A HYBRID SOLAR-WIND SYSTEM: PERSPECTIVES IN PRESENT AND FUTURE SCENARIO

Garima Verma[1],
[1]Electrical and Electronics Engineering Department,RIET JAIPUR, India

Abstract

Considering the irregular natural energy resources and the seasonal un-balance, a hybrid electrical power supply system may be considered including the photovoltaic and wind generation systems to serve remote locations where a conventional grid connection is inconvenient or expensive. Although, the hybrid system including the photovoltaic and wind generation systems can also be connected with grid and operators are allowed to sell excessive power back to the electric utility. This paper explains the analysis of local solar PV-wind hybrid systems for supplying electrical power to a independent house or small company with electrical power depending on the site needs

Keywords:solar PV, wind power, hybrid generation, renewable energy.

INTRODUCTION

The total solar power received to earth can account about 178 billion MW of electrical power, which is approx 20,000 times of total world's demand. Due to the continuously increasing pollution concerns on environment caused by utilizing the conventional sources for electricity generation, renewable energy sources have become a primary choice for generating electricity. The key advantages of electricity generation from nonconventional sources include freely availability, absence of byproducts with harmful emissions and the main advantage of local generation. In this direction solar, wind and hydro has found a huge application because of simplicity and vast reserve in the nature.

Now a day's Wind energy is finding its huge application as a important method of generating electricity. When Wind energy conversion systems (WECS) are connected to the grid, they produce a substantial amount of power, which can provide the base power as generated by thermal, nuclear, or hydropower plants. Because of variation in speed of wind round the clock, the obtained power has variation in the frequency. But wind turbine can be implemented for a fixed speed or variable speed operation. With variable speed operation, the power electronics converters can be used to get fixed frequency and power with fixed voltage can be fed to the connected loads. The squirrel cage induction generator is mostly used for Wind energy conversion systems (WECS) due to robust and simple construction.

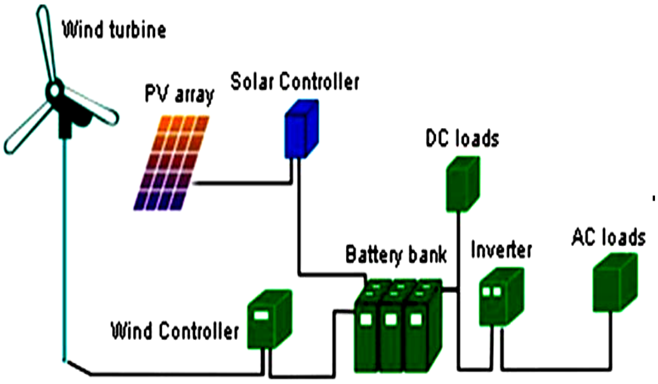

Fig. 1 Wind and solar hybrid system

Now days Self exited Induction generator (SEIG) has attracted a interest of engineers to get hybrid configuration photovoltaic (PV) cell with wind turbine. If we use solar PV or wind turbine as individual source for the generation of electricity than we will not get good results but the integration of solar PV or wind provides far better results.

Although there are lot of advantages linked with electricity generation using wind power, improvement in the control of wind generator requires, to obtain the constant frequency output. For that purpose the flow of active and reactive power is require to be controlled which can be done implementing IGBT inverters deploying direct torque control or vector control technique in between the grid and generator.

SPECIFIC SITE CONDITIONS FOR PHOTOVOLTIC-WIND HYBRID SYSTEM

Discontinuous and seasonally disturbed natural energy resources are the most important reason to install a hybrid energy system. The PV-wind hybrid system suits to conditions where sun light and wind has seasonal shifts i.e., in summer the daytime is long and sun light is strong enough, while in winter the days are shorter and there are more clouds, but there is usually an increased wind resource that can complement the solar resource. The PV-wind hybrid systems especially suit remote locations, where it is inconvenient or expensive to use conventional grid supplies. For the Photovoltaic array, a direction without any obstacle facing the sun is required. For the wind turbine, appropriate wind speed and wind direction are the key elements. The turbine should be subjected to non-turbulent wind and mounted higher than trees and other obstacles.

SYSTEM COMPONENTS

Normally, a local solar PV-wind hybrid system consist of the solar PV modules and wind turbine, the solar cell mounting, the tower for wind turbine, the controlled inverter, the safety equipment, the measuring instruments, the battery bank and the charge controller/regulator, the connection wires, switches and sockets etc. PV Modules can be assembled together to make a PV array. By connecting modules in series the provided voltage is increased and by connecting in parallel, the provided current is increased. Either way, the power production remains the same.

A typical PV module has a dimension of about 0.5 sq. m (about 1.5 by 3.5 feet) and produces approximately 75 watts of DC electricity in full sun. In case of wind turbines generally turbines have either two or three blades. These three-bladed wind turbines are operated "upwind," with the blades facing the wind. The other common wind turbine type is the two-bladed, downwind turbine. The wind turns the blades, which rotates a shaft, which is mechanically connected to a generator and produces electrical power. Small turbines, with output less than 50 kilowatts, are used for domestic or small application i.e. telecommunications dishes, or water pumping. Inverter converters low voltage direct current (DC) power, which is obtained from the solar photovoltaic or from wind turbine or stored in the battery bank, to AC generally at 240V and 50Hz frequency.

The “modern sine wave” inverters provide uninterruptible power, to avoid the possibilities of blackouts or brownouts. Such types of inverters are available in range from 250 watts to over 8,000 watts. One of the largest problems in systems containing power inverters is power quality because of harmonic injections to the grid. This problem becomes serious if the inverter used in the system does not have a good sinusoidal waveform output and causes problems such as harmonic contamination and poor voltage regulation. According to IEEE standards, a maximum of 3 to 4% total harmonic distortion may be allowed from inverter outputs. The mounting of solar PV modules may be a ground mount that may be installed either on the ground or rooftops, or pole mount for getting them up in the air. Both are angle-adjustable so that solar PV array will receive the sunlight as perpendicular as possible.

Trackers are another option with solar PV mounting, which adjusts automatically so that PV module receives the maximum sunlight. Wind turbine should be mounted into non-turbulent wind and the height of wind turbine from ground should be above from 9 m.lightning arrestors can be installed for the protection of the wind turbine against lightning surges.

Most of the modern controllers does system voltage regulation electronically by changing the width of DC pulses that inverters send to the batteries, this is known as pulse width modulation (PWM). Another type is the "shunt type" controllers which divert excess power to the "shunt load." A new generation controllers of solar PV modules uses "maximum power point tracking." Maximum Power Point Tracking is basically electronic tracking. The charge controller checks the output voltage of the panels, and compares it with battery voltage. It then find out what would the best power that the panel should put out to charge the battery. It considers this and changes it to best level of voltage to have the maximum amperes to the battery. Most of modern MPPT's are approx 93-97% efficient.

SOLAR- PHOTOVOLTAIC

Photovoltaics are a solar cell, made from semiconductor materials. PV cell converts sunlight to D.C. voltage directly. When sun light strikes the PV cell, electrons are emitted. In such a way the generated electricity can be used to supply a load or can be supplied to the battery.

There are two major types of Photovoltaic system: the off-grid (stand alone) systems and inter-tied system. The off-grid (stand alone) systems are used where there is no service from utility grid and it is economical to provide electricity at remote sites.

The major components of Solar PV cell include P.V. cells, battery and inverter. The logical way to estimate the capacities of these components is to determine the load to be supplied. [4]

The Photovoltaic cell is made of silicon, which is available in abundant amount on earth, being a primary element of sand. A Solar Photovoltaic Module is consist of several PV cells accompanied with weather proof unit.

The PV cell is basically a diode that permits incident rays to be absorbed and further converted to electricity. To estimate the size of Solar PV modules, the amount of energy consumption must be determined. Therefore, the size of PV module in $W_p$canbe calculated as [5]:

$$W_p = \frac{\text{Daily energy Consumption}}{\text{Isolation x efficiency}} \qquad (1)$$

Where Isolation is measured in KWh/m2/day and the energy consumption is in kilowatts.

Wind energy can be converted into electrical energy with the use if wind mill (also called as wind turbine). When the wind passes through the wind mill, it turns drives a generator to produce the electrical power [6]. An combination of wind generator, wind turbine, aero generators together is known as a wind energy conversion system (WECS)[7]

Wind energy conversion systems basically consist of the following parts: (i) A tower – where the wind turbine is mounted; (ii) A rotor - turned by the wind; (iii)Nacelle - holds the equipment, including the generator. Blades of rotor need to be strong and light in order to be efficient aerodynamically and to withstand in high winds[8]. Wind turbines basically are of two basic types depends on the axis about which the turbine rotates. Horizontal axis turbines are more common. Vertical-axis turbines are less frequently used [8].

The power transferred to a wind turbine is directly proportional to the density of the air(ρ), area swept out by the rotor(A) and the cube of the wind speed(V^3). The power P is given as:

$$P = \frac{1}{2} C_p \, \rho A V^3 \qquad (2)$$

Where Cp is turbine power coefficient. A proposed maximum value of Cp is 0.593 theoretically , ρ = air density (kg/m^3)

CONCLUSION

In this paper the key concept is that two or more non conventional energy sources can be connected to the grid. Hybrid electrical power system reduces the dependence on single source and also increases the reliability of the system. Hence the overall efficiency of the electrical power system can be improve in comparison with single mode of generation. A complete hybrid electrical power system may be too expensive and also too labor intensive for Industrial application. There is a huge requirement for making provision of an alternative reliable power system to provide electrical power to remote and unreachable area. Hybrid combinations of wind, solar, geothermal, hydroelectric, tidal, biomass generated power, energy from incineration of solid

wastes, and many other technologies could also be considered depending on local interests, situation and resources availability.

REFERENCES

[1]. "Energy Conversion Systems", IEEE Canadian Review - Spring / Printemps.

[2]. Y. Dayu, Local photovoltaic PV wind hybrid systems with battery storage or grid connection, Master's Programme in Renewable Energy Technology (Physics), EEE Dept., Bharat Institute of Engineering &Technology, Hyderabad, India, 2004

[3]. G. Pepermans, J. Driesen, D. Haeseldonckx, R. Belmans, W. D'haeseleer, "Distributed generation: definition, benefits and issues", Energy Policy, Vol. 33, No. 6, pp. 787–798, 2005

[4]. M. Thomas (Ed) "Solar Electricity", John Wiley and Sons Ltd, Chichester, 2nd Edition. (2004).

[5]. U.K Mehta. "Principle of Electronics", S. Chand & Company Ltd.New Delhi. (2004)

[6]. Technical brief on Wind Electricity Generation: Retrieved from www.windpower.org,(2009).

[7]. E.E. Iheonu, F.O. A. Akingbade, M. Ocholi Wind Resources Variations over selected sites in the West African sub-region. Nigerian J. Renewable Energy, 10, 43-47(2002).

[8]. W.W.S. Charters. "Solar and Wind Power Technologies for Remote Applications". CSC Technical Publication Services No 187, Commonwealth Science Council. (1985).