A Hybrid Model of Solar and Wind Power Generation System

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ABSTRACT:

This project presents the design and implementation of a hybrid solar-wind power generation system. The system generates electricity using solar photovoltaic (PV) pa nels and a wind turbine. Because solar energy is ava ilable during the day and wind energy may be availa ble at night or under cloudy conditions, combining s olar and wind energy increases the reliability and e fficiency of power generation. The generated power is managed by a charge. controller before being stored in a battery. An. inverter converts DC powe r into an AC supply for loads in homes or businesses. The hybrid system. reduces dependency on conventio nal fossil fuels while providing a clean, sustainable, and renewable energy source. In remote and rural areas without grid connectivit, the system perfor ms admirably.

Keyword- Hybrid Solar–Wind Power Generation System, Solar Photovoltaic (PV) System, Wind Energy Conversion System (WECS), Maximum Power Point Tracking (MPPT), Battery Energy Storage System, Renewable Energy Integration, Sustainable Power Generation

Literature Survey:

Hybrid Model of Solar and Wind Power Generation System:

Because of growing energy demand and environmental concerns, renewable energy sources have become increasingly important in recent decades. The most popular renewable energy sources are solar and wind. Both sources, though, have certain drawbacks. While wind power is dependent on wind speed, which varies throughout the day, solar power generation is dependent on the availability of sunlight. Researchers have suggested integrating both systems into a hybrid solar–wind power generation system in order to get around these restrictions.

Combining solar and wind energy sources enhances system reliability and power continuity, according to numerous studies on the performance of hybrid renewable energy systems. The combination helps balance power generation because wind energy may be

available at night or in cloudy conditions, while solar energy is typically available during the day. Because solar and wind energy complement each other, hybrid systems are more efficient than standalone ones. Combining solar and wind energy sources increases system reliability and power continuity, according to numerous studies on the performance of hybrid renewable energy systems. The combination helps balance power generation because wind energy may be available at night or in cloudy conditions, while solar energy is typically available during the day. They concluded that hybrid systems can provide reliable electricity, especially in rural and remote areas.

Yang et al. (2008) offered an ideal sizing technique for standalone hybrid systems, which was another significant contribution. To assess system dependability, they presented the idea of Loss of Power Supply Probability (LPSP). According to their research, proper battery storage, wind turbine, and solar panel sizing is crucial for lowering system costs while preserving a steady supply of electricity.

Control strategies and power electronic converters used in hybrid systems have also been the subject of numerous studies. To get the most power out of wind turbines and solar panels, Maximum Power Point Tracking (MPPT) techniques are frequently employed. To increase system efficiency in the face of changing weather, researchers have compared various MPPT techniques, including fuzzy logic control and Perturb and Observe (P&O).

Economic and environmental factors have also been examined in addition to technical performance. Numerous studies show that, especially in off-grid locations, hybrid systems are more economical in the long run than diesel generators. Additionally, hybrid renewable energy systems support sustainable development and drastically cut carbon emissions.

It is evident from the literature that hybrid solar-wind systems provide better energy efficiency, increased dependability, and environmental advantages. To improve overall system performance, more study is still required in the areas of intelligent forecasting, grid integration, and advanced control strategies.

Introduction:

The rapid depletion of fossil fuels, the growing need for electricity, and growing worries about the environment have all led to a rise in demand for renewable energy sources. Using coal, oil, and natural gas to make electricity is a major cause of greenhouse gas emissions and global warming. Because of this, eco-friendly and long-lasting options like solar and wind energy are becoming more and more popular around the world.

Two of the most plentiful and pure renewable energy sources are solar and wind. Both sources do, however, have certain drawbacks. Solar power generation depends on the amount of sunlight, which is also influenced by weather and operation at night. Similarly, wind energy is dependent on erratic and unpredictable changes in wind speed. Because of these variations, depending only on one renewable source may not guarantee a steady and dependable supply of electricity.

Component used:

Solar Panel: it converts solar energy into DC electrical energy.

Wind Turbine: It converts wind energy into DC Electrical energy

Rectifier: It converts DC into AC

Charge Controller: It is use to regulates the voltage and current from solar and wind power plant to batteries, preventing overcharging and damage.

Battery: It Stores electrical energy.

Inverter: It converts DC supply into AC.

Load: Lamp, fan, or small appliances.

Working of Hybrid Solar and Wind Power Generation System:

The Workings of a Hybrid Solar and Wind Power Generation System A hybrid solar–wind power generation system combines electricity from solar panels and wind turbines to power a shared load. The main reason for combining these two renewable energy sources is to ensure reliable and steady power generation across a variety of weather conditions.

Solar Power Generation:

Production of Solar Power The solar component of the system is comprised of photovoltaic (PV) panels. When sunlight hits the surface of the solar panels, the photovoltaic cells immediately transform solar energy into DC (Direct Current) electricity. This process is known as the photovoltaic effect. The amount of power generated depends on the sun's strength. Because solar output fluctuates depending on the weather and time of

day, a Maximum Power Point Tracking (MPPT) controller is commonly utilized. The MPPT controller ensures that the solar panel operates as efficiently and produces the maximum amount of power.

Wind Power Generation:

The wind energy system consists of a generator coupled to a wind turbine. When the wind blows, the turbine blades rotate. This mechanical rotation powers the generator, which converts mechanical energy into electrical energy. The design of the generator determines whether it can produce DC or AC (alternating current) power. The generated AC power must first be converted into DC using a rectifier before it can be combined with the solar output.

Power Condition and Control Unit:

The electricity produced by solar panels and wind turbines is usually in DC form after rectification. These outputs are connected to a common DC bus via charge controllers. The charge controller is responsible for controlling voltage and current. prevents battery overcharging and deep discharge. maintains system stability. If the system has MPPT controllers for both sources, they can operate independently and as effectively as possible.

Energy Storage System (BATTERY):

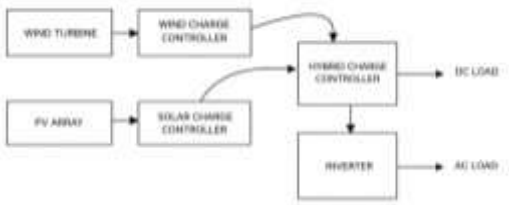
Most hybrid systems use a battery bank to store excess energy generated during periods of high production. For example: In sunny and windy conditions, batteries store extra energy. When there is little wind or sunlight, the load is driven by stored energy. This storage system ensures a consistent power supply and improves dependability.

Inverter and Load Supply:

Since most household and commercial loads require AC power, the battery's stored DC power is converted into AC using an inverter.

The required voltage and frequency are maintained constant by the inverter's DC to AC conversion. supplies power to the load. In grid-connected systems, the inverter also synchronizes with the grid and supplies extra power to the utility grid.

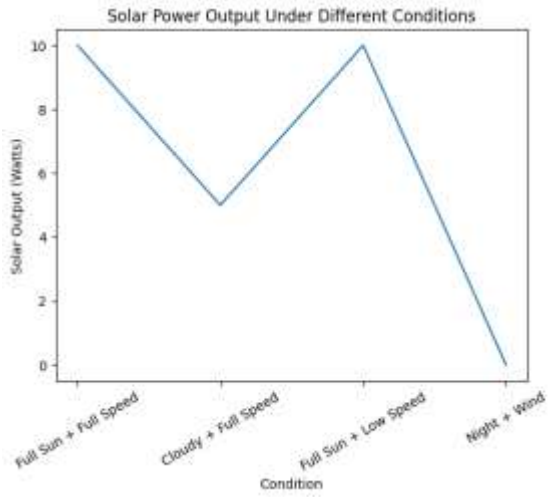
Circuit Diagram :



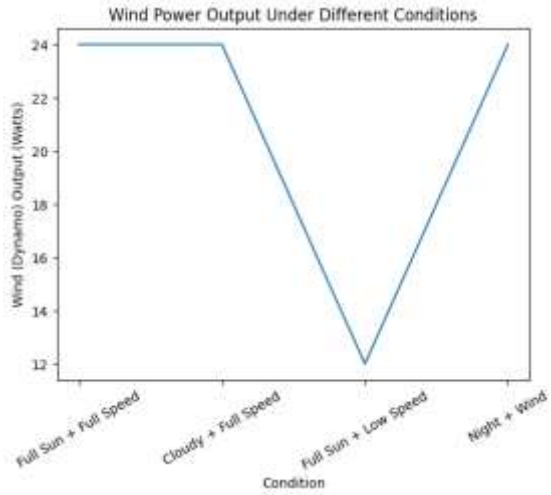
Observation and calculation:

Condition	Solar Output	Dynamo Output	Total Output
Full sun + full speed	10W	24W	34W
Cloudy + full speed	4–6W	24W	28–30W
Full sun + low speed	10W	10–15W	20–25W
Night + wind	0W	24W	24W

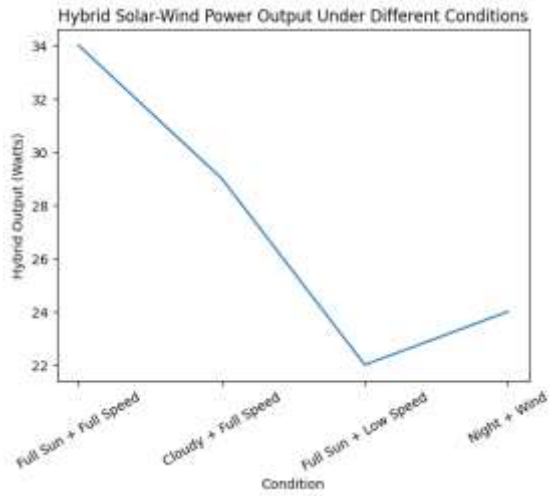
Solar output:



Wind output:



Hybrid output:



Results:

I. Continuous and reliable powersupply
II. Reduced dependence on fossil fuelsand diesel generators
III. Lower operating and maintenancecosts
IV. Reduced carbon emissions andenvironmental impact
V. Better utilization of renewableenergy resources
VI. Improved power availability in offgrid areas

Conclusion:

In conclusion, the hybrid solar–wind power generating system provides a reliable and sustainable energy solution by combining two complementary renewable energy sources. It reduces dependence on conventional energy sources, improves power availability, and has a smaller environmental impact. Due to its long-term cost-effectiveness and suitability for remote and rural locations, this system is a good way to meet future energy demands.

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