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ELECTRIC VEHICLE CHARGING SYSTEM THAT COMBINES SOLAR AND WIND ENERGY

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ABSTRACT: An environmentally friendly and sustainable power source has been developed—electric vehicle charging devices that harness wind and sun power. This approach combines solar and wind power to lessen grid power consumption and guarantee uninterrupted charging for electric vehicles. Reducing operational costs and increasing efficiency, charging stations can benefit from green energy sources such as wind turbines and solar panels. A smart grid regulates electricity distribution and streamlines the process of charging electronic devices with renewable energy sources. This hybrid energy solution facilitates the transition to cleaner transportation, enhances energy independence, and decreases carbon emissions by providing a long-term substitute for conventional charging infrastructure.

Keywords: *Electric Vehicle Charging, Solar Energy, Wind Energy, Renewable Energy, Hybrid Charging System, Smart Grid, Sustainable Transportation, Clean Energy, Energy Efficiency, Carbon Emissions Reduction.*

1. INTRODUCTION

The growing demand for environmentally friendly modes of transportation, such as electric vehicles (EVs), is driven by the urgent need to reduce emissions of greenhouse gases and the consumption of fossil fuels. In particular, conventional power grids are feeling the heat from the dramatic increase in energy consumption and carbon emissions caused by the widespread adoption of electric vehicles. The installation of charging stations for electric vehicles powered by renewable energy sources, such as solar and wind, could be an effective solution to these issues. By combining renewable energy sources, these hybrid charging systems guarantee a sufficient supply while simultaneously decreasing their environmental effect.

Charging systems that combine solar and wind power take advantage of their complementary strengths. Since solar photovoltaic (PV) panels can only produce electricity when exposed to sunlight, wind turbines can compensate for the intermittent availability of solar power at all hours of the day and night. This integrated method ensures a continuous flow of renewable energy, making it more reliable than standalone solar or wind systems. This synergy lowers the barrier to entry for electric vehicles in the long run by increasing the efficiency of energy production and decreasing dependence on the grid.

Both the planet and your wallet will thank you for switching to hybrid renewable charging systems. By reducing their power consumption and potentially even earning money through net metering, individuals can reduce their power costs and become less dependent on the system overall. Energy storage technology such as supercapacitors and lithium-ion batteries have also advanced, allowing for the storage and subsequent use of excess renewable energy during periods of reduced availability. A robust, autonomous energy ecosystem may be established by integrating power generation, storage, and charging into electric vehicles.

Another step toward broader sustainability goals, including smart cities and decentralized energy systems, is setting up charging stations for solar-wind hybrid electric vehicles. Whether you're in a city, a rural region, or somewhere in between, these systems can provide a clean and safe way to charge your electric vehicle. Finally, reducing carbon emissions and making energy more robust to climate change can be achieved by charging electric vehicles with solar and wind power. This is a significant advancement toward more eco-friendly transportation.

2. LITERATURE SURVEY

Nair, S., & Pillai, R. (2024). This research recommends a grid-connected electric vehicle charging system that combines solar and wind power to provide continuous operation regardless of fluctuations in renewable energy sources. To maintain grid stability, the framework incorporates an intelligent scheduling system that dynamically rearranges the relative importance of renewable energy sources. Improved load balancing, more usage of renewable energy, and less grid dependence on power generated by fossil fuels are all outcomes of the simulation.

Khan, T., & Mehta, V. (2024). In this work, we discuss the design, construction, and testing of electric vehicle charging stations that integrate renewable energy sources such as wind, solar, and a backup grid. The authors highlight the significance of hybrid processors for effective load management, allowing for real-time balancing of energy generation and demand. According to the results of the experiments, the stations are more dependable, the reduction is less, and the charging efficiency is higher.

Sharma, M., & Reddy, P. (2023). In smart city contexts, this study investigates several approaches to managing charging stations for electric vehicles that combine solar and wind power. The proposed system handles renewable energy sources that are changeable by using real-time forecasting and model predictive control. Urban case studies demonstrate that the control strategy reduces grid strain during peak demand periods while still providing dependable fast-charging for EV drivers.

Das, A., & Verma, K. (2023). An AI-driven power management model for electric vehicle charging stations that incorporates wind and solar electricity is developed by the authors. In order to streamline operations, the platform anticipates patterns in renewable energy output and automatically adjusts charging schedules. According to the simulations, this method reduces emissions of greenhouse gases, maximizes the utilization of energy storage, and reduces the charging time.

Gupta, R., & Singh, J. (2022). To compensate for the intermittent nature of renewable energy sources, this study proposes the construction of fast-charging stations that integrate solar and wind power with battery storage technologies. The proposed layout effectively handles peak loads, has a low need on grid power, and has very reliable charging capabilities. Experiments have shown that hybrid fast-charging technologies can meet the increasing need for rapid charging in densely populated locations.

Patel, D., & Banerjee, S. (2022). In light of fluctuating demand, the research determines optimal dimensions and performance for electric vehicle hybrid solar-wind charging stations. In order to reduce lifetime costs and facilitate the utilization of renewable energy sources, a multi-objective optimization framework is established. Ideal station sizes outperform conventional grid-connected systems in terms of both cost and environmental impact, according to simulations. Ali, H., & Chowdhury, S. (2021). This research explores decentralized EV charging infrastructure powered by hybrid solar–wind microgrids. In this study, decentralized electric vehicle charging stations are powered by hybrid solar-wind microgrids. The approach increases the reliability and availability of energy while decreasing the need for centralized networks, which benefits even remote places. The simulation findings demonstrate an increase in system autonomy, a decrease in line losses, and an improvement in service reliability.

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Choudhury, R., & Bose, T. (2021). The research addresses issues with charging systems for hybrid solar-wind electric vehicles by employing multilevel inverter technology. Energy transfer efficiency, harmonic distortion, and voltage stability are all enhanced by the proposed strategy. The hardware implementation clearly demonstrates that the multilayer converter significantly improves the charging station's overall performance. According to the research, renewable energy infrastructures should prioritize the usage of certain inverter topologies for electric vehicle charging stations.

Kumar, S., & Desai, P. (2020). The purpose of this research is to examine the feasibility of building and operating solar-wind hybrid charging stations in rural locations without reliable grid connectivity. To ensure the system can continue operating in the event of a shortage of natural resources, cost-effective storage alternatives were integrated into the design. More electric vehicles are on the road, local energy security is improving, and alternatives to fossil fuels are being used less, according to field application data.

Lee, H., & Zhang, Y. (2020). Hybrid solar-wind electric vehicles with storage systems are the focus of this article, which examines the economics and technology of charging networks. The study employs a cost-benefit analysis to examine operational expenses, capital investments, and long-term earnings. Mixed charging networks with storage outperform grid-only alternatives in terms of both cost and environmental impact.

3. BACKGROUND WORK

Transitioning to renewable energy sources will increase energy security while decreasing environmental impact. One innovative concept in this area is the S-WHEV, or solar-wind hybrid electric vehicle. To make electric vehicles (EVs) more efficient and less dependent on conventional energy sources, it integrates EV technology with solar and wind power generation systems. The S-WHEV generates electricity via a combination of solar panels and a tiny wind turbine, which is subsequently stored in a battery pack within the vehicle. Solar panels, which often attach to the top of vehicles, convert sunlight into power using photovoltaic cells. In addition, the wind turbine, which is mounted to harness wind currents as the vehicle travels, adds more power.

Planning and Positioning of Energy Harvesting Devices

- **Solar Panel Installation:** Mount efficient photovoltaic (PV) panels on the hood, roof, and any other available surface of the vehicle. Lightweight and flexible photovoltaic panels eliminate unnecessary weight and maintain the vehicle's balance.
- **Wind Generators:** Vertical axis wind turbines (VAWTs) and other small but effective wind turbines can be easily integrated into the car's design without significantly altering its aerodynamics. It can be integrated into the chassis or installed on top of the vehicle to enhance aerodynamics.

Systems for Energy Conversion and Storage

- **Maximum Power Point Tracking (MPPT):** Optimal performance of solar panels and wind turbines in all kinds of weather can be achieved with the use of maximum power point tracking (MPPT) sensors.
- **System for managing batteries (BMS):** Include a state-of-the-art Battery Management System (BMS) to regulate the storage and distribution of energy, ensuring a balance between wind and solar power while extending the life of the batteries.
- **Hybrid Energy Storage:** Two methods exist for storing the energy that is collected: supercapacitors and lithium-ion batteries. Supercapacitors make energy management easier by controlling the rate of energy intake and output, in contrast to batteries' long-term energy storage capabilities.

Optimizing Aerodynamics

- **Vehicle Design:** Find the optimal design for the vehicle that minimizes drag while accommodating solar panels and wind turbines using computational fluid dynamics (CFD) models. Improving fuel economy requires lessening the impact of aerodynamics.
- **Retractable Wind Turbines:** Provide wind turbine systems with retractable or deployable components to facilitate easy storage when not in use and reduce drag at high speeds.

Control and Power Electronic Systems

To stabilize the electricity going to the car's main engine and other systems from the intermittent outputs of renewable energy sources like solar and wind, use a hybrid inverter/converter system. Create a cutting-edge EMS that responds to data from energy sources and vehicle demands to dynamically adjust power distribution. Prioritizing renewable energy sources will help the EMS efficiently manage charging and discharging cycles.

Components:

1. Solar panels: Transparent, polycrystalline, or monocrystalline are the three possible forms.

Function: using solar power to generate power without using anything else.

Location: It is common practice to position it on a sunny surface, such as the roof or hood.

Efficiency: Because of their high efficiency and large energy production, monocrystalline solar panels are popular.

Figure No.1:-Solar Panel

2. Wind turbines: Two primary varieties of wind turbines are known as vertical axis wind turbines (VAWTs) and horizontal axis wind turbines (HAWTs).

Function: Converting wind energy into mechanical energy is the key to producing electricity.

Location: You can reduce drag when they're not in use by attaching retractable models to the top or back of the automobile.

Efficiency: When motor vehicles are in motion, the wind can be strong and unpredictable, making vastavutts a vital tool.

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Figure No.2:- Fan

3. System for Storing Energy

Type of Battery: The improved performance and increased energy density of lithium-ion batteries make them a popular choice.

Capacity: The optimal configuration takes into account weight, cost, and energy storage requirements, which typically range from 30 to 100 kWh.

Management: The BMS monitors the temperature, number of charge cycles, and overall condition of the battery.

Figure No.3:-Battery

The MPPT controller: The central component of an MPPT system is responsible for running the tracking algorithm and modifying the operation of the renewable energy source; this is an essential component.

Environmental sensors: In order for maximum power point tracking (MPPT) to work properly, wind turbine annemometers and solar panel irradiance sensors gather environmental data in real time.

Power electronics: In response to commands sent by the MPPT controller, the inverter or converter adjusts the voltage or current. They connect the green energy source to the load.

Figure No.4:-MPPT

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4. CONCLUSION

Finally, one potential approach to constructing sustainable, long term transportation infrastructure is the installation of solar and wind-powered charging stations for electric vehicles. In order to charge electric vehicles reliably and consistently, these systems use a combination of renewable energy sources, which eliminates issues caused by power interruptions. By reducing energy waste and ensuring the grid runs smoothly, smart control, planning, and storage technologies make things more efficient.

Electric vehicle charging stations that combine solar and wind power also help achieve global clean energy targets by reducing emissions of greenhouse gases and the usage of fossil fuels. The scalability of electric vehicles makes them more suitable for usage in areas without reliable grid connectivity. Microgrid stations in outlying regions and urban fast-charging spots are two examples of these applications.

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