

INTEGRATED SOLAR-WIND POWER TRACKING SYSTEM FOR GRID

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Abstract: Basic need of human being is energy. There is different form of energy available on earth which is used by the people but electrical energy is best among all. Renewable energy sources i.e. solar energy, wind energy, biomass energy, hydro power energy, and ocean energy resources are considered as a technological option for generating electrical energy. But the energy generated from solar and wind is much less than the production by fossil fuels, however, the generation of electricity by utilizing PV cells and wind turbine increased rapidly in recent years. This presents the Solar-Wind Integration. Power system that harnesses the renewable energies in Sun and Wind to generate electricity with increased efficiency. System control relies mainly on microcontroller. It ensures the optimum utilization of resources and hence improves the efficiency as compared with their individual mode of generation. Further, to avoid the issue of the solar panels' efficiency, we have been implementing the solar tracking system. In Thus, it increases the reliability and reduces the dependence on one single source. This hybrid solar-wind power generating system is suitable for industries and also domestic areas. The initial cost of the project may be high for standalone system, but if the hybrid generation system is connected to grid, entire generation system can recovers its initial cost in 3 to 4 years and per unit consumption charges from grid can be reduced by credit facility provided under the net metering scheme. Battery storage is also provided as an additional backup system which stores the power generated by the solar wind hybrid system for compensating the case simultaneous occurrence of power cuts and the non-availability of hybrid resources. This hybrid system not only encourages the distributed generation system, but also provides some relaxation to the utilities and helps in controlling the environmental pollution which is one of the greatest concerns amongst the world growing with an extreme rate. It also ensures reliable and self-sustainable electricity.

Keywords - Grid Integration, Renewable Energy Source, Power system, Solar Power, Wind Power

I. INTRODUCTION

Energy plays a important role in all the areas of human life. Energy is required to sustain and improve the standard of living. All energy sources are of consuming nature except renewable energy source. For example thermal power generating station consumes coal in huge quantities and Hydraulic power station would not need raw material, but need water flow; it depends completely on water flow and is preferred with specific location. The idea of grid integration connected Wind Turbine Generation Systems have been developed in the last decades to MW size power generation units with advanced control .The power output is not only based on the incoming wind speed but also based on system requirements. In contrast with the past, the WTGS technological developments [1] enable wind farms to be operated according to the Virtual Power Plant (VPP) concept, thus providing necessary support to the primary activities. Wind energy has become an increasingly significant portion of the generation mix. Large scale wind farms are normally integrated into power transmission networks so that the generated electric power can be delivered to load centers in remote locations whereas the Small scales wind farms can be integrated into power distribution networks to meet local demands[2]. The solar power monitoring [3] can be classified as three categories: system level, string-level, and module-level. Fig. 3 shows the three-level monitoring based on wireless communication systems. The commercial capacity ranges from 10kW to 100kW, which are commonly found on the roof of a commercial building. Utility scale is designed to the installations above 100kW, which are traditionally ground-based installations on fields. In this technique using integrate communication systems [4] - the photovoltaic panel, voltage, current and temperature of each module was collected and the information is sent to the monitoring interface. The proposed work of integration of power resources consist of the following-

Wind: Wind energy is one of the best sources of alternative energy. Wind refers to the movement of air from high pressure areas to low pressure areas. Wind is caused by uneven heating of the earth's surface by the sun. Hot air rises up and cool air flows in to take its place. Wind will always exist as long as solar energy exists and people will be able to harness the energy from till then. Wind power is another source which can be harnessed to generate electric power. Wind power is the use of air flow through wind turbines to mechanically power generators for electricity.

Solar: Solar energy is a very large, inexhaustible source of energy. The power from the sun intercepted by the earth is approximately 1.8×10^{11} MW, which is many thousands of times larger than the present consumption rate on the earth of all commercial energy sources.

Thus in principle, solar energy could supply all the present and future energy needs of the world on a continuing basis. This makes it one of the most promising of the non-conventional energy sources.

Solar Tracker: A Solar Tracker is a device onto which solar panels are fitted which tracks the motion of the sun across the sky ensuring that the maximum amount of sunlight strikes the panels throughout the day. The Solar Tracker will attempt to navigate to the best angle of exposure of light from the sun

Solar-Wind Hybridization: As the wind does not blow all the time nor does the sun shine all the time, solar and wind power alone are poor power sources. Hybridizing solar and wind power sources together with storage batteries to cover the periods of time without sun or wind provides a realistic form of power generation. The system creates a stand-alone energy source that is both dependable and consistent.

II. MODEL DESIGN

To achieve the objective in the model following steps are needed to be accomplished:

- Connect the complete system to the grid through solar energy meter.
- Design a circuit, this can automatically calculate the electrical energy transmission to and from the grid and can control its movement
- Construct a battery bank to store generated power.
- Construct an inverter circuit i.e. to operate bulb with the help of charged battery from the solar panel.
- Construct a model prototype solar cell movement system with a mechanical assemble to move the panel from 1800 E to W.
- Design an electronic circuit to sense the intensity of light and to control DC motor driver for the panel movement.
- Construct a wind turbine generator compatible with the solar system

III. COMPONENTS USED:

- Step down transformer: 220V-12V.
- Rectifier circuit: Capacitors 100 uf, rectifier diode 4007, voltage regulator 7805.
- Microcontroller: ATMEG16
- Amplifier circuit: to amplify the signal of energy meter and forward it to microcontroller
- LCD Screen
- Variable resistance: 10K-ohm (LCD brightness controller)
- I.C. L293 (motor driver IC)
- Relay driver circuit: transistors 548 (npn), LED reverse biasing diodes (to amplify the supply from microcontroller)
- Relays: (to operate the transmission of power to or from grid)
- Toggle switch: to prevent islanding.

IV. INTEGRATED POWER GENERATION SYSTEM :

The block diagram of integrated solar- wind residential power system is shown in the diagram which is then connected to grid to supply the excess generated power. The block diagram consists of wind generator system, solar panel, solar tracking system, charge controllers, charge regulators, solar MOSFET inverter, converters (ac-dc), solar energy meter and switch to supply the generated power to grid.

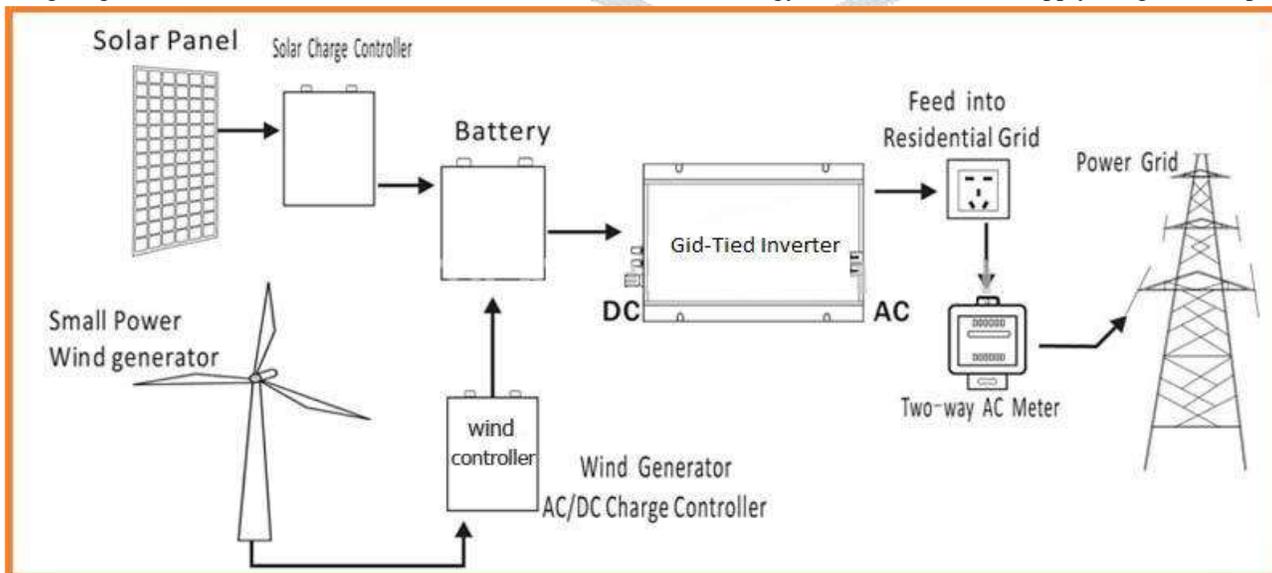


Fig. 1. Hybrid solar-Wind Power generation system

The major advantage of the system is that it meets the basic power requirements of non-electrified remote areas, where grid power has not yet reached. The power generated from both wind and solar components is stored in a battery bank for use whenever required. A hybrid renewable energy system utilizes two or more energy production methods, usually solar and wind power. The major advantage of solar / wind hybrid system is that when solar and wind power productions are used together, the reliability of the system is enhanced. Additionally, the size of battery storage can be reduced slightly as there is less reliance on one method of power production. Wind speeds are often low in periods (summer, eventually) when the sun resources are at their best. On the other hand, the wind is often stronger in seasons when there are less sun resources. Even during the same day, in many regions worldwide or in some periods of the year, there are different and opposite patterns in terms of wind and solar resources. And those different patterns can make the hybrid systems the best option. An hybrid wind-solar electric system demands an higher initial investment than single larger systems: large wind and solar PV systems are cheaper than smaller systems. But the hybrid solution is the best option whenever there is a significant improvement in terms of output and performance - which happens when the sun and the wind resources have opposite cycles and intensities during the same day or in some seasons.

Model Of The PV Cell:

A solar cell (PV cell) could be a specialized semiconductor that converts light into DC (DC). Some PV cells can even convert infrared (IR) or ultraviolet (UV) radiation into DC electricity. Electrical phenomenon cells area unit Associate in Nursing integral a part of solar- electric energy systems, that are getting more and more necessary as different sources of utility power. The subsequent shows that equivalent circuit model.

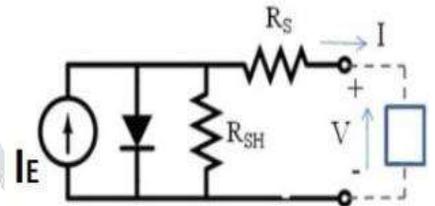


Fig.2. Circuit diagram of the PV model

In an ideal cell, the total current I is equal to the current IE generated by the photoelectric effect minus the diode current ID and shunt resistance current ISH, according to the equation: $I = I_E - I_D - I_{SH}$ ----- (1)

$$I_E - I_0(\text{EXP } QV/KT - 1) \text{ ----- (2)}$$

Where I₀ is the saturation current of the diode, Q is the elementary charge 1.6x10⁻¹⁹ Coulombs, K is a constant of value 1.38x10⁻²³J/K, T is the cell temperature in Kelvin, and V is the measured cell voltage that is either produced (power quadrant) or applied (voltage bias). The diode ideality factor is taken n which is between 1-2 (1.3 is the typical for silicon solar cell). A more accurate model will include two diode terms; however, we will concentrate on a single diode model in this document. Expanding the equation gives the simplified circuit model shown below and the following associated equation, where n is the diode ideality factor.

$$I = I_L - I_0 \{ \text{EXP}[V + I.R_S]/nKT] - 1 \} \text{ ----- (3)}$$

Construction And Working Principle Of The Wind Turbine:

Wind turbines are designed to exploit the wind energy that exists at a location. Aerodynamic modeling is used to determine the optimum tower height, control systems, number of blades and blade shape. Wind turbines convert wind energy to electricity for distribution. Conventional horizontal axis turbines can be divided into three components

- The rotor component, which is approximately 20% of the wind turbine cost, includes the blades for converting wind energy to low speed rotational energy.

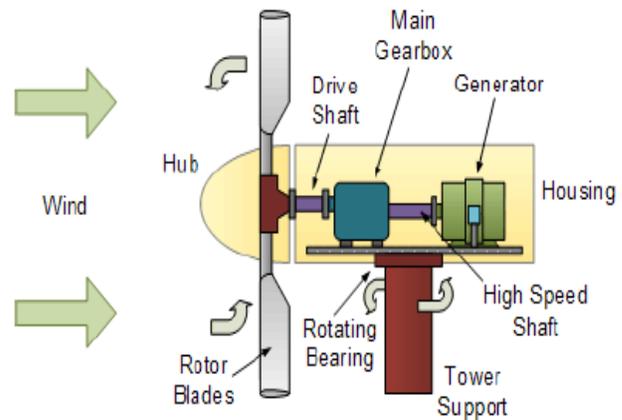


Fig.3. Construction of wind turbine

- The generator component, which is approximately 34% of the wind turbine cost, includes the electrical generator, the control electronics, and most likely a gearbox (e.g. planetary gearbox), adjustable-speed drive or continuously variable transmission component for converting the low speed incoming rotation to high speed rotation suitable for generating electricity.
- The structural support component, which is approximately 15% of the wind turbine cost, includes the tower and rotor yaw mechanism.

Hybrid (Solar And Wind) Power Generation:

The combination of solar and wind energy provides a chance to harness more reliable and eco friendly system for rooftop power generation system. To generate maximum power efficiently through the hybrid system, we need to understand the geography as well as the climatic variations of the location throughout the year. The approximate amount of sunny days and the average annual wind velocity should be known to install the best combination of the solar-wind hybrid rooftop plant. For example, the coastal areas have descent wind velocity throughout an year to generate a good amount of energy through wind generators, therefore, these area can be installed with higher number of wind generators.

There are various designs that can be installed on the rooftop according to the rooftop space available, geographical locations and climate variations which are shown in the figure.



Fig.4. Hybrid model of Solar-wind system

V. WORKING OF THE PROJECT :

Solar panels convert the light energy into electrical energy and also the wind turbine converts the wind's kinetic energy into electrical energy. The efficiency of the solar panels is increased by using an automatic solar tracker. The solar tracker is operated with the supply from the grid. Both the outputs are supplied to the charge controller. The charge controller can be used separately or in combined form. The output of the solar panel being DC can be directly fed into the storage system without any requirement of the conversion of dc into ac through the charge controllers. But, the output of the wind turbine, being ac, is rectified using a full bridge converter which is inbuilt in the wind charge controller and fed to the battery system to charge it. The battery bank is interconnected with the battery based grid tied inverter. The Inverter transmits the electrical energy produced by the solar panels and the wind turbine after completely charging the battery bank to the house load. The inverter is also interconnected to the grid, which will supply power to the load when the energy produced by the hybrid system is unavailable, hence working as the backup for the hybrid system. When the supply from the hybrid system is surplus, the excess energy is sent to the grid through a two way meter. In case of failure of both the systems i.e. hybrid rooftop system and the grid, the battery bank will work as the additional backup to the load thus making the system more reliable. Until now, grid-tied solar power systems operated only when utility power was available. When the grid went down, the electricity from your solar panels was not used. Now, specialized inverters enable your grid-tied hybrid system to charge a battery bank from which you can power your home. When the grid is running properly, your home or business will use power generated from your solar panels or pull electricity from the grid. Any excess power generated over and above your needs go back to your utility company for credits on your power bill in areas where net-metering is available. In the event of grid blackouts, these systems will switch to "off-grid mode" drawing power stored in your battery bank to power your home and using your more efficient hybrid system to recharge your battery bank.

Grid Interfacing:

The grid interfacing main service panel is the main component of this project which enables a hybrid rooftop power generation system to be interfaced with the grid. This panel allows the hybrid power system users to supply their excess generated power into the grid and also to use the grid power whenever the hybrid system fails.

VI. CONCLUSION

The amount of energy generated by a 3 kW Hybrid rooftop power system using solar tracker is more than the energy produced by a stand-alone fixed mount solar PV rooftop system. There appears to be no fundamental technical, resource, or manufacturing barrier to achieve solar and wind integrated system. The available evidence suggests the costs for doing integration so are not enormous; adding variability and new transmission costs would likely increase the cost of wind power share. This would make wind electricity more expensive, but in many cases still less expensive than that from other source of energy. Solar, in contrast, has quite high first costs, and adding variability and new transmission costs makes solar not economically competitive at current prices. Significant cost reductions in solar, however, integrated system could bring costs down to where solar wind integration could play a role in meeting future electricity needs.

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