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SOLAR HYBRID POWER SYSTEM

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Abstract - *The Solar Hybrid Power System is an efficient and reliable method of generating electricity by combining solar energy with another power source such as wind energy, battery storage, or conventional power supply. The main objective of this project is to utilize renewable energy sources to produce clean electricity and reduce dependence on fossil fuels. Solar energy is one of the most abundant and eco-friendly sources of energy available in nature. However, solar power generation depends on sunlight availability, which may vary during cloudy weather or nighttime. To overcome this limitation, a hybrid system is developed that integrates solar panels with an additional energy source and battery storage to ensure continuous power supply.*

Key Words*: *Solar Hybrid power system, wind Energy, Solar Energy, eco-friendly*, *Power Generation

1.INTRODUCTION

A Solar Hybrid Power System is a system that combines solar energy with another power source such as batteries, grid electricity, or generators to supply continuous and reliable power. It uses solar panels to convert sunlight into electricity and stores extra energy in batteries for later use. When solar power is not enough (for example at night or during cloudy weather), the system automatically uses the backup power source. Solar hybrid power systems are becoming popular because they help reduce the use of fossil fuels and decrease electricity costs. They are especially useful in areas where electricity supply is irregular or where grid connection is not available. The system usually consists of solar panels, inverter, battery storage, charge controller, and sometimes a grid or generator connection. The main advantage of a solar hybrid power system is that it provides uninterrupted power supply while making use of clean and renewable solar energy. It also helps in reducing carbon emissions and protecting the environment. These systems are widely used in homes, industries, offices, and rural areas for reliable electricity generation. In conclusion, solar hybrid power systems are an efficient solution for modern energy needs because they combine renewable energy with backup sources to ensure a stable and sustainable power supply.

2. LITERATURE REVIEW

The development of Solar Hybrid Power Systems is closely associated with the evolution of solar photovoltaic (PV) technology and renewable energy integration. Initially, standalone solar systems were widely used; however, their dependency on sunlight limited their reliability. To overcome this issue, researchers introduced hybrid systems that combine solar energy with other power sources such as wind energy, battery storage, diesel generators, and grid supply.

Over the years, advancements in photovoltaic technology, energy storage systems, and intelligent control techniques have significantly improved the efficiency and reliability of hybrid systems. Modern hybrid systems are designed to ensure continuous power supply by integrating multiple energy sources and optimizing their operation through advanced control strategies.

Various research studies have been carried out to analyse the performance, design, and efficiency of solar hybrid systems:

Overall, the literature clearly indicates that solar hybrid power systems offer a reliable, efficient, and sustainable solution for modern energy needs. These systems reduce dependence on fossil fuels, minimize environmental impact, and ensure uninterrupted power supply, especially in rural and remote areas. Continuous research in energy storage, smart control systems, and renewable integration is expected to further enhance the performance and feasibility of hybrid power systems in the future.

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2.1 RESEARCH GAP

Most existing systems focus on either solar or solar-wind combinations, but lack proper integration and optimization of multiple energy sources for maximum efficiency.

There is a need for a simple, cost-effective, efficient, and practically implementable solar hybrid power system that ensures reliable power supply with minimal maintenance.

2.2 PROBLEM STATEMENT

The demand for electricity is increasing rapidly due to population growth, industrial development, and technological advancements. However, conventional energy sources such as coal, diesel, and natural gas are limited and contribute to environmental pollution.

Solar energy is a clean and renewable source, but it has a major limitation—it depends on sunlight and cannot generate power during night or cloudy conditions. This leads to intermittent and unreliable power supply, especially in rural and remote areas where grid electricity is not stable or unavailable.

To overcome these challenges, there is a need to develop a system that can:

- Provide continuous and reliable power supply
- Utilize renewable energy efficiently
- Reduce dependence on fossil fuels
- Be cost-effective and easy to maintain

Therefore, the problem addressed in this project is to design and develop a solar hybrid power system that integrates solar energy with other sources such as wind energy and battery storage to ensure uninterrupted, efficient, and eco-friendly power generation for small-scale applications.

3. OBJECTIVE

The main objectives of the Solar Hybrid Power System project are as follows:

1. To study the working principle of a solar hybrid power system.

2. To design and develop a hybrid system that combines solar panels, battery storage, and an inverter for efficient power generation.

3. To provide continuous power supply by storing solar energy in batteries for use during night or low sunlight conditions.

4. To reduce dependence on conventional electricity sources and promote the use of renewable energy.

5. To improve energy efficiency and reduce electricity costs for residential or small-scale applications.

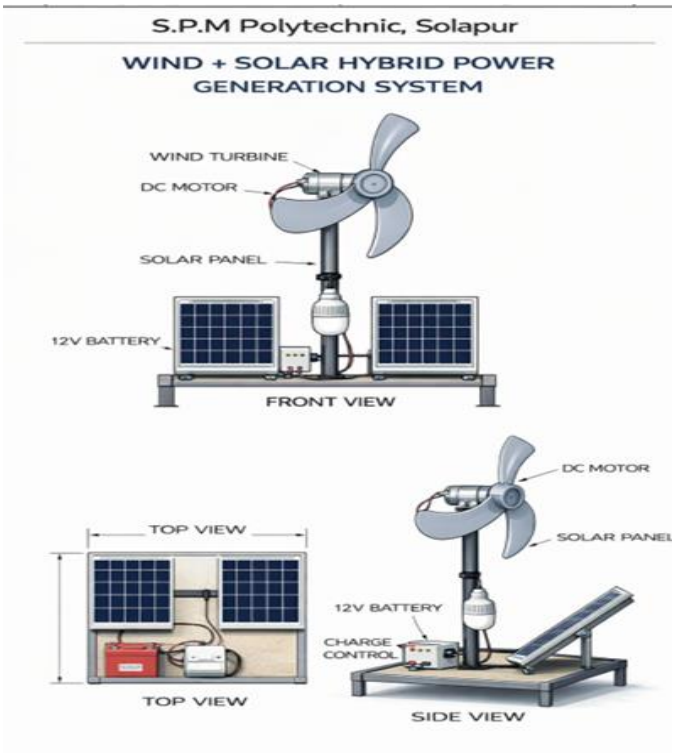
6. To develop an environmentally friendly system that reduces carbon emissions and pollution.

7. To understand the components and operation of solar power systems such as solar panels, charge controllers, batteries, and inverters.

4.METHODOLOGY

The solar hybrid power system works by converting solar energy into electrical energy and ensuring continuous power supply using backup sources. Solar panels generate DC power from sunlight, which is regulated by a charge controller and stored in a battery. The inverter then converts the stored DC power into AC power for running electrical loads. When solar energy is insufficient, the system automatically uses the backup source to maintain uninterrupted power supply.

5. DSIGN & 3D CAD MODEL



6. Material selection

Material selection plays an important role in ensuring the efficiency, durability, and cost-effectiveness of the solar hybrid power system. The materials are selected based on strength, availability, corrosion resistance, electrical properties, and economic considerations.

1. Frame Material

Material Used: Mild Steel (MS)

Reason:

High strength and durability

Easy to fabricate and weld

Low cost and easily available

2. Solar Panel

Material Used: Silicon-based photovoltaic cells

Reason:

High efficiency in converting sunlight to electricity

Long lifespan and low maintenance

3. Wind Turbine Blades

Material Used: Plastic / PVC / Aluminum

Reason:

Lightweight for easy rotation

Good resistance to environmental conditions

4. Shaft / Support Pipe

Material Used: Steel

Reason:

High mechanical strength

Supports turbine load and rotation

5. Battery

Type Used: Lead-acid battery (12V)

Reason:

Cost-effective

Reliable energy storage

Easily available

6. Electrical Wiring

Material Used: Copper wires

Reason:

High electrical conductivity

Low power loss

7. Inverter Components

Material Used: Electronic components (semiconductors, PCB)

Reason:

Efficient DC to AC conversion

Compact and reliable

8. Fasteners (Bolts, Nuts, Screws)

Material Used: Steel

Reason:

Strong and secure assembly

Easy installation and maintenance

The selected materials ensure that the system is strong, efficient, economical, and suitable for small-scale applications, while maintaining durability and ease of fabrication.

7.FABRICATION & ASSEMBLY

The assembly process of the solar–wind hybrid power model is carried out in several steps. First, a strong base frame is fabricated using mild steel square pipes and a wooden board to support the entire structure. The frame is welded properly to ensure stability. Next, a vertical metal pipe is welded at the center of the base frame. This pipe acts as the support structure for mounting the wind turbine and generator. After that, the wind turbine is assembled by attaching three blades to a central hub. The hub is connected to a DC motor which acts as a generator. The turbine assembly is then fixed at the top of the vertical pipe. Solar panels are mounted on the base board using bolts or brackets at an angle to capture maximum sunlight. The battery, switch board, and electrical wiring are installed on the base platform. Electrical connections are made between the solar panels, wind generator, battery, and load using insulated wires. Finally, the system is tested to ensure that the solar panels and wind turbine generate electricity properly and the output load such as LED light works correctly.

7.1 COMPONENTS USED IN MACHINE

1. Solar Panels Solar panels convert sunlight into electrical energy using photovoltaic cells.

2. Wind Turbine Blades The blades capture wind energy and rotate to produce mechanical motion.

3. DC Motor / Generator the DC motor converts mechanical rotation from the turbine into electrical energy.

4. Battery The battery stores electrical energy generated by the solar panels and wind turbine.

5. Support Frame The frame supports the entire structure and keeps all components stable.

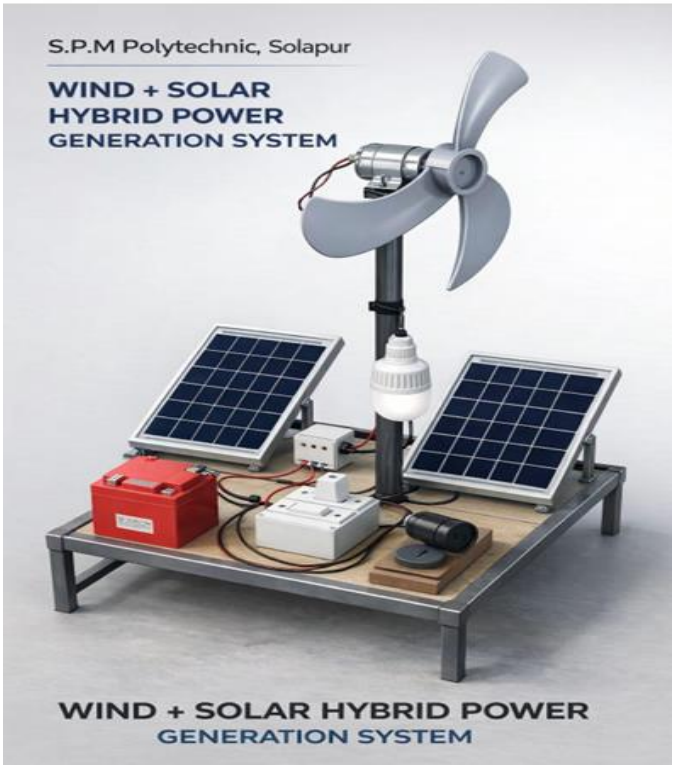
6. Vertical Shaft / Pipe The pipe holds the wind turbine at a suitable height for wind flow.

7. Electrical Wiring Wires connect all electrical components and allow the flow of current.

8. Switch Board The switch controls the electrical output and allows the load to be turned on or off.

9. LED Lamp / Load The LED lamp is used as a load to demonstrate the electricity generated by the system.

8.WORKING MODEL WITH WORKING PRINCIPAL



The Wind + Solar Hybrid Power Generation System works by combining two renewable energy sources—solar energy and wind energy—to generate continuous electrical power.

1. Solar Energy Generation

Solar panels convert sunlight into Direct Current (DC) electricity using photovoltaic cells. This energy is supplied to the system and also used to charge the battery.

2. Wind Energy Generation

The wind turbine rotates when wind flows over the blades. This rotational motion drives a DC motor (generator), which converts mechanical energy into electrical energy.

3. Energy Storage

Both solar and wind generated electricity are stored in a battery. The battery acts as an energy storage unit and supplies power when generation is low or unavailable.

4. Power Regulation

A charge controller regulates the voltage and current coming from both sources to protect the battery from overcharging and ensure safe operation.

5. DC to AC Conversion

The inverter converts stored DC power into Alternating Current (AC), which is used to operate electrical loads like bulbs, fans, and mobile chargers.

6. Power Supply to Load

The generated and stored energy is supplied to the load (LED bulb or appliances).

- During daytime → Solar panel provides power
- During windy conditions → Wind turbine generates power
- During night/low energy → Battery supplies power

This hybrid system ensures continuous and reliable power supply by utilizing both solar and wind energy, reducing dependence on conventional energy sources.

8.results

The Wind + Solar Hybrid Power System was successfully fabricated and tested under different operating conditions. The system was able to generate electrical energy from both solar and wind sources and store it efficiently in the battery.

During the daytime, the solar panels generated sufficient electrical power, while the wind turbine produced additional energy when wind was available. The hybrid system ensured a more stable and continuous power output compared to using a single energy source.

The generated energy was stored in a 12V battery and later used to operate electrical loads such as LED bulbs and mobile charging devices through an inverter. The system performed efficiently under varying environmental conditions and demonstrated reliable operation.

9. Application

The Wind + Solar Hybrid Power System has wide applications due to its ability to provide reliable and continuous power supply:

Used in rural and remote areas where grid electricity is not available

Suitable for residential homes for lighting and small appliances

Used in street lighting systems

Applicable in telecommunication towers

Used for charging mobile phones and small devices

Suitable for farms, small industries, and remote monitoring systems

Can be used as a backup power system during power cuts

10. Advantage & disadvantages

10.1 Advantages

Provides continuous power supply using two energy sources

Environment friendly (no pollution)

Reduces electricity bills

Uses renewable energy sources

Low operating and maintenance cost

Suitable for remote and off-grid locations

Increases system reliability and efficiency

10.2 Disadvantages

High initial installation cost

Battery requires periodic maintenance and replacement

System design is complex compared to single source systems

Output depends on weather conditions (sunlight & wind)

Requires proper installation and monitoring

11.CONCLUSION

The Wind + Solar Hybrid Power System is an effective and sustainable solution for electricity generation using renewable energy sources. The system successfully combines solar and wind energy to produce continuous electrical power.

It improves reliability, reduces dependence on conventional energy sources, and minimizes environmental pollution. The project demonstrates that hybrid systems can efficiently generate and store energy for small-scale applications such as lighting and mobile charging.

Overall, the system is economical in the long run and supports the development of clean and green energy technologies.

12.FUURE SCOPE

Use of high-efficiency solar panels to increase power generation Adoption of advanced batteries for better energy storage Integration of smart control and monitoring systems Expansion for large-scale and rural electrification projects Development of more efficient wind turbine designs

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