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Optimization of Renewable Energy System for Charging of Battery

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Abstract - The increasing energy demand has led to the development of various renewable energy sources such as solar and wind power. In this study, we propose an optimized system for charging a battery using solar and wind power to meet the energy needs of households and small businesses. The proposed system consists of solar panels, wind turbines, and a battery bank that stores the generated energy. We employ a control algorithm to optimize energy generation that determines the optimal operation of the solar panels and wind turbines based on the available weather forecast data. The algorithm also regulates the charging and discharging of the battery to ensure that the energy is utilized efficiently. The performance of the proposed system was evaluated through simulations using real weather data. The results show that the optimized system is capable of meeting the energy demands of households and small businesses while reducing the dependence on grid power. The proposed system also has the potential to reduce carbon emissions and improve the environmental sustainability of the energy sector.

Key Words: solar panel, Wind setup, Power converters, Battery

1. INTRODUCTION

Optimizing the use of renewable energy for charging batteries has become an important topic in recent years due to the increasing demand for sustainable energy solutions. With the world's growing concern about climate change and the need for reducing carbon emissions, renewable energy sources such as solar and wind power have gained significant attention [1]. These sources of energy have the potential to replace traditional fossil fuels and provide a cleaner and more sustainable energy supply [2]. Various techniques and technologies are being developed and implemented to optimize the use of renewable energy for charging batteries. These include energy storage systems, power electronics, and advanced control strategies that efficiently integrate renewable energy sources into the grid.[3] These technologies not only help to maximize the utilization of renewable energy but also ensure the stability and reliability of the power supply Optimizing renewable energy for charging batteries is a complex task that requires a comprehensive understanding of the energy system, the battery technology, and the power electronics involved. It also requires careful consideration of various factors such as weather conditions, energy demand, and battery capacity. By developing and implementing innovative technologies and strategies, it is possible to achieve optimal utilization of renewable energy and ensure a sustainable energy future.

2. HARDWARE SETUP

In this section, the hardware components required for the development of a Renewable energy system for charging batteries and their working will be illustrated.

2.1 Hardware components:

Solar Panels: High-efficiency solar panels are required for converting solar energy into electrical energy. The number of panels will depend on the power requirement and the available space. Charge Controller: A charge controller is required to regulate the charging of the battery [4].

Battery: Deep-cycle batteries are preferred for renewable energy systems. The battery capacity should be sufficient to meet the power requirements during periods of low sunlight. *Inverter*: An inverter is required to convert the DC output from the battery to the AC output for running electrical devices.

MPPT Fuzzy Logic Controller: The MPPT fuzzy logic controller is used to optimize the power output of solar panels. It calculates the maximum power point of the solar panels and adjusts the output voltage and current accordingly[5].

Sensors: Sensors such as temperature, irradiance, and voltage sensors are required to monitor the system's performance and provide feedback to the MPPT fuzzy logic controller. Cables and Connectors: High-quality cables and connectors are required for connecting the various components of the system. Mounting Structures: Mounting structures are required to install solar panels and other components of the system. By using the above hardware setup, a renewable energy system can be optimized for Charging a battery using MPPT fuzzy technique. This system can be used for off-grid applications such as remote locations, camping, and emergency backup power.[6]

3. WORKING

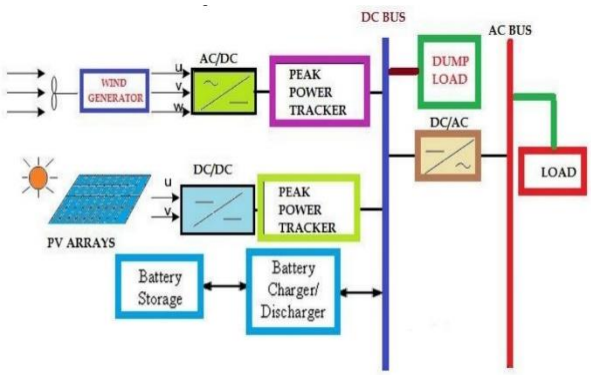

Fig-1. Block architecture of optimization of renewable energy for charging a battery.

The block architecture is shown in Fig. 3. Renewable energy systems can be optimized for charging batteries by utilizing various techniques such as improving energy efficiency, reducing losses, optimizing the system design, and using advanced control algorithms. The following steps can be followed to optimize a renewable energy system for battery charging: Assess the Energy Needs: The first step in optimizing a renewable energy system is to understand the energy needs of the battery. This includes the power and energy requirements of the battery, the expected charging time, and the discharge rate. Determine the Renewable Energy Source: The next step is

SI.NO	COMPONENTS	RANGE/TYPE	QUANTITY
1	Battery	12V	1
2	Microcontroller	8 bit 80C51	1
3	Boost Converter	DC-DC	1
4	MOSFET Switch	Ir840	1
5	Diode	IN408	1
6	Capacitor	63V,100mf	1
7	Solar Panel	12V	1
8	Wind Setup	12V	1

to select the appropriate renewable energy source for charging the battery. This could be solar, wind, hydro, or a combination of these sources. Optimize the System Design: The system design can be optimized by selecting the most efficient components such as inverters, charge controllers, and batteries. The system can also be optimized by reducing losses such as shading, cable losses, and voltage drops. Use Advanced Control Algorithms: Advanced control algorithms can be used to optimize the energy flow and maximize the battery charging efficiency. These algorithms can include Maximum Power Point Tracking (MPPT), which optimizes the solar panel output, and Battery Management Systems (BMS), which monitor and controls the battery charging process. Monitor and Maintain the System: Monitoring and maintaining the renewable energy system is critical for optimizing battery charging. Regular maintenance and monitoring can help detect and address any issues that may affect the performance of the system.

4. EXPERIMENTAL AND OBSERVATION

In this section, the experimental approaches made and the corresponding results obtained are presented.

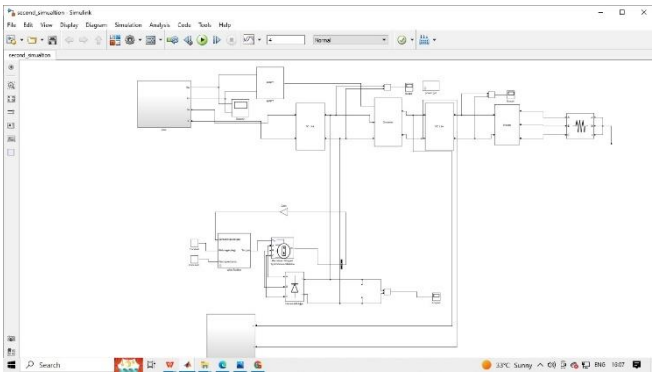

Fig-2. Code simulation in MATLAB Simulation

By using the MATLAB simulation, We placed the wind and PV cells according to the block architecture. We have given many internal connections by placing the power inverter at the output of the PV cell converted from DC to AC.

4.1 MATLAB Output

Fig-3. Solar Output in MATLAB Simulation

The above graph shows the output voltage, at the solar radiation 1000 DNI (Direct Nation Irradiation) we can find the voltage above the graph.

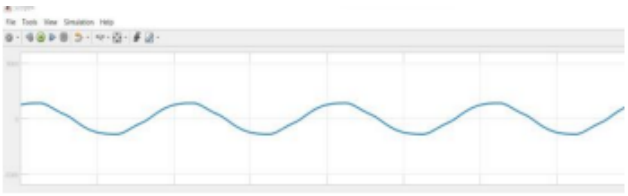

Fig-4. Final inverter output voltage waveforms The above graph is the final output of the voltage at the load, At the load, we can absorb the sinusoidal wave which means the AC supply

5. CONCLUSION

In conclusion, the optimization of renewable energy systems for battery charging has become an essential aspect of sustainable energy utilization. This approach reduces the dependence on fossil fuels and minimizes carbon emissions, resulting in a cleaner and greener environment. The use of advanced technology and efficient equipment in renewable energy systems is crucial to maximizing energy conversion and battery charging efficiency. Therefore, further research and development in this area can lead to the widespread adoption of renewable energy for battery charging, which is a significant step toward a sustainable future.

6. FUTURE SCOPE

The future scope of optimizing renewable energy systems for battery charging is vast and promising. With the increasing demand for sustainable energy sources, there is a need for efficient and cost-effective solutions. By harnessing the power of solar, wind, and other renewable sources, it is possible to create a robust system for charging batteries. This approach can reduce energy costs, lower carbon emissions, and increase energy independence. By leveraging cutting-edge technologies and innovative designs, renewable energy systems can be optimized to meet the evolving needs of consumers and businesses alike.

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