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DESIGN AND IMPLEMENTATION OF SOLAR POWERED ADVERTISEMENT BOARD

[1] K. M. Dhenge, [2] Harsh Wasnik, [3]Manswi Dhanvijay,[4]Kanchan Yuwanate,
[1]Assistant professor, [2]UG Student, [3]UG Student, [4]UG student
[1] Department of Electrical Engineering,
[1]K.D.K. College of Engineering, Nagpur ,Maharashtra, India

Abstract: This paper outlines the design, development, and installation of a solar-powered advertisement board as an environmentally friendly and cost-effective means of replacing electric-powered signage. As the demand for energy-efficient solutions increases and the price of electricity continues to rise, it has become vital to incorporate renewable energy sources in commercial uses. This project revolves around using solar energy to drive advertisement boards and minimize the use of grid electricity and reducing environmental footprint. The system comprises photovoltaic (PV) panels for generating energy, a charge controller for effective power management, a battery storage device for sustained operation, and an LED screen for content display. Energy efficiency, ruggedness, and cost-effectiveness are the key considerations in the design to guarantee sustained usage. By conducting extensive tests and analysis, the performance of the system is quantified under varying environmental conditions. The findings reveal that solar-powered advertisement boards can function efficiently with little maintenance, and they are a viable option for contemporary advertising purposes. This research is an addition to the development of green technology in digital advertising, encouraging the use of renewable energy for commercial and public display applications

Keywords **- solar energy, advertisement, LED display**

I. INTRODUCTION

In today's fast-paced world, outdoor advertising plays a vital role in commercial promotions and public awareness campaigns. However, most advertisement boards rely on grid electricity, making them costly to operate and dependent on non-renewable energy sources. This project focuses on designing and implementing a solar-powered advertisement board that utilizes renewable energy to provide a more sustainable and cost-effective solution for digital advertising. As the demand for eco-friendly and energy-efficient technologies continues to rise, solar power has emerged as a viable alternative for powering modern display systems. This project integrates solar energy with advanced display technology to create an independent advertising board that does not rely on conventional power grids. Such an innovation is particularly advantageous in remote locations with limited electricity access, ensuring continuous operation while reducing environmental impact.

The primary objectives of this project include developing a highly energy-efficient solar-powered system, enhancing visibility through advanced technology, and reducing operational costs through minimal maintenance. By leveraging recent advancements in renewable energy and power management, the project aims to provide a scalable and practical solution for modern advertising needs.

This report details the system's design, including its hardware and software components, and highlights its key benefits, such as reduced electricity costs, sustainability, and adaptability across various advertising environments. With this innovation, the project contributes to a cleaner and more efficient future for digital advertising

II. LITERATURE REVIEW

A. O. Onokdar[1]

Onokdar et al. (2023) explored the development of a solar-powered mini billboard that integrates a three-phase power system for improved efficiency. Their research highlights the use of photovoltaic (PV) panels, battery storage, and an automatic control system to optimize energy consumption. The study demonstrated that solar-powered advertisement boards can function effectively in off-grid locations, reducing operational costs and environmental impact. Their findings emphasize the importance of efficient energy storage and power management for prolonged functionality in diverse weather conditions

A.K. Singh[2]

Singh et al. (2017) investigated the role of solar charge controllers in renewable energy applications, focusing on Pulse Width Modulation (PWM) and Maximum Power Point Tracking (MPPT) technologies. Their study revealed that MPPT-based controllers significantly improve energy efficiency by dynamically adjusting voltage and current levels from solar panels. This research is relevant to the solar-powered advertisement board project, as an efficient charge controller ensures stable energy supply, enhances battery lifespan, and reduces power wastage.

P. Gaurkhede[3]

Gaurkhede et al. (2022) examined the use of solar energy for wireless LED display boards, emphasizing its benefits in public information dissemination and advertising. Their study focused on P10 LED modules, which provide high brightness and low power consumption, making them ideal for outdoor applications. The research concluded that integrating solar energy with LED displays enhances visibility, ensures reliability in remote locations, and significantly lowers maintenance costs. Their findings validate the feasibility of solar-powered advertisement boards as a cost-effective and sustainable solution for digital advertising.

III. METHODOLOGY

1. Block Diagram and Working

The block diagram of the advertisement board powered by the sun offers a straightforward presentation of the design and structure of the system. It presents the path of energy from the solar panels to the advertisement display unit with notable elements such as the charge controller, battery storage, voltage regulator, and control unit. Charge controller is responsible for controlling the supply of power and charging the battery to the level that it must be protected against overcharging and deep discharge. Buck converter does the voltage regulation, while display functions are dealt with by control unit to permit smooth operation of the LED display

The fig no.1 illustrates a diagrammatic guide to how the different parts are interconnected and their functions towards the smooth working of the advertisement board.

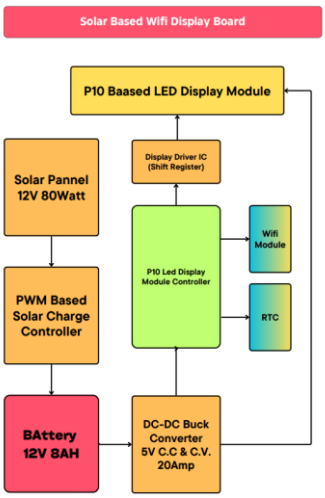

fig no.1

The project begins with extensive planning to determine the feasibility of energizing an LED advertisement board with solar power. The primary considerations are energy needs, component selection, climatic

conditions, and integration of the system. The board must function under varying climatic conditions with constant operation, especially during nighttime when there is no solar power.

The initial step is to calculate the overall power demand of the ad board. The display, controllers, and the related electronics require a constant power supply, which will be obtained from solar power only. A block diagram is drawn to visualize the system layout and identify how different components will interact with one another. This diagram serves as a reference point, giving a distinct integration of the solar panel, charge controller, battery storage, voltage regulators, and display screen.

The climate contributes heavily to determining the system design. Because the ad board is to be outdoors, sunlight availability, weather, and component durability receive special considerations. The solar panel tilt angle and location are designed to ensure the highest exposure to sunlight throughout the day in order to ensure a constant flow of energy

2. Component Selection

The accurate choice of components is a crucial aspect of guaranteeing the efficiency, reliability, and long-term performance of the solar-powered advertisement board. Due to the fact that the system is run using renewable energy, components need to be chosen that not only deliver maximum energy efficiency but also perform under optimal performance in various environmental conditions. Every component is tested according to pivotal factors such as performance

2.1 Solar panel

The solar panel is the fundamental power supply mechanism of the system, converting sunshine into electricity courtesy of photovoltaic (PV) cells. The solar panel is selected depending on various conditions,

i. Power Output (Wattage**):** The panel must generate sufficient power to meet the energy demands of the LED display and supporting electronics. A high-wattage panel is chosen to ensure that the system operates effectively throughout the day while also charging the battery for nighttime use.
ii. Efficiency: Higher efficiency panels convert more sunlight into electricity, making them ideal for locations with limited sunlight exposure.
iii. Durability**:** The panel must be able to withstand extreme weather conditions, including high temperatures, rain, and dust. A weather-resistant and corrosion-proof panel is selected to ensure longevity.
iv. Mounting and Positioning**:** The panel is installed at an optimal angle to receive maximum sunlight throughout the day. Proper positioning enhances power generation and system efficiency.

The solar panel ensures that the advertisement board functions independently without relying on external electricity sources, making it a sustainable and cost-effective solution.

2.2 Solar Charge Controller

The charge controller regulates the flow of electricity from the solar panel to the battery and prevents damage caused by overcharging or deep discharging. This component plays a crucial role in ensuring efficient power management and extending the lifespan of the battery.
There are two main types of charge controllers considered for this project

i. Pulse Width Modulation (PWM) Charge Controller**:** A cost-effective and simple option. Regulates battery charging by reducing excess voltage. Less efficient than MPPT controllers but suitable for small-scale applications.
ii. Maximum Power Point Tracking (MPPT) Charge Controller**:** More advanced and efficient than PWM controllers.

Adjusts the voltage to optimize power extraction from the solar panel. Improves overall efficiency by 20-30%, making it ideal for this project. Given the benefits of higher energy conversion and better battery performance,
An MPPT charge controller is chosen for the system.

2.3 Battery Storage System

A rechargeable battery is an essential component, as it stores excess solar energy during the day and supplies power to the advertisement board at night or in low-light conditions. The battery selection is based on several factors:

Capacity (Ampere-hour, Ah / Watt-hour, Wh): The battery must have enough storage capacity to power the LED display for extended hours when solar energy is unavailable.
Depth of Discharge (DoD): Batteries that allow deeper discharge cycles without losing efficiency are preferred to ensure long-term performance.
Lithium-ion batteries: More efficient, lightweight, and longer-lasting but costlier than lead-acid batteries. For this project, a lithium-ion battery is chosen due to its superior efficiency, longer lifespan, and faster charging capability. The battery is connected to the charge controller, ensuring stable energy storage and regulated power distribution to the LED display

2.4 Buck Converter

A buck converter is an essential voltage regulation device that lowers the battery voltage to a level suitable for powering the LED display and other electronic components. This regulation ensures the system operates within safe voltage limits while optimizing energy efficiency and reducing unnecessary power loss.

The buck converter functions by:

i. **Utilizing an inductor for energy storage** – It temporarily stores electrical energy in an inductor before gradually releasing it at a lower voltage.
ii. **High-frequency switching mechanism** – The system rapidly alternates between on and off states, maintaining a consistent output voltage.
iii. **Maximizing energy efficiency** – By minimizing power wastage, the converter ensures that a larger portion of the available energy is utilized effectively.

By integrating a buck converter, the system can regulate voltage efficiently and prevent electrical damage to components

2.5 P10 LED Display Module

The P10 LED module is chosen for the advertisement display due to its high brightness, energy efficiency, and durability in outdoor environments. This module is particularly well-suited for digital signage as it delivers clear and vivid visuals while consuming minimal power. The selection of the P10 LED module is based on several key factors:

i. **Superior Brightness and Contrast** – The display is designed to remain clearly visible even in direct sunlight, with a high contrast ratio ensuring sharp and legible content.
ii. **Energy Efficiency** – Compared to conventional billboards, this LED module requires significantly less power, making it an ideal choice for solar-powered applications.
iii. **Weatherproof Design** – Built to withstand harsh conditions, the module is both waterproof and dustproof, ensuring uninterrupted operation in various climates.
iv. **Extended Lifespan** – With a lifespan exceeding 50,000 hours, the P10 LED module offers long-term reliability and requires minimal maintenance.

2.6 HD-WF1 LED Controller

The HD-WF1 controller plays a crucial role in managing the LED display and handling the advertisements shown on the board. It is selected for its advanced connectivity, compatibility, and customization features, making advertisement management seamless and efficient

i. **Remote Connectivity** – With Wi-Fi and USB support, advertisements can be updated remotely, eliminating the need for manual adjustments.
ii. **Software Integration** – The controller is compatible with HD2020 software and the Led Art mobile application, providing an easy-to-use interface for content management.
iii. **Versatile Display Features** – It supports multiple formats, including scrolling text, static images, and animated visuals, allowing for dynamic and engaging advertisements.

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The strategic selection and integration of these components result in an energy-efficient, cost-effective, and reliable solar-powered advertisement board. Each element plays a key role in optimizing performance—from solar energy generation and storage to display control and content management. By utilizing high-efficiency solar panels, advanced charge controllers, and a robust LED display, the system ensures continuous operation with minimal energy costs. The fusion of renewable energy and smart technology makes this project a scalable and sustainable solution for modern outdoor advertising.

3. Building the System

The development of the solar-powered advertisement board involves systematically assembling and integrating all selected components to create a fully operational system. This process requires careful planning to ensure proper electrical connections, structural stability, and efficient power management. The construction follows a step-by-step approach, where each component is securely installed and thoroughly tested to verify its functionality before final integration.

3.1 Installation of the Solar Panel

The solar panel is installed in a location that ensures maximum exposure to sunlight throughout the day, optimizing energy generation. To achieve this, the panel's angle and direction are carefully determined based on the geographic location, allowing it to capture the highest amount of solar energy. It is securely mounted on a durable metal frame, providing stability and ensuring it can withstand harsh environmental conditions such as wind, rain, and dust. Proper ventilation around the panel is maintained to prevent overheating and enhance overall efficiency. Once the installation is complete, a meter is used to measure the panel's output voltage and current, verifying that it generates the expected power and operates efficiently within the system.

3.2 Connecting the Solar Charge Controller and Battery

After installing the solar panel, it is connected to the solar charge controller, which plays a crucial role in regulating the flow of electricity to the battery. This step is essential to prevent overcharging and deep discharging, both of which can significantly reduce the battery's lifespan. The connection process begins by linking the solar panel to the charge controller, allowing it to regulate the incoming voltage efficiently. Next, the battery is wired to the controller to ensure safe charging and proper power storage for later use. Based on the battery type—whether lithium-ion or lead-acid—the charge controller is configured to optimize charge cycles. Once the system is set up, a voltage meter is used to test the connections, ensuring the battery is charging correctly and power regulation is functioning as expected. To enhance durability and safety, all electrical connections are properly insulated and weatherproofed, protecting the system from short circuits and environmental damage.

3.3 Integrating the Buck Converter

Since the LED display operates at a lower voltage than the battery's output, a buck converter is integrated into the system to step down the voltage to the required level. The installation process begins by connecting the converter to the battery's output, allowing it to receive the higher voltage and regulate it accordingly. The output voltage is then carefully adjusted to match the LED display's power requirements, ensuring compatibility and efficient operation. A multi-meter is used to verify the voltage output, guaranteeing stable regulation and preventing fluctuations. This step is crucial in avoiding overvoltage issues, protecting the LED display from potential damage, and ensuring reliable performance

3.4 Mounting and connecting the P10 LED Display

The P10 LED module functions as the primary advertising display and must be securely mounted to ensure both visibility and durability. The installation process starts with attaching the LED panel to a sturdy frame capable of withstanding outdoor environmental conditions such as wind, rain, and dust. The LED module is then connected to the HD-WF1 controller, which is responsible for managing the display content and ensuring smooth operation. To provide a stable power supply, the LED screen is linked to the buck converter's output, which regulates the voltage to a safe operating level. The display is then tested under different lighting conditions to check for uniform brightness and clarity. Finally, the system is powered on to confirm that the display receives electricity and functions as expected, ensuring proper operation for advertising purposes

3.5 Setting Up the HD-WF1 LED Controller

The HD-WF1 controller plays a crucial role in managing the content displayed on the LED screen, ensuring seamless operation and efficient advertisement updates. The setup process begins with connecting the controller to the LED display using HUB75E ports, allowing it to communicate and control the visuals effectively. Next, the HD2020 software and Led Art app are installed on a computer or mobile device, providing an intuitive interface for configuring and managing display content. The display settings, including brightness, refresh rate, and scrolling speed, are carefully adjusted to optimize visibility and performance. Advertisements are then uploaded via Wi-Fi or USB, enabling quick and flexible content updates without manual intervention. Once configured, the controller undergoes testing to ensure that it correctly processes and displays the advertisements as intended, providing a smooth and reliable advertising experience.

3.6 Final Electrical Testing and Safety Checks

Before the system is fully deployed, it undergoes a series of electrical tests to ensure stability, efficiency, and safe operation. The process begins with checking all electrical connections to confirm that there are no loose wires or short circuits that could affect performance. The power flow is then tested, tracing the energy path from the solar panel to the battery, charge controller, and LED display, ensuring seamless energy transfer. To maintain efficiency, energy consumption is measured to verify that the system operates within expected power limits, preventing unnecessary energy loss. Additionally, all exposed connections are insulated and

waterproofed to safeguard against environmental factors like moisture and dust. If any issues are detected during testing, they are resolved before proceeding with deployment to guarantee a reliable and long-lasting solar-powered advertisement board.

IV. ADVANTAGES

Eco-Friendly – Uses solar energy, reducing reliance on conventional power sources.
Cost-Effective – Eliminates electricity costs, offering long-term savings.
Reliable & Self-Sustaining – Operates independently, even in remote locations.
Low Maintenance – Durable components with minimal upkeep required.
Remote Content Updates – Supports Wi-Fi and USB for easy advertisement changes.
Weather-Resistant – Designed to withstand outdoor conditions like rain and dust

V. APPLICATIONS

Highways & Roadsides – For billboards and traffic information displays.
Public Spaces – Parks, bus stops, and railway stations for public awareness.
Commercial Areas – shopping malls, retail stores, and business advertisements.
Educational Institutions – Campus announcements and event promotions.
Remote & Rural Areas – Advertising where grid electricity is unavailable

VI. RESULT

The solar-powered advertisement board was successfully implemented and tested under real-world conditions. The system effectively generated sufficient power from the solar panel**,** ensuring stable operation throughout the day and providing uninterrupted power supply at night through battery storage. The LED display maintained high visibility and clarity, making advertisements easily readable under different lighting conditions. The voltage regulation system worked efficiently, preventing power fluctuations and ensuring the longevity of components. The ability to update advertisements remotely via Wi-Fi and USB added convenience and flexibility. The system operated smoothly in various weather conditions, confirming its durability and reliability for long-term outdoor use.

VII. CONCLUSION

The project demonstrates that a solar-powered advertisement board is an energy-efficient, sustainable, and cost-effective solution for modern outdoor advertising. By utilizing renewable energy, it eliminates electricity costs and provides a self-sustaining operation. The system's low maintenance requirements and ability to function in remote areas make it a practical alternative to traditional electric-powered billboards. The successful implementation suggests that this technology can be widely adopted for urban, rural, and commercial advertising needs, offering an eco-friendly and scalable approach to digital advertising.

VIII. REFERENCES

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