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DEVELOPMENT OF SOLAR ENERGY BASED EV CHARGING STATION IN COLLEGE CAMPUS

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ABSTRACT

The rapid adoption of electric vehicles (EVs) demands sustainable charging infrastructure to reduce dependence on fossil fuel-based grid electricity. This project presents the development of a vehicle-mounted solar power generation system for EV charging applications within a university campus environment. The system comprises solar photovoltaic panels mounted on a movable vehicle roof, a Luminous Solar PCU –NXT+ 3.75 KVA inverter with inbuilt Maximum Power Point Tracking (MPPT) charge controller and buck converter, a battery bank of 150 Ah Luminous Solar Tall Tubular batteries, Miniature Circuit Breaker (MCB), and AC switchboard with EV charging outlet. The MPPT controller maximizes solar energy extraction under varying irradiance conditions, while the buck converter regulates voltage for safe battery charging. The inverter converts stored DC power to stable AC power (230V, 50 Hz) suitable for EV charging. Results demonstrate that the system generates sufficient power during peak sunlight hours (11:00 AM – 2:00 PM), with battery storage enabling uninterrupted operation during low sunlight or nighttime. Vehicle mobility allows optimal panel positioning and on-demand power delivery across campus locations. The system reduces grid dependency, lowers carbon emissions, and serves as an effective educational platform for renewable energy technologies. This project validates the feasibility of mobile solar EV charging infrastructure for campus environments, contributing to sustainable transportation and clean energy adoption.

KEYWORDS: Electric Vehicle Charging, MPPT Charge Controller, Battery Energy Storage, Vehicle-Mounted Solar System, Renewable Energy Integration

INTRODUCTION

The global shift toward clean energy and sustainable transportation is driving the adoption of solar-powered EV charging systems. Solar energy, being abundant and renewable, offers an effective way to power electric vehicles while reducing dependence on fossil fuels. Integrating solar panels with EV charging stations helps lower carbon emissions, decrease grid load, and improve energy efficiency.

University campuses are ideal for such systems due to available space and growing EV usage. A solar EV charging setup typically includes photovoltaic panels, batteries, inverters, and charging units, ensuring reliable and flexible operation. It can work in both standalone and grid-connected modes, providing uninterrupted service.

Despite challenges like high initial costs and solar variability, advancements in smart energy management and storage systems make implementation feasible. Overall, solar-powered EV charging campuses promote sustainability, reduce costs, and provide valuable learning opportunities, contributing to a greener future.

Research Paper

MATERIALS AND METHODS:

System Overview

A vehicle-mounted solar power system was developed for EV charging within a university campus. The setup included photovoltaic (PV) panels mounted on the vehicle roof, a Luminous Solar PCU–NXT+3.75

KVA inverter with inbuilt MPPT controller and buck converter, a 150 Ah tubular battery bank, an MCB, and an AC switch board with an EV charging outlet.

Configuration

Solar panels were connected in a series-parallel arrangement to meet required voltage levels. The MPPT controller optimized power extraction, while the buck converter regulated voltage for battery charging. Batteries were arranged to meet system voltage and capacity needs and housed safely inside the vehicle.

Operation

The inverter converted DC power to standard AC supply (230V, 50 Hz). An MCB provided protection against faults, and the switchboard distributed power to the EV charger.

Installation and Testing

The system was installed on a movable vehicle for flexible positioning. Testing was conducted under different weather and time conditions, monitoring output power, battery performance, voltage stability, and load handling. Standard safety and operational procedures were followed.

RESULTS

Experimental Design

The system was tested to evaluate solar power generation, battery performance, and inverter output under varying weather and load conditions.

Solar Power Generation

Maximum output occurred between 11:00 AM and 2:00 PM. Power decreased during morning and evening due to lower sunlight. Even under cloudy conditions, sufficient energy was generated for battery charging. Relocating the vehicle to unshaded areas improved performance.

Battery Performance

The MPPT controller ensured efficient and safe charging. Batteries charged faster during peak sunlight and provided reliable power during low or no solar conditions. No overheating or overcharging issues were observed.

Inverter Performance

The inverter maintained stable output (230V, 50 Hz) with consistent performance under different loads. It handled sudden load changes without failure.

System Efficiency & Protection

The MPPT improved energy utilization, and overall system losses were minimal. The MCB effectively protected the system during fault conditions, ensuring safe operation.

Discussion:

The results demonstrate that the vehicle-mounted solar EV charging system is feasible and effective for campus use. Consistent solar power generation under different conditions confirms the reliability of solar energy for mobile applications.

The MPPT controller significantly improved energy efficiency by maximizing power extraction, while the buck converter ensured safe battery charging. Battery performance showed reliable energy storage, enabling continuous operation during low sunlight conditions.

The inverter provided stable AC output suitable for EV charging, and safety components like the MCB ensured secure operation. A key advantage observed was system mobility, allowing better solar exposure and flexible deployment across campus.

However, limitations such as weather dependency and lower power capacity exist. Despite this, the system is well-suited for campus environments where flexibility and sustainability are prioritized.

CONCLUSIONS

The solar-based EV charging system proves to be a practical, reliable, and sustainable solution for campus applications. The system effectively generates solar power, optimizes energy use through MPPT control, and ensures continuous operation with battery storage.

It reduces dependence on the grid and lowers carbon emissions while offering the added advantage of mobility. Overall, the project demonstrates the feasibility of solar-powered EV charging and serves as a valuable platform for learning and research in renewable energy technologies.

TABLES AND FIGURES

Table1: Comparison of Fixed v/s Vehicle-Mounted Solar Systems

Parameter	Fixed Solar System	Vehicle- Mounted Solar System
Mobility	No	Yes
Shading Issues	High	Can be avoided
Installation	Permanent	Portable
Flexibility	Limited	High
Emergency Use	Limited	Excellent

Table 2: System Component Specifications

Component	Specification
Solar Panels	Polycrystalline, series- parallel configuration
Inverter	Luminous Solar PCU– NXT+ 3.75 KVA
MPPT Controller	In built within inverter
Buck Converter	In built within inverter
Battery Bank	Luminous Solar Tall Tubular, 150 Ah
Protection Device	Miniature Circuit Breaker (MCB)

Fig. 1: Block Diagram of Solar Implemented EV Charging System

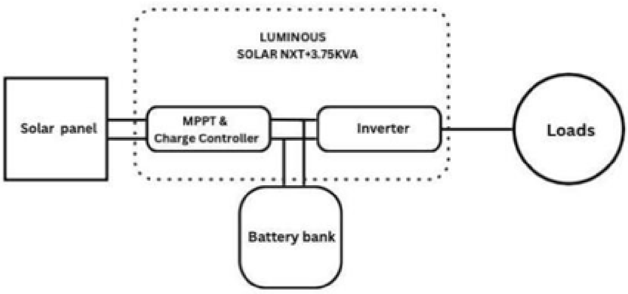

Fig. 2: Solar Panels

Fig. 3: MPPT Solar Charge Controller (Inbuilt)

Fig. 4: Buck Converter (Inbuilt)

Fig. 5: Battery Bank

Fig. 6: Solar Inverter

Fig. 7: Miniature Circuit Breaker

Fig. 8 Switch Board and EV Charging Outlet

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