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Controller for charging electrical vehicle at workplaces using grid tied solar energy

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ABSTRACT

Grid-tied solar energy fed charging stations for electric vehicles (EVs) at workplaces have gained significant attention as a sustainable solution for promoting clean transportation and reducing carbon emissions. This research paper explores the integration of solar energy systems into EV charging infrastructure within workplace environments. The study investigates the feasibility, design, and operational aspects of grid-tied solar energy-fed charging stations, emphasizing their environmental benefits, economic viability, and impact on grid stability. Through advanced modeling and simulation techniques, this research assesses the performance, efficiency, and reliability of such charging stations, addressing challenges related to intermittent solar energy availability and varying EV charging demands. The findings provide valuable insights for the development of scalable and eco-friendly EV charging solutions in workplace settings, contributing to the sustainable evolution of transportation systems.

INTRODUCTION

With the accelerating adoption of electric vehicles (EVs) and the increasing emphasis on renewable energy sources, integrating solar energy systems into EV charging infrastructure has emerged as a promising avenue for sustainable transportation. Workplace charging stations, in particular, play a pivotal role in promoting EV usage among employees and reducing the overall carbon footprint of commuting. This paper focuses on the conceptualization and implementation of grid-tied solar energy-fed charging stations dedicated to workplaces.

The integration of solar energy into EV charging stations offers several advantages, including reduced dependence on non-renewable energy sources, decreased operational costs, and substantial environmental benefits. By harnessing solar power, these charging stations contribute to mitigating greenhouse gas emissions and fostering energy independence. However, the intermittent nature of solar energy production poses challenges in maintaining a consistent and reliable charging service. This study addresses these challenges through innovative grid-tied systems that balance solar energy generation, storage, and grid connectivity.

In this research, we delve into the technical intricacies of designing grid-tied solar energy-fed charging stations, considering factors such as solar panel capacity, energy storage solutions, and intelligent grid integration. Moreover, we explore the economic feasibility by conducting cost-benefit analyses and

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evaluating the return on investment over the station's lifecycle. Additionally, the study investigates the impact on grid stability, considering the fluctuations in energy demand and supply, and proposes adaptive control mechanisms to optimize energy utilization.

This research contributes to the ongoing discourse on sustainable transportation solutions by providing a comprehensive analysis of grid-tied solar energy-fed charging stations in workplace environments. Through empirical data, simulations, and innovative design strategies, this study aims to pave the way for the widespread adoption of solar-powered EV charging stations, fostering a greener, more energy-efficient future for workplaces and urban areas alike.

PROPOSED CONFIGURATION

In the wake of escalating concerns regarding climate change and the environmental impact of fossil fuels, the global transition to electric vehicles (EVs) is gaining momentum. Simultaneously, the integration of renewable energy sources, particularly solar power, into mainstream energy infrastructure is becoming imperative to reduce carbon emissions. One noteworthy avenue in this endeavor is the development of grid-connected photovoltaic (PV) powered EV chargers. Unlike traditional charging systems, these setups harness solar energy directly from photovoltaic panels without the intermediary of Energy Storage Systems (ESS). This integration holds immense promise, not only in terms of fostering sustainable transportation but also in optimizing the use of clean energy resources. This introduction explores the significance and potential of grid-connected PV powered EV chargers without ESS, delving into the technological advancements, challenges, and environmental benefits associated with this innovative approach to electric vehicle charging.

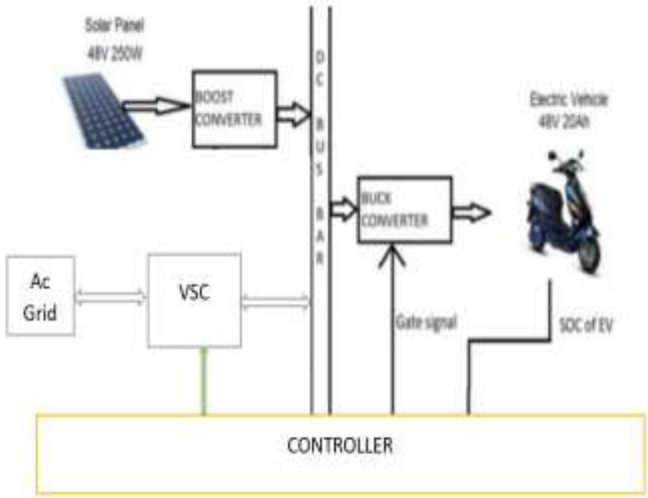

Fig 1 proposed system configuration

Photovoltaic panels generate electricity from sunlight during daylight hours. This DC electricity is produced directly from the sunlight falling on the PV cells. The DC electricity generated by the PV panels is converted into AC (alternating current) electricity by an inverter. This conversion is necessary because most electrical grids and EV chargers operate on AC power. The inverter sends the AC electricity into the grid. The PV system is connected to the local electrical grid, allowing any excess electricity generated by the PV panels to be fed back into the grid. This process is often facilitated through a net metering arrangement, where excess power results in credits or reduced electricity bills for the owner. When an electric vehicle is plugged into the charger, it draws power directly from the grid. The EV charger converts the grid AC electricity to the DC electricity needed to charge the vehicle's battery. The charging rate of the EV charger can be adjusted based on the real-time power

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output from the PV panels. If the PV system is generating more power than the charging station and other appliances on the grid are using, the surplus power can be utilized for charging the EVs. Conversely, if the PV system's output is lower than the total demand, the grid supplies the additional power required for charging.

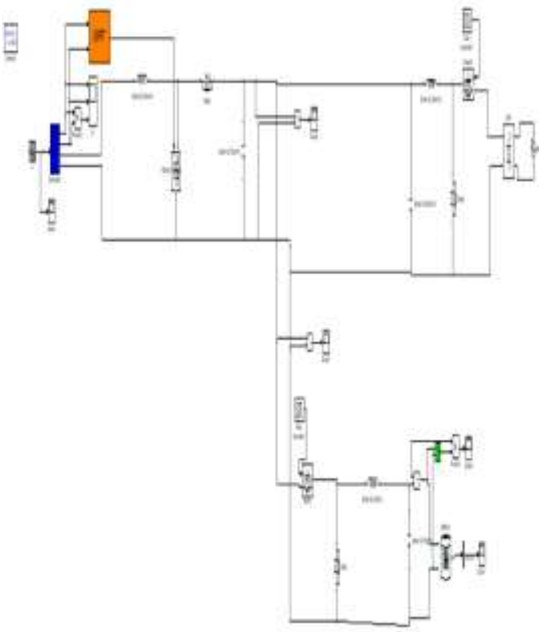

Fig 2 proposed system simulation

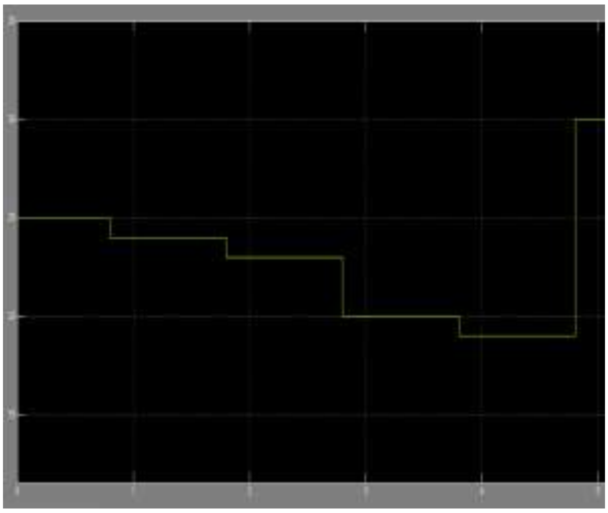

Fig 3 Pv panel temperature curve vs time

Grid-connected PV powered electric vehicle (EV) chargers without Energy Storage Systems (ESS) offer several advantages By eliminating the need for energy storage, the initial setup and maintenance costs are reduced, making the system more affordable. Without batteries, the design and installation of the charging station are simpler and require less space, leading to easier implementation. Directly connecting to the grid allows for a continuous power supply, ensuring stability and reliability in charging operations. Excess energy generated by the PV panels can be fed back into the grid, reducing wastage and maximizing the utilization of renewable energy. Grid-connected systems can be easily scaled up or down to meet varying demands without the complexities associated with energy storage management.

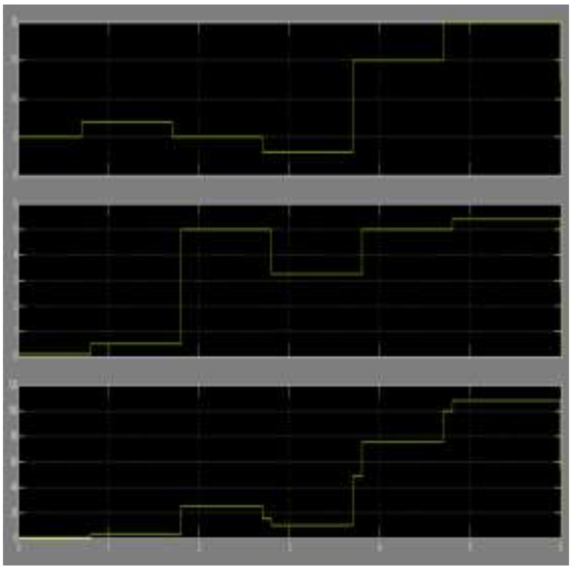

Fig 4 Pv panel voltage current and power vs time

Grid-connected chargers can seamlessly switch to grid power when sunlight is insufficient, ensuring uninterrupted charging services. By utilizing solar power and reducing dependency on grid electricity, these

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chargers contribute to a greener environment, reducing carbon emissions. Grid-connected PV systems can integrate with smart grid technologies, enabling intelligent monitoring, control, and demand response, thus optimizing energy usage. Grid-connected PV powered EV chargers are often preferred for public charging stations, where reliability and ease of access are paramount. Many regions have regulations that support grid integration of renewable energy sources, making grid-connected PV systems a compliant choice for EV charging infrastructure.

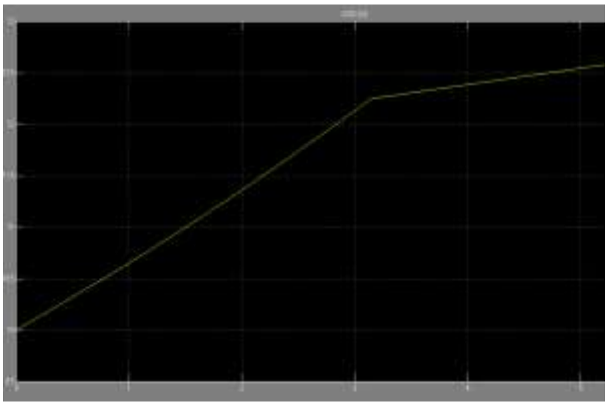

Fig 5 SOC vs time

CONCLUSION

grid-connected PV powered EV chargers without Energy Storage Systems (ESS) represent a promising step toward sustainable transportation infrastructure. Through simulation and real-world implementation, these systems demonstrate their potential to efficiently utilize renewable energy sources, reduce greenhouse gas emissions, and enhance grid stability. The absence of ESS emphasizes the need for intelligent algorithms that balance fluctuating solar output, grid demand, and EV charging requirements in real-time. Despite the lack of energy storage, these systems play a pivotal role in advancing clean energy adoption. However, ongoing research and development are crucial to refining algorithms, improving efficiency, and ensuring seamless integration with existing grid infrastructure. As technology evolves, grid-connected PV powered EV chargers without ESS are poised to make significant contributions to a greener, more sustainable future of electric transportation.

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