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# A Review On The Solar And Wind Hybrid System

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## Abstract

The Wind & Solar Hybrid System represents a sustainable and efficient approach to harnessing renewable energy from wind and solar sources. This innovative system combines the strengths of both wind and solar technologies to enhance overall energy production, improve reliability, and address the intermittency challenges associated with individual renewable sources. The integration of wind and solar components maximizes energy generation while minimizing environmental impact.

The Wind & Solar Hybrid System consists of interconnected wind turbines and solar panels, strategically designed to complement each other's energy production profiles. The system incorporates advanced control algorithms and smart grid technologies to optimize the utilization of available resources and ensure a consistent power output.

Keyword: Wind Turbine , Solar Panel , Solar Charge Controller , Wind Charge Controller , Battery , DC Load.

## 1. Introduction

The combination of renewable energy sources, wind & solar are used for generating power called as wind solar hybrid system. This system is designed using the solar panels and small wind turbines generators for generating electricity.

To better understand the working of solar wind hybrid system, we must know the working of solar energy system and wind energy system. Solar power system can be defined as the system that uses solar energy for power generation with solar panels. The block diagram of solar wind hybrid system is shown

in the figure in which the solar panels and wind turbine are used for power generation.

Wind energy is also one of the renewable energy resources that can be used for generating electrical energy with wind turbines coupled with generators.

Wind turbine can be defined as a fan consisting of 2 or 3 blades that rotate due to blowing wind such that the axis of rotation must be aligned with the

direction of blowing wind. A gear box is used for converting energy from one device to another device using mechanical method; hence it is termed as a high-precision mechanical system. There are different types of wind turbines, but the frequently used wind turbines are horizontal axis turbines and vertical axis turbines.

Solar Power system consists of three major blocks namely solar panels, solar photovoltaic cells, and batteries for storing energy. The electrical energy (DC power) generated using solar panels can be stored in batteries or can be used for supplying DC loads or can be used for inverter to feed AC loads. Solar Energy is available only during the day time whereas wind energy is available through out the day depending upon the atmospheric conditions.

Wind and solar energy are complementary to each other, which makes the system to generate electricity almost throughout the year. The main components of the Wind Solar Hybrid System are wind aero generator and tower, solar photovoltaic panels, batteries, cables, charge controller and inverter. The Wind - Solar Hybrid System generates electricity that can be used for charging batteries and with the use of inverter we can run AC appliances. Wind aero-generator is installed on a tower having a minimum height of 18 metres. From the ground level.

Because of the height, the aero-generator gets wind at higher speed and thereby generates more power.

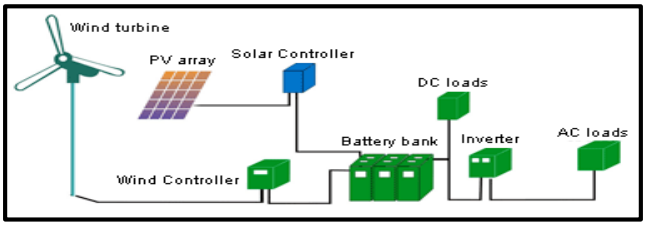


**Fig : 1.1** Block Diagram Of Solar And Wind Hybrid System

## 2. Literature Review

Scientific Studies: Numerous research articles and literature exist on the optimization, performance, and challenges of solar and wind hybrid systems.

Innovation: Ongoing research explores innovative approaches to improve the efficiency and reliability of hybrid renewable energy systems.

The utilization of hybrid solar wind is a necessity for the development of the country. The different researches were carried out on the development and performance assessment of the solar and wind hybrid system.

1. Makbul A.M. Ramli et.al presented a case study model on the hybrid solar and wind system on the techno-economic energy analysis in Saudi Arabia. The study is carried out for economic production for the electric using the hybrid system; the different parameters are taken into consideration for economic production.

2. Vikas Khare et.al presented the review on the HRES. The presented research concentrated on the different issues related with HRES such as optimum sizing, feasibility analysis, modeling, control aspects and reliability.

3. Binayak Bhandari et.al, in this paper author differentiates power produced from both the photovoltaic (pv) and wind turbine base on weather conditions. They found that by using storage system for backup we can improve the system and make it more convenien According to that they apply various optimization techniques for hybrid system & make component specifications according to that. Again they focus on the present scenario of environmental crises.

4. Renu Sharma et.al, this paper main focus is on rural development in India by using separate hybrid system. They study combinations of hybrid system for generating power. By calculating load demand for rural villages, load is divided into phase on that basis further analysis is done.

## 3. Problem Definition

The challenges faced by the renewable energy industry are many. Political pressures, government policies, corporate influence, age-old infrastructure, lack of proper battery storage system, and present market scenario stand in its way for a wider adoption worldwide.

Despite these factors, renewable energy has undertaken a global adoption as a means to alleviate climate change. It is free of direct pollution and carbon emissions. It is the most feasible substitute for fossil fuels. With time it is becoming an inevitable part of the mix of energy production.

### 3.1. The high initial cost of installation.

Carbon emissions are the main cause of global warming. Many efforts have been taken to increase its adoption. However, the cost is an important factor affecting its adoption. One of the stumbling blocks on the way to its development is the high initial cost of installation.

### 3.2. Lack of infrastructure

Wind and solar energy can be better investments when lifespan costs are considered. Lack of infrastructure is a barrier to renewable energy development. The present infrastructure is mainly built for fossil fuel plants and nuclear plants.

The existing energy infrastructure needs urgent reform as it is not capable of handling large amounts of renewable energy. Most importantly, some of its best sources are left with no infrastructure at all.

The main problem with the power grid is its age. Most electric transmission and distribution lines were constructed during the 1950s and 1960s. It has passed its 50-year life expectancy. Therefore, making them incompetent to meet the demand of the hour and the severe climatic changes.

### 3.3. Power Storage

Most importantly, the lack of power storage at an affordable cost is another drawback. Renewable energy sources generate most of their energy at certain times of the day. Its electricity generation does not match with the peak demand hours. The intermittency of sunshine and wind cannot provide an on-demand power source 24

hours a week. Solar energy and wind are unpredictable. There is volatility in generation and volatility in loads.

Energy generation by the burning of fossil fuels is more consistent. On the other hand, intermittent power generation by renewable energy sources poses a need for an efficient battery storage system. A battery storage system helps to store the surplus energy for later use. It can help with grid instability, thereby preventing blackouts. Technological advancement has improved the longevity and battery capacity of the storage system. Its high cost stands in its way of being wide installation. Battery prices have to come down to make storing of solar energy more cost-effective.

## 4. Components Of Wind – Solar Hybrid System

A solar and wind hybrid system combines both solar photovoltaic (PV) panels and wind turbines to generate electricity. This approach helps to harness renewable energy from two different sources, increasing overall system efficiency and reliability. Here are the key components of a solar and wind hybrid system:

### 4.1. Solar Photovoltaic (PV) Panels:

Function: Converts sunlight into electricity.

Details: Solar panels consist of semiconductor materials that generate a direct current (DC) when exposed to sunlight. Multiple panels are connected to form an array, and the size of the array depends on the energy requirements.

### 4.2. Wind Turbine:

Function: Converts wind energy into electricity.

Details: Wind turbines have blades that rotate when the wind blows. This rotation drives a generator, producing electrical power. The size and capacity of the wind turbine depend on the wind conditions at the installation site.

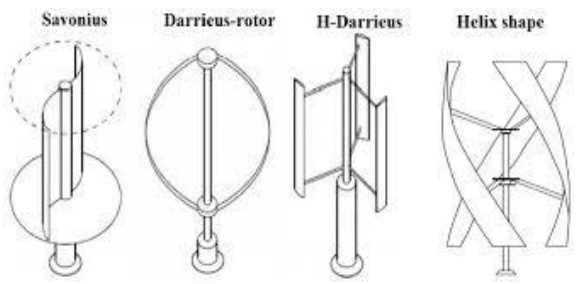


**Fig 4.2.1** :- Types of Vertical Axis Wind Turbine

### 4.3. Charge Controller:

Function: Regulates and controls the charging of batteries.

Details: Charge controllers prevent overcharging and discharging of batteries. They optimize the charging process to extend battery life. In hybrid systems, charge controllers manage both solar and wind inputs.

### 4.4. Battery Bank:

Function: Stores excess energy for later use during periods of low solar or wind activity.

Details: Batteries store electricity generated by the solar panels and wind turbine. Common types include lead-acid, lithium-ion, and others. The capacity of the battery bank depends on the energy storage requirements.

### 4.5. Inverter:

Function: Converts DC electricity from solar panels and wind turbines into AC electricity for use in homes or businesses.

Details: Inverters are essential for systems that use both solar and wind components, as they ensure compatibility with standard AC appliances and the electrical grid.

### 4.6. Wind and Solar Controllers:

Function: Monitor and control the operation of wind turbines and solar panels.

Details: These controllers optimize the performance of each system component based on the available resources. They can adjust the angle of solar panels or the pitch of wind turbine blades to maximize energy capture.

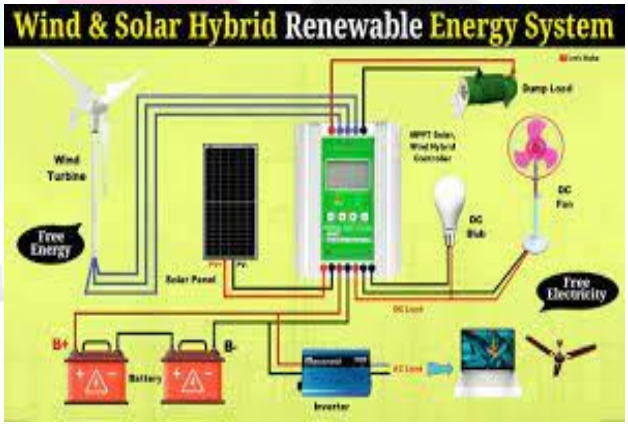


**Fig 4.6.1:-** Wind and Solar MPPT controller

### 4.7. Wiring and Connectors:

Function: Transmit electrical power between components.

Details: High-quality wiring and connectors are crucial to minimize energy losses and ensure the safe and efficient operation of the entire system.

When designing a solar and wind hybrid system, it's important to conduct a site assessment to determine the available solar and wind resources, ensuring that the system is appropriately sized and configured for the specific location. Professional installation and maintenance are recommended to ensure the system's optimal performance and longevity.

## 5. Working Details:

### 5.1 Solar Power Generation:

During daylight hours, solar panels generate electricity from sunlight.

The charge controller regulates the flow of this electricity to the battery bank .

### 5.2 Wind Power Generation:

Wind turbines generate electricity when there is sufficient wind.

The charge controller manages the flow of electricity from the wind turbines to the battery bank .

### 5.3 Battery Charging:

Excess electricity generated by both solar panels and wind turbines is directed to the battery bank for storage.

The charge controller ensures that the batteries are charged optimally without overcharging.

### 5.4 Power Distribution:

The inverter converts DC electricity from the batteries into AC electricity for use in homes or businesses.

Electricity is distributed to power appliances and devices.

### 5.5 Grid Interaction (if applicable):

If the system is connected to the grid, excess electricity can be fed back into the grid through a grid-tie inverter.

### 5.6 Monitoring and Control:

Monitoring systems track the performance of solar panels, wind turbines, battery status, and overall system health.

Automated control systems may adjust the operation of components based on real-time data and weather conditions.

Keep in mind that the design and sizing of a solar and wind hybrid system depend on factors such as location, energy consumption, and specific site conditions. Professional consultation is recommended for optimal system design and installation.

## 6. Advantages Of Installing A Hybrid Solar Wind System

– The solar wind hybrid system generates approximately twice as much wind or solar energy than the singly-installed systems.

– Installing these hybrid systems will enhance the reliability of the power generation systems.

– The battery size can be minimised as the dependency on a single source for generating electricity is less.

– Unlike individual energy systems, hybrid systems do not require grid expansion. It is because they produce power at different courses of time and during different seasons.

– Acquiring land for a hybrid system is easier. It is because you do not need separate pieces of land to install solar panels and windmills. Both can be installed on a single piece of land.

## 7. Disadvantages Of Installing A Hybrid Solar Wind System

– The initial investment is very high, though it is less than the combined cost of solar and wind projects.

– Hybrid systems cannot be installed in urban areas. That is because the wind speed is lesser in these areas due to the friction forces against the surface of skyscrapers. As a result, windmills cannot operate with full efficiency in these areas.

– Wind turbines are of different types. These are installed depending on the location. Due to this drawback, not all types of wind turbines can be installed as the wind speed differs in different places.

– Due to restricted space, if the hybrid system is installed in such a way that sunlight does not fall directly on the panels, it won't be able to generate electricity as required. The same scenario can occur if the wind is not falling directly on the blades of the windmills.

Generation During Sunlight Hours Only.

Availability of Seasonal Sunlight.

Cloudy Days and Snow Coverage.

Space and Installation Considerations.

Hight Cost to Invest.

Difficult for Small Scale Deployment.

## 8 . Applications

Solar Wind Hybrid Energy Systems are using in almost all field small electric power usage. Some of the applications of SWHES are given below.

- Grid connected and Stand alone Grid connected: The large power rating of SWHES, where the access of wind and sun irradiation is more, they can be connected to Grid. In these types of generation, if the system failed to generate power the Grid will supply the load. Stand alone: Almost all SWHES applications are stand - alone not connected to the grid.
- Street lighting: The foremost application of SWHES is solar street lighting. Solar Street light become as SWHES lighting. Use of this reduces the load from conventional power plants.
- Household: Residential appliances can use power generated through hybrid solar wind energy system. SWHES are used to supply electricity to different offices or other parts of the building in reliable manner.
- Remote Applications: like military services where it is impossible to provide conventional power supply these SWHES systems are useful.
- Ventilation system: The proposed systems are also used for ventilation purposes, these helps in running Bath fans, floor fans and ceiling fans in buildings.
- Power Pump: SWHES can also help to pump the water to any building. DC power operated pump can circulate the water through your home.

## 9. Maintenance

### Introduction to maintenance :-

No of machine in the universe is 100% maintenance free machine. Due to its continuous use it is undergoing wear and tear of the mating and moving components. Also due to the chemical reaction takes place when the material comes in the contact with water, makes its corrosion. Hence it is required to replaced or replaced. This process of repairing and replacing is called as maintenance work.

**Fig 9.1** : Daily maintenance of solar panel

### Daily maintenance of solar panel :-

As the buildup of dust or debris can affect the production of renewable energy, maintaining your solar panels might just require grabbing a hose or bucket of water and spraying off your panels. "That's the only self-maintenance you really need.

## 10. Refrances

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