

HYBRID POWER GENERATION SYSTEM

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ABSTRACT

A PV –wind hybrid electrical power supply was developed for many remote locations where a conventional grid connection is inconvenient or expensive. While the hybrid system is also applicable with grid connection, owners are allowed to sell excess electricity back to the electric utility by using net meter. Intermittent natural energy resources and energy resources seasonal un- balance are the most important reason to install a hybrid power generation

The p-v hybrid system composed of a photo –voltaic solar cell array, a mast mounted wind generator , lead-acid storage batteries or charge controllers, an inverter unit to convert dc power to ac power ,electrical heating loads ,electrical lighting loads ,several fuses and junction boxes and associated wiring and test instruments for measuring voltages ,current ,power factor and harmonic contamination data throughout the system. The proposed hybrid solar –wind power generating system can be extensively used to illustrate electrical concepts in hands –on laboratories and demonstration in the industrial technology curriculum. In this paper the major system components, work principle and specific working condition are presented .this paper explain an analysis of local P-V-wind hybrid systems for supplying electricity to a private house, farmhouse or a small company with electrical power depending on the need at the site.

KEYWORDS : Charge controllers, Fuses , Inverters, Hybrid system, PV cells.

I INTRODUCTION

Energy has playing an important role in human, economic development and world peace. At current energy consumption rate, proven coal reserves should last for about 200 years, oil for approximately 40 years and natural gas for 60 years. With the contradiction between rapid development and diminishing fossil fuel resource, as well as to avoid pollutant emission or other environmental problem and not to involve the resulting healthy hazard, we should consider the manner in which we produce and consume energy for sustainable development.

Renewable energy that is energy generated from solar, wind, biomass, hydropower, geothermal and ocean resources, could increase diversity of energy supplies and offer us clean energy .the energy generated from wind and solar is much less than the production by fossil fuels, however, electricity generation by utilizing PV cells and wind turbine increased rapidly in recent years, particular in Japan, Germany Denmark and the U.S.

Wind energy has become the least expensive renewable energy technology in existence and has peaked the interest of scientists and educators all over the world. Wind power is electricity produced by a generator, which is driven by a turbine according to aerodynamics in flowing air. Wind power is one of the fastest growing renewable energy technologies around the world. PV cell or photovoltaic cell commonly known as solar cell are electronic devices that are based on semiconductor technology and can produce an electric current directly from sunlight. The best silicon PV modules now available commercially have an efficiency of over 18 %, and it is expected that in about 10 years time module efficiencies may rise over 25%.

PV-wind Hybrid system are now widely used in developed countries to produce electrical power in locations where it might be inconvenient or expensive to use conventional grid supplies ,while other homeowners who choose the renewable energy sources prefer to connect their energy system to grid as a huge battery for some convenient grid tied situation .however ,the fact that natural energy resources are intermittent and storage batteries are expensive ,has led to utilization of so called hybrid renewable energy systems. Any power system that incorporates two or more of the following is referred to as a hybrid power system PV panels ,wind turbine or diesel, propane gasoline generators. For small loads , the most common combinations are PV –wind hybrid system PV and wind is a good match , because inland speed tends to be lower in summer , when solar energy can compensate ,and higher in winter ,when sunshine falls to very low levels.

The main purpose of the wind and solar energy demonstration system is to develop first –hand experience on electric generation for residential, agricultural, and small business applications in the region. Expected outcomes of the project include increasing public awareness of the benefits of renewable energy, developing a knowledgebase to assist the residents, farmers and small owners who wish to develop their own generation system. The aim of this study is to introduce the local PV wind hybrid system working principle by reviewing one case where the system is connected to the grid.

II NEED FOR HYBRID SYSTEM

The need of hybrid system arises because the only wind turbine and PV cells alone are not enough for meeting the power requirement now a day. As the wind does not flow all the time or does the sun shines all the time, solar and wind power alone are the poor power sources. Then by the hybridization of the wind turbine and the PV cells they provide the realistic form of power generation.

Photovoltaic cells are basically known as the solar cell or PV cells. They are used for the conversion of the solar energy or the energy from the sun light into the electrical energy. PV cell are more advantageous than other renewable sources of energy as they require very less maintenance and generate almost no noise. Wind energy has now a day's became a least expensive source of renewable energy. The variable feature of wind turbine power generation is different from conventional fossil fuel, nuclear, or hydro based power generation. Wind turbine power generation has peaked the interest of scientist and educators all over the world. Most industrial uses of electricity require AC power. Wind turbines and PV cells provide DC power. A semiconductor based device known as a power

inverter is used to convert the DC power into the AC power. These devices have the relatively simple operation and are generally used in the hybrid system.

Then by hybridizing the solar and the wind power sources together along with the storage batteries to cover the period of time i.e. without sunlight and without the wind provide a realistic form of power generation.

III ANALYSIS OF THE HYBRID SYSTEM

3.1 Required Site Condition For The PV-Wind Hybrid System

The most important reason to install a hybrid energy supply system is the intermittent natural energy resources and energy resources seasonal unbalance. The hybrid system of PV cells and the wind turbine are generally suits to the condition where the sun light and wind has the seasonal shifts i.e., in summer the sunlight is strong and in the winter days are shorter and there are more clouds, but there is usually an increased wind resource which can compensate the lesser power generation by the PV cells.

Generally this type of hybrid systems is used in the remote location because usually in these areas it is inconvenient and expensive to use the conventional grid supplies. The common type is connecting with battery storage. For PV array, a direction is needed. For the wind turbine, appropriate wind speed and wind direction are the key elements to the whole system. Enough space is needed to the site the PV module, wind turbine tower, and also to properly anchor the guy wires.

3.2 System Components

Generally to obtain a local, cost-effective, safe, and durable hybrid system we require the core parts i.e. PV modules and wind turbines, then we require PV module mounting along with the Wind turbine tower, DC-AC inverter, safety equipments such as fuses, disconnects, and lightning arrestors meters and instrumentations, batteries, charge controllers for storing the charge and finally the backup power resources for battery storage systems and also connection wires, switching and wall socket. The working and use of all the equipments required for the hybrid system are explained below:

3.2.1 Photovoltaic (PV) Modules : We know the PV cell are used for the conversion of the sunlight into direct current. A typical PV module measures about 0.5 square meters (about 1.5 by 3.5 feet) and produces power of about 75watts of DC electricity in full sun. to form an PV array modules can be wired together either in series or in parallel. When modules are wired in the series then the available than the available voltage is increased and when The Modules Are Wired In Parallel Then The Available Current Is Increased.

3.2.2 Wind Turbine : The function of wind turbine is exactly opposite to that of the fan. It takes wind as an input and converts this wind energy into the electrical energy. Mostly wind turbines have two or three blades. The wind strikes the blades of the wind turbine, which spins the shaft, which is connected to a generator and n=makes

electricity. The utility scale turbines are range in size from 50 to 750kilowatts. Single small turbines, below 50 kilowatts, are used for the homes, telecommunications dishes, or water pumping.

3.2.3 DC-AC Inverter: It changes the low voltage direct current (DC) power into the standard alternating current (AC) house power i.e. 120-240V AC, 50 or 60 hertz. The low power is generated by the PV cells in the hybrid system. The inverters come in the size from 250watts to over 8000watts. While there are also “modified sine wave” inverters are cheaper but can still handle most household tasks.

However, this type of inverter may create a buzz in some electronic equipments and telephones, which can be annoying. The better sine wave inverters have made great strides in performance and price in recent years. Many inverters that are now used have built in battery chargers to keep the batteries topped off either the grid or the generators.

3.2.4 PV Module Mounting And Wind Turbine Tower: Both of these are used for the mounting of PV modules and wind turbine. The PV module mounting can be a ground mount that works either on roof top or the ground. They are mainly mounted in such a way that they get maximum exposure as the sun changes its angle in the summer season. Also we can use trackers that can automatically adjust the PV mounting so that the PV module faces the sun throughout the day. The wind turbine should be mounted into the non-turbulent wind tall enough wind turbine is needed (9m and above to 120m)

3.2.5 Safety Equipments: It includes equipments that provide protection from the over-current and lightning. Over-current protection components are such as fuses and fused disconnects protects the system wiring and components in the case of the short circuit. Fuses and fused disconnects are rated by the amount of the current they can handle. They may be small as a few amperes for supplying metering to as large as 400 amperes for supplying the inverter. Commercial lightning arrestors are available to help protect RE system electronics against the lightning.

3.2.6 Meters And Instrumentations: These basically helps the owner to keep the record of important things or data such as the battery voltage, the amount of power they are consuming currently, the state of charge in those batteries and also they record that how much electricity transfers between their supply system to the utility grid for the grid connection situations.

3.2.7 Batteries: They basically stores electrical energy being produced by RE resources in a reversible chemical reaction. Most of the batteries that are used in the RE system uses the lead-acid batteries typically enclosed in plastic and they are wired together either in series strings and parallel strings by the installer. These batteries do not belong inside the living space due to dangerous chemical in them. Battery capacity is usually rated in amp-hours. A typical 12-volt system may have 800 amp-hours of battery capacity. There are many brands and types of batteries available for RE systems and the most common batteries are the L-16 and golf card sizes.

3.2.8 Charge Controllers Regulator: They are used for the prevention of the PV array and the wind turbine from over-charging of the batteries. PV system vary the width of the DC pulses they send to the batteries (this is called Pulse Width Modulation or PWM) in order to maintain the system voltage. This is basically done because the amount of power goes into the batteries increases as the width of the pulse goes on increasing. Another type of the controllers which are called as “Shunt type controllers” divert the excess of energy into a “Shunt load”. This type of controller is more commonly used in wind or hydro systems, since these systems generally should not run open circuited.

3.2.9 Back Up Power Resources: They can come either from a generator or from the utility grid when too much energy is consumed or when there has not been enough renewable energy coming into the system. However, for the hybrid system, the latter situation seems could be avoid, and a considerable energy consuming style might assist to solve the former problem.

IV METHODOLOGY

In order to address the shortcomings of existing instructional techniques for electrical power systems, the system is designed and implemented with the following goals:

- To be intimately related to real world industrial power issues such as power quality.
- To be completely different from traditional electricity labs and to be fresh and interesting.
- To motivate learning by introducing such elements as environmental and economic concerns of practical interest to the students.
- To show a complex, interrelated system that is closer to the “real world” than the usual simple system covered in educational labs.

V ESTABLISHMENT OF A WIND/PV HYBRID UNIT

The process of establishing the energy supply system (fig1) is extremely important step. Whichever system will be installed, analyzing owner’s load and renewable energy resource of the site ought to first step.

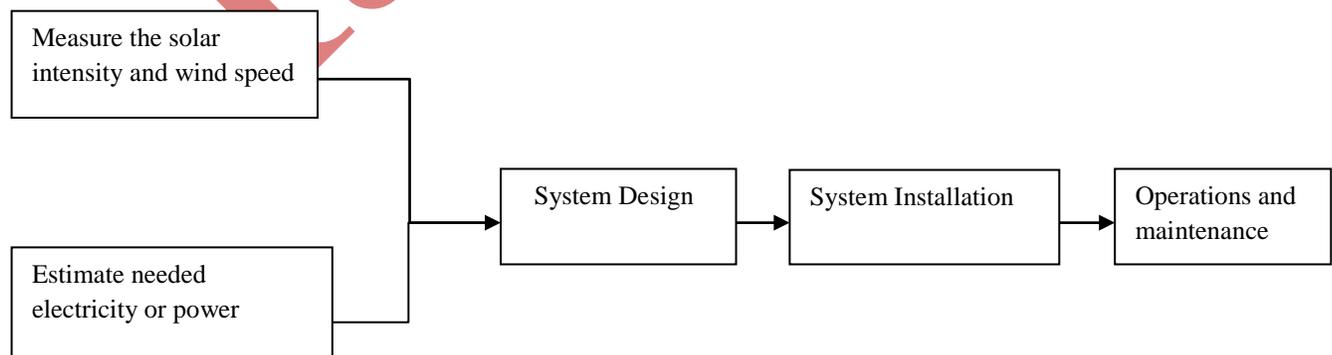


Fig. 1. Steps for establishing a Hybrid Solar and Wind plant

The hybrid unit contains two complete generating plants, a PV solar cell plant and a wind turbine system. These sources are connected in parallel to a 120V AC line. The power is next connected to a DC to AC inverter and is then supplied from inverter's output to a single phase 60 Hz, 120 v AC load. Overall structure is presented in fig 2.

The wind turbine is installed at the top of a steel tower that has a height of 18.3 meters and a diameter of 8.9 cm. The instrumentation panel depicted monitors the outputs of the generator using digital panel meters. One of the low maintenance features is the turbine's brushless alternator and an internal governor. The actual system's pictures are shown in fig 2. The turbine's blades are made of a carbon fiber reinforced composite that will intentionally deform as the turbine reaches its rated output. This deformation effect changes the shape of the blade, causing it to go into a stall mode, thus limiting the rotation speed of the alternator and preventing damage in high winds. Another feature of the wind turbine is a sophisticated internal regulator that periodically checks the line voltages and corrects for voltage conditions. The solar panels are 12 V DC units were chosen for their ultra clear tempered glass that is manufactured for long-term durability. A slight ripple in power regulation can clearly be seen. This ripple is a function of the unpredictable nature of the sunshine along with the dynamic effects of the electrical load.

To monitor and store the voltage, current, power and harmonic contamination data, two power quality analyzers are used in the system. In addition, AC/DC digital panel meters form part of the system's instrumentation. A laptop computer is interfaced to the system via the power quality analyzers to store data in real-time. The AC filter is a circuit made up of a resistor (R), inductor (L), and a capacitor (C). Such filters are commonly installed in industrial situations to remedy power quality problems. The inverter is of a six pulse type and the control circuit models are both standard models in the PSCAD/EMTDC software package. Voltage sags may cause a crucial damage to high precision measurement and protection devices, especially computer equipment present in many highly automated industrial plants.

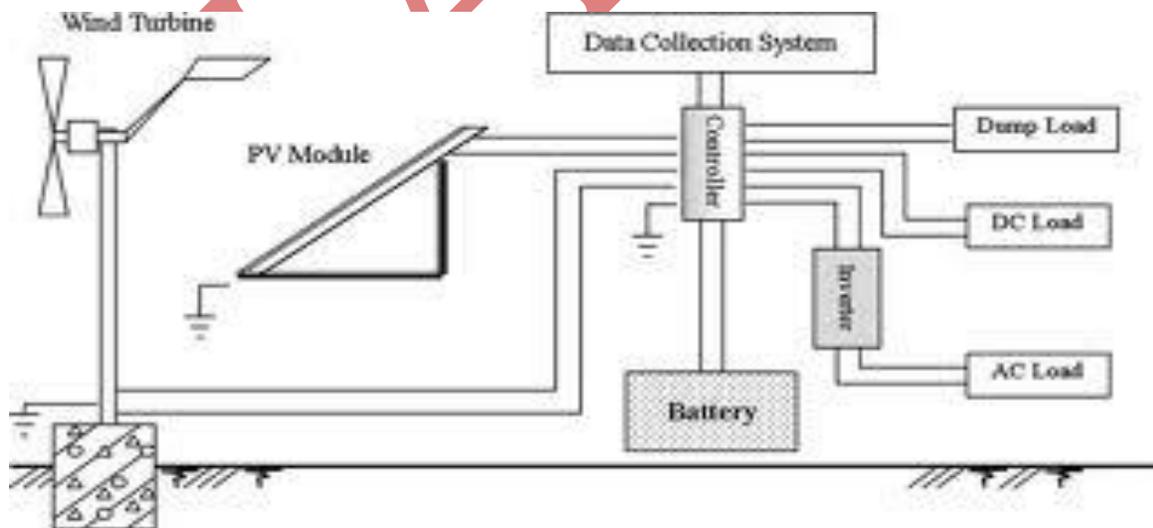


Fig.2. A simple Hybrid Solar & Wind System

VI FUTURE STUDY

A computer measurement and control bus will be added to the hybrid system. The measurement bus will be connected to all the major signals in the system and will allow for computerized data acquisition simultaneously of all the major signals in the system. Computer controlled relays will be added to allow all the major element of the system to be switched in and out of the system through computer programs. These improvements will allow the benefits to instruction realized in electricity and electronics classes to be extended to control and instrumentation classes. These improvements will also allow for the study of more complex issues like power faults caused by sudden over voltages like lightning .Fig 3 shows the block diagram of Scope for Future Research

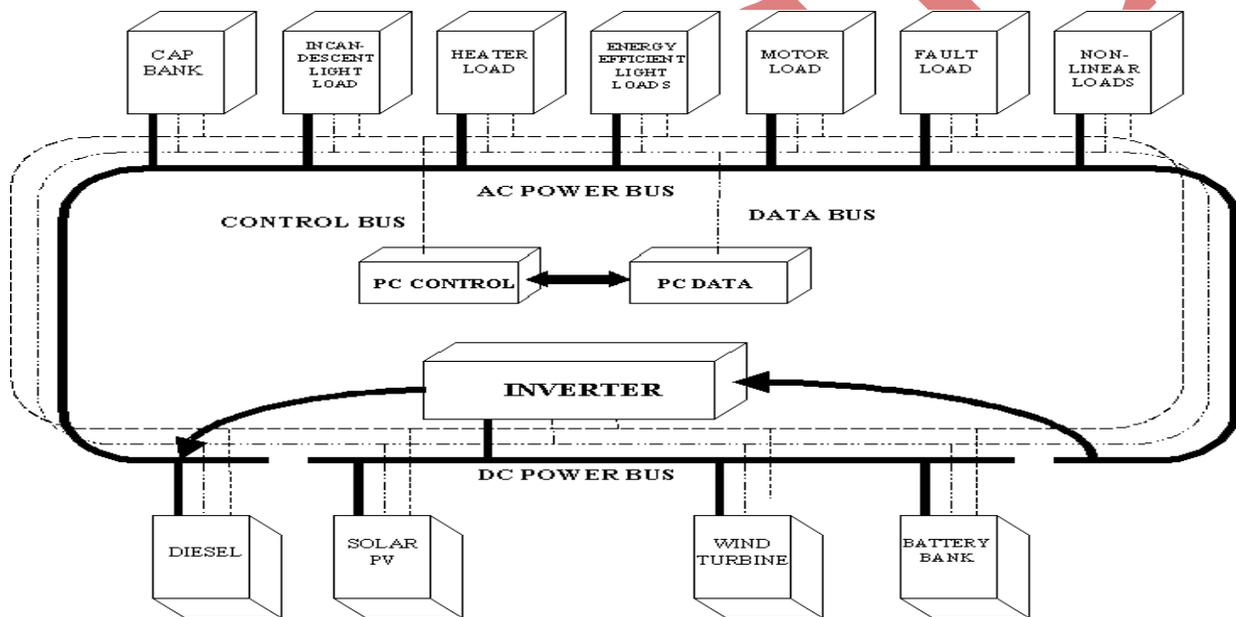


Fig.3. Block diagram of scope for future Research

VII CONCLUSIONS

A complete hybrid power system may be too expensive and too labor intensive for many Industrial Technology Departments. The enhancements to instruction, especially in making electrical power measurements more physical, intuitive ,and real world are substantial and the costs and labor involved in some adaptation of the ideas in this paper to a smaller scale setup are reasonable. However, many of the same benefits could be gleaned from having some subset of the system, for example a PV panel, invertors, batteries and a DC motor.

The use of solar and wind hybrid power generation is an especially vivid and relevant choice for students of electrical technology as these are power sources of technological ,political ,and economic importance in a country.

Hybrid combination of wind power, solar power, geothermal power, hydroelectric power, biomass generated power, tidal power, power incineration of solid wastes, and many other technologies could be considered depending on local interests and resources. The key elements of this test bed concept presented in this paper are two or more renewable power sources can be connected to a power grid with complex electrical interactions.

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