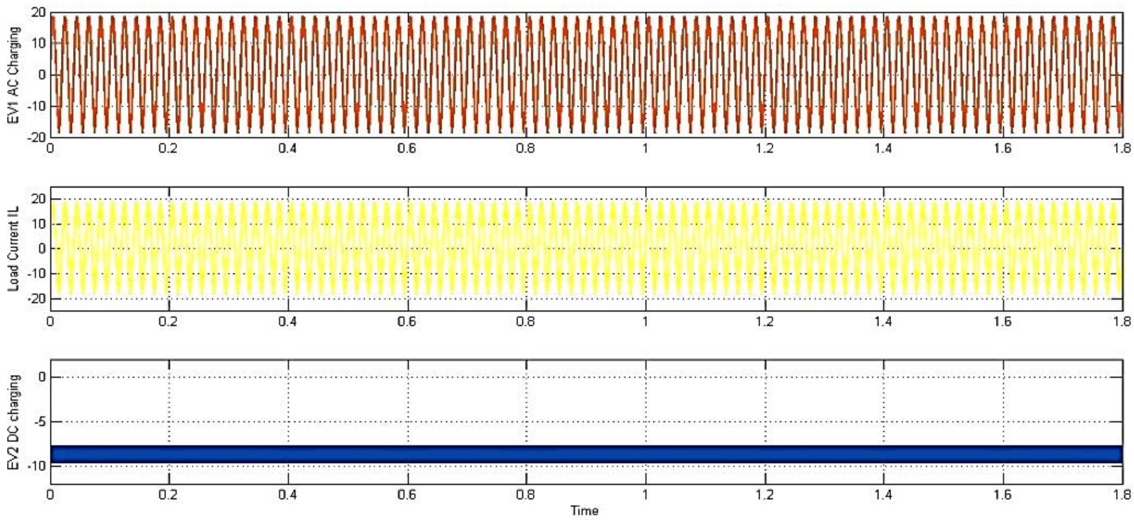

Figure 3. EV charging by solar

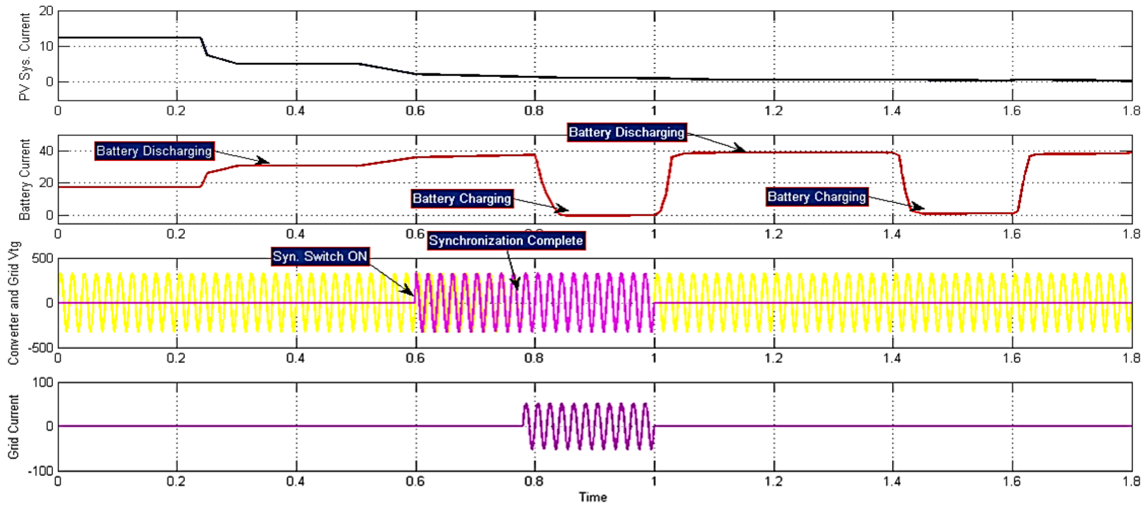

Figure 4. EV charging by grid

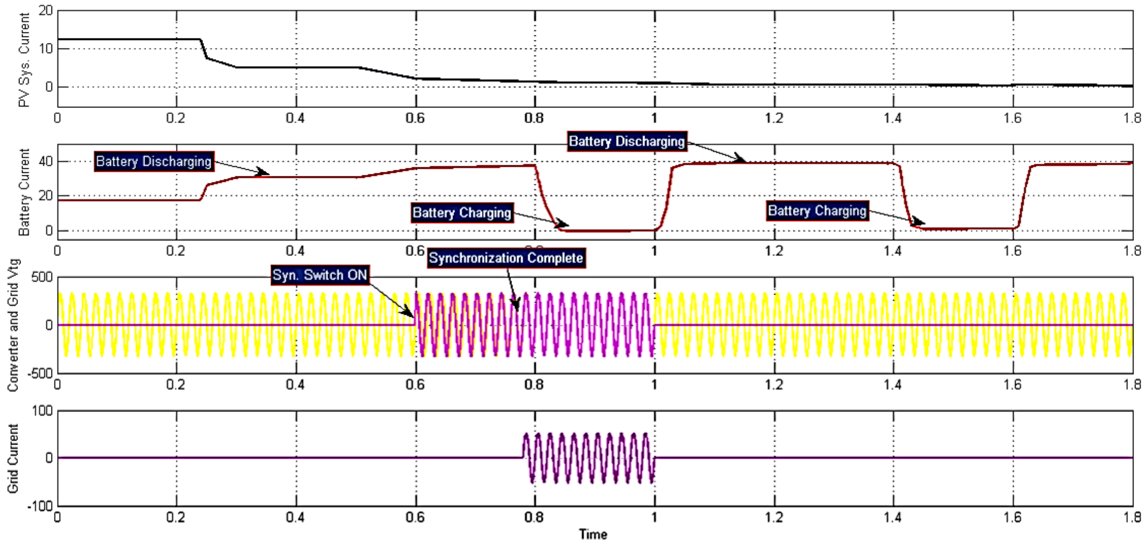

Figure 5. Diesel generator set connected charging

Table 1. Simulation parameters

System	Specification
Grid connected	1 Phase, 230 V, 50 Hz
Lead-acid battery	360 Volt, 14 Ah
PV arrey	1 Kilowatt
EV1 AC	2.6 Kw
EV2 DC	2.6 kw
Load	4.6 Kw

4. CONCLUSION

This paper described simulation analysis of electric vehicle charging station using hybrid sources such as photovoltaic panels, batteries, and diesel generator and to provide continuous charging. Charging of the battery in charging stations by the solar panel first. If battery is discharge due to solar power absent than it takes automatically power from the other two sources. In comparison with all the hybrid sources, diesel generator with good voltage quality as compare to solar and grid in EV charging station seen in the simulation results. The outcome of this paper is, diesel generator set as a feasible solution in charging station for battery charging because it can provide continuous, efficiently and economical charging.

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