



Introduction to Solar Wind Hybrid Energy Systems

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Abstract: This paper presents the applications and the effective use of Solar Wind Hybrid Energy systems (SWHES). The future of Energy generation depends on Solar Energy, as it the most abundant natural source of energy. Conventional power generation is going to become a difficult task in the future; it is due to the non-availability of coal. The increased per unit generation cost in the thermal power plant. The transmission power loss is also one reason. Pollutants released from the conventional power generation will affect the environment. To overcome these difficulties in future we have to depend on solar power generation. It is clean source of energy and it can transform to any source of energy with no effect on the environment. To get continuous power supply we should operate wind and solar power plants together as a single unit. By this combined mode of operation, the overall efficiency of the system increases. The combined power generation will give the continuity power supply for household applications with battery as a storage element. SWHES are more reliable to small power application. This configuration also reduces the load on the conventional power generating system with no effect on the environment.

Keywords: Hybrid Energy Systems, Solar Power Applications, Wind Power Applications, Combined Power Generation, Continuous Power Supply, SWHES.

I. INTRODUCTION

Alternative energy sources have become a popular renewable source of electrical energy, where the product of electricity by conventional means is unpractical. Now, electricity is the most requisite means for man. All the energy resources are depleting day by day. Consequently, we must move from traditional to non-traditional energy resources. In this state, a mix of two energy resources occurs. This operation excites sustainable energy exchequer without harming nature. We can give uninterrupted energy using a hybrid system of energy. This system consists of the integration of a dual-energy system that will provide stable power. Solar panels are used to convert solar energy, and wind turbines are used to convert wind energy into electricity. The article discusses the cases of power generation using two sources, which leads to the obstetrics of electricity at affordable prices without disrupting the natural balance. Introduction. The uses of energy have evolved as humans have changed patterns of energy consumption. Although renewable resources such as wind, water, and biomass were the first sources of energy tapped to provide heat, light, and usable power, it was the energy stored in fossil fuels and, more recently, nuclear power that fueled the tremendous expansion of the world industrial, residential, and transportation sectors during the 20th century. But as fossil-fuel consumption has increased, a result of population growth and growth in our standard of living, so have the concerns over energy security and the negative impacts of greenhouse gases on the environment

I. POWER GENERATION FROM SOLAR SYSTEM

Solar energy is the radiation from the Sun capable of producing heat, causing chemical reactions, or generating electricity. The total amount of solar energy received on Earth is vastly more than the world's current and anticipated energy requirements. Sun energy reaches the earth in different amounts at different places; it is because of geographical conditions of the earth. The major renewable energy resources are the solar energy that can be used for different applications. Like; Water heaters, solar lamps, etc.

A. Solar Panel's Working Principle

When light reaches the p-n junction, the light photons can easily enter in the junction, through very thin p-type layer. The light energy, in the form of photons, supplies sufficient energy to the junction to create a number of electron-hole pairs. The incident light breaks the thermal equilibrium condition of the junction. The free electrons in the depletion region can quickly come to the n-type side of the junction.



Similarly, the holes in the depletion can quickly come to the p-type side of the junction. Once, the newly created free electrons come to the n-type side, cannot further cross the junction because of barrier potential of the junction. Similarly, the newly created holes once come to the p-type side cannot further cross the junction because of same barrier potential of the junction. As the concentration of electrons becomes higher in one side, i.e. n-type side of the junction and concentration of holes becomes more in another side, i.e. the p-type side of the junction, the p-n junction will behave like a small battery cell. A voltage is set up which is known as photo voltage. If we connect a small load across the junction, there will be a tiny current flowing through it.

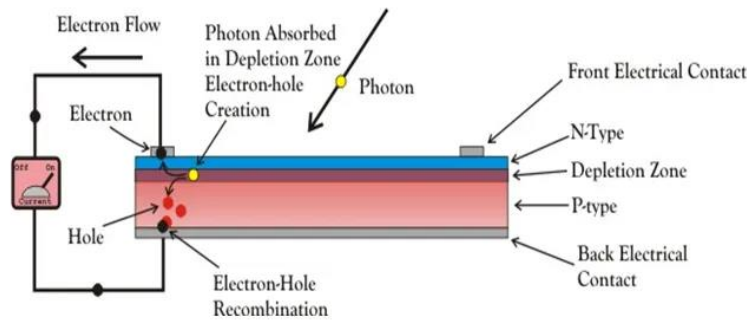


Fig 2.1 Solar Panel Working Principle

In the above fig 2.1 shows the working principle of the solar panel. It resembles the PN junction diode model. As the photon energy falls on the solar panel electrons gets energized. This moves towards the P- type channel. This constitutes the current to flow if the load is connected. Continuations of the electros flow in the closed path drive the load. The battery is connected for reliability of power. This stored energy can be used for DC operated devices. If the connected load is an AC load, to dive this Inverter is needed.

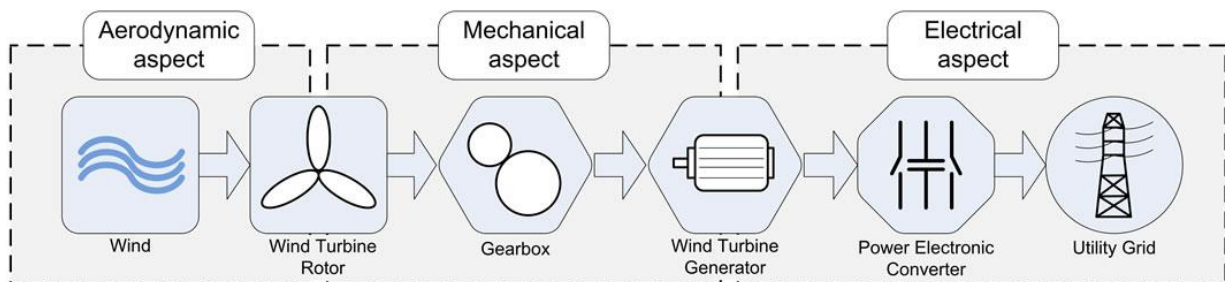
B. Solar Power System

Power from the PV panels is connected to the loads, in grid connected or standalone manner. Grid connected PV systems have more efficient as they can feed the loads continues by using grid power. Small power PV systems provides the cost effective power generation in remote places.

II. WINDPOWER

Wind power or wind energy is mostly the use of wind turbines to generate electricity. Wind power is a popular, sustainable, renewable energy source that has a much smaller impact on the environment than burning fossil fuels. Wind power or wind energy is mostly the use of wind turbines to generate electricity. Wind power is a popular, sustainable, renewable energy source that has a much smaller impact on the environment than burning fossil fuels. Historically, wind power has been used in sails, windmills and windpumps but today it is mostly used to generate electricity. Wind farms consist of many individual wind turbines, which are connected to the electric power transmission network.

A. Wind Energy Conversion





$$\text{Kinetic energy } K_E = \frac{1}{2}mv^2 \quad (1)$$

Where,

m: mass of particle (kg),

v: velocity of the particle (m/s), and

$m = \rho A d$

We can write the Kinetic energy as below

$$\text{Kinetic Energy } K_E = \frac{1}{2} \rho A d v^2$$

Power (P_w) = Energy per unit time.

$$\text{Power } (P_w) = \frac{1}{2} \frac{\rho A v^2}{t}$$

$$\text{Power } (P_w) = \frac{1}{2} \rho A v^2 \left(\frac{d}{t}\right)$$

$$\text{Power } (P_w) = \frac{1}{2} \rho A v^3 \quad (2)$$

Where,

$$\text{Velocity } (v) = \frac{\text{Distance } (d)}{\text{Time } (t)}$$

ρ = air density,

A = rotor swept area,

d = distance,

m = mass of air = air density * volume

$m = \rho * A * d$,

and

v = distance/time.

From above, equations (1) and (2), it is observed that the amount of power depends on the cube of the velocity of the wind. Generally, to run the wind turbine minimum and maximum speeds calculated by the ratings of the turbine generator. We can extract the wind power up to its cut in speed 3m/s. Research is going on to decrease the cut in speed, so from the little bit of wind flow, it is possible to extract the power.

B. Electric Power Generator

Electric power generator is connected to the wind turbine in WECS. In this we use Synchronous or induction generator depends on the requirement. Which generates the AC power, and it converts to DC by Rectifiers if required depending on the load.

C. Converters

In this proposed system of SWHES, the use of converter and inverter are needed. Generated AC power can be converted to DC to store the battery. Solar panel generates the DC Power, this power has to convert to AC Power if the connected load is AC Power operated device. DC power operated devices directly connected to the battery. In hybrid systems, power converters play important role. Load switching from solar to wind vice versa will be done by these converters.

D. Energy Storage

Solar Wind Hybrid Wind Energy System uses the battery for storage of energy. Storage elements improve the system reliability. The rating of the battery depends on our load. All the DC power operated devices connected this battery directly.



III.HYBRID POWER GENERATION (SOLAR -WIND)

SWHES consists of two generating units, solar and wind up to their maximum power operation. Depending on the load requirement these units get into operation mode. Remaining period this system to feed the battery gets charged. Through this battery, the house loads are connected with the help of inverter in case of Ac loads.

The Combine power generation consists of two small units fitted to the house as in convenient places. On the roof we can place the solar panels. On the top and nearby windows also, we may put the wind models of small power capacity. The entire system is connected to the battery of energy storage. For effective usage of the building, we can attach the solar panels to the house. It good appearance and saving the land cost. In household applications, we use a single-phase power from morning to evening for water heaters, cookers, fans, lights, etc. This creates the more burdens on the conventional power system. This load may be diverted to the solar power plant. Every individual household should have SWHES to reduce the load on the conventional power system.



Fig. 4.1 Integrated Solar Wind Hybrid Energy System

Energy conversion takes place from wind energy to electrical energy. Wind turbine, electric generator plays a key role in this conversion. The amount of converted energy depends on the wind energy available at that place. The classical equation of wind power can be explained below. Wind power can be computed by the kinetics which relates the objects in motion.

IV.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.

A. 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.
- **Village Power:** The proposed system is very useful in villages which are in valley and on hills, where it is not possible to send electricity.

V.CONCLUSION

The present worldwide trends concern energy security and sustainable development across the globe. The role of renewable energy has therefore become ever more significant. The developed world is already on the track for walking out from the fossil fuel era and involving mainly the areas of renewable energy technologies and energy efficiency. Utilizing solar and wind energy for electricity production will help in resolving the challenges such as climate change and greenhouse emissions and can emerge as the best solution for resolving the energy crisis. The hybrid energy system suggested in this paper has advantages such as continuity in power supply, high efficiency, low maintenance cost, optimized utilization of the resources, and load management. The results given in this paper show that the use of hybrid PV-wind power generation units could save up to 10%–20% of the cost of current systems. This study encourages the use of hybrid systems in India and abroad in order to improve electricity production sustainability. Hybrid systems will provide a viable, secure power supply to rural areas while also providing a pool of funding for community grid maintenance and economic development. Ultimately, these systems will help to increase the usage of renewable energy for generating electricity globally and thereby contribute to resolving the environmental problems currently facing the world.

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