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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.

Nomenclature

PV : Photovoltaic
AC : Alternating current
DC : Direct Current
K.E : Kinetic Energy
SWHES : Solar Wind Hybrid Energy Systems
WECS : Wind Energy Conversion System
ρ : air density
A : rotor swept area
m : mass of air
v : velocity of air
d : Distance

I. INTRODUCTION

Solar-Wind Hybrid Energy Systems are using solar panels and wind turbine generators to generate electricity power. Renewable Energy experts will explain that a small hybrid system that combines wind power, solar power technologies offers several advantages to home applications. In future electrical power is most important in our daily life, without electricity, we can't imagine the present world. The idea of the combined power generation is to get continuous power during day and night for small power applications with storage battery. This will achieve by SWHES. Fig 1.1 shows the block diagram of SWHES.

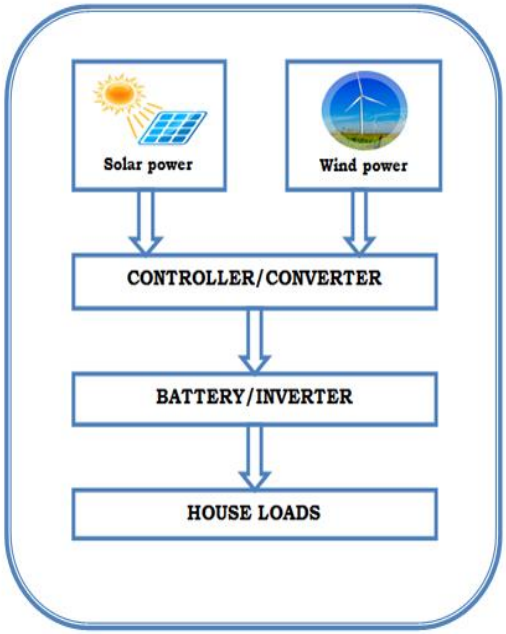

Fig. 1.1 the block diagram of the solar - wind hybrid energy system.

SWHES consists of two generating units, solar and wind up to their maximum power operation. Depending on the load requirement these units gets 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.

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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 makes 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.

II. POWER GENRATION FROM SOLAR SYSTEM

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

Solar panel is made up of solar cells; it is used to convert solar energy into electrical energy. The working principle of solar cell is similar to PN junction diode operation. As it is a semi conductor device, initially every particle is in stationary in their orbit. As the nature of semiconductor, only few electrons are available, they form an energy gap between P-type and N-type regions.

Majority carriers are electrons in N-type, holes in P-Type regions. As Photon energy falls on the solar panels, excited electrons from N-type region allowed to P-type region constitutes a flow of current. This process continues the battery to get charged. The recombination of electrons and holes takes place. Solar cells are arranged in serial manner to sum up the voltage. It makes the solar panel behaves like another battery, these serially connected batteries store energy. Energy from the solar panel is also connected to the inverter, if we need a three phase power supply.

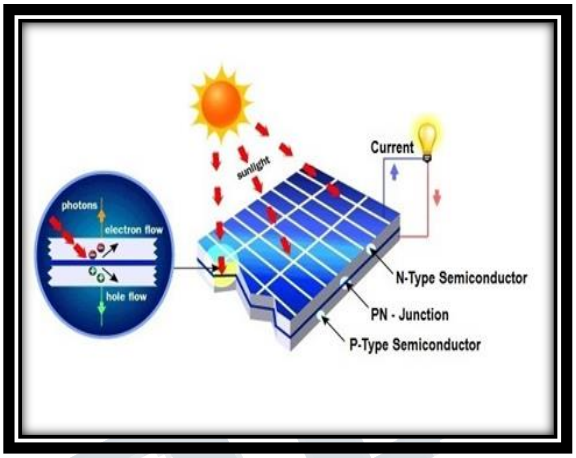

Fig. 2.1 Solar Panel working Principle

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 stand alone 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.

III. WINDPOWER

Wind power, the natural source of energy. Wind flows from high pressure to low pressure. This is due to solar radiation falling on the earth surface. The flow of wind having kinetic energy it is due to the virtue of its motion.

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Wind power is available more at the coastal areas during day and night, whereas solar energy is available only during the daytime. Power generation is done only in this half of the day. Next half of the day (i.e., nighttime) the unit has to be off mode. To overcome this difficulty wind generation is integrated with the solar power generation.

Wind turbine will extract the kinetic energy from the wind and converts to mechanical power which helps to rotate the Electric power generator. Fig 3.1 shows the wind energy conversion principle.

A. Wind Energy Conversion

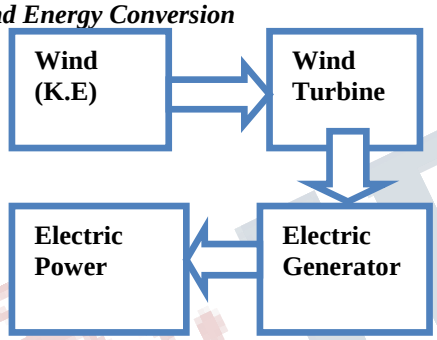

Fig. 3.1 Block Diagram of Wind Energy Conversion

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.

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

Where, m: mass of particle (kg),
v : velocity of the particle (m/s), and
m= ρAd

We can write the Kinetic energy as below

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

Power (P_w) = Energy per unit time.

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

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

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

Where,

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= ρ*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 covert 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 plays important role. Load switching from solar to wind vice-versa will be done by theses converters.

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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.

IV. HYBRID SOLAR WIND ENERGY SYSTEMS

Solar-Wind energy systems integrated to form the SWHES (Solar Wind Hybrid Energy System). In this proposed system two renewable energy sources works in tandem to charge a battery via controllers. The energy sources supply the load separately or simultaneously depending upon their availability. Each source operates on its maximum power point operation for generating maximum power.

The combine power generation system improves the overall efficiency of the system. It is more suitable for isolated power applications. Addition of extra power source helps in supplying continuous power. Below fig. 4.1 describes the integrated Solar wind hybrid energy system.

Fig. 4.1 Integrated Solar Wind Hybrid Energy System

The combination of wind turbines and solar arrays generate the electric power with the help of respective controllers. Generated power may supplies the connected house load.

In small utility areas this SWHES is much preferred. This two energy sources are acting simultaneously to generate electric power. Load sharing takes place in this proposed system. And it can be operated on their maximum power point.

Continuity of power supply also takes place in this system, if any one failed to generate power the other one will supply the load. This load monitoring was done by the respective control algorithms. Under this both power generating systems works to generate the power. By this SWHES the overall system performance is increased and will get continuous power supply.

V. 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.

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- ***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.
- ***On shore :*** The wind blows more at coastal areas, SWHES are installed near sea and on the boats for power generation
- ***Commercial:*** In hotels, tourist places SWHES give the required electric power.

VI. CONCLUSION

Solar Wind Hybrid energy Systems become reliable for small power applications. To improve the solar Photovoltaic power generation efficiency, wind energy is integrated to form as hybrid energy system. The proposed systems help to reduce air pollution caused by the conventional power generation system.

By installing SWHES to every house, the burden on the conventional power generating system reduces. The storage of the battery will give power for some time, even no generation takes place by this system. Almost in all field of electric power usage, the SWHES are being used. It provides the power to inaccessible convention power places.

SWHES are more reliable and efficient energy generating system with less effect on the environment and almost no maintenance.

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