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Hybrid Solar-Wind Power System

Jaishanakar Rai[1], Manish Bharti[2], Naveen Gupta[3], Jay Shankar[4], Manisha Gupta[5] and Rohit Garg[6]

[1,2,3,4,5,6]GNIOT Greater Noida (U.P)
E-mail: [1]er.jairai@gmail.com, [2]mrmbharti@gmail.com, [3]you2naveeen@gmail.com
[4]shankar.jay68@gmail.com, [5]manishagupta031@gmail.com, [6]rohit_garg123@yahoo.com

Abstract—*Natural renewable resources of sun and wind power have been utilized by us for production of Electricity. Thus, the Electrical Power has been generated with a minimum cost and without any pollution by our Hybrid Solar-Wind Power System. This report will reveal a novel step in generation of electricity and availability of natural resources without disturbing the ecological balance. This report describes a novel and developing Electrical Power Generation mechanism by integrating non-conventional energy sources like Solar and Wind Energy. Thus we can have an uninterrupted power supply irrespective of the weather condition without any sort of environmental pollution. Furthermore this process makes possible the electricity generation at least production cost. The equipment consists of combination of PV solar-cell array & a mast mounted wind generator, storage batteries (lead-acid), lighting loads, safety fuses, junction boxes, associated wiring, and test instruments for measuring voltages and currents. This hybrid solar-wind power generating system is suitable for Industries and also domestic areas.*

1. Introduction .

Energy is essential to our society to ensure our quality of life and to underpin all other elements of our economy. The escalation in cost and environmental concerns involving conventional electrical energy sources have increased interest in renewable energy sources. Many societies across the world in which we live have developed a large appetite for electrical energy. This appetite has been stimulated by the relative ease with which electricity can be generated, distributed, and utilized, and by the great variety of its applications. It is arguable whether the consumption of electricity should be allowed to grow unchecked, but the fact is that there is an ever-increasing demand for this energy form. Clearly, if this demand is to be met, then the world's electricity generating capacity will have to continue to grow. Presently almost all the electricity generation takes place at central power station which utilizes coal, oil, gas, water or fissile nuclear material as the primary fuel source. There are problem facing the further development of generating methods based on any of these conventional fuels.

Hydro-power generation is restricted to geographically suitable areas, and reserves of coal, although presently plentiful, are not renewable .The possible hazards of nuclear power have been much publicized, particularly those concerning the storage and military use of nuclear waste material. Nevertheless, to assist in maintaining electrical supply in many of our societies it seems likely that an increasing nuclear power presence, involving breeder and possibly fusion reactors, will be tolerated. To achieve this and also to aid in management of the existing fossil-fuel resources, it is essential that some part and an increasing part, of future electrical energy research and development be concerned with so called nonconventional methods of generation Solar-Wind power generations are visible options for future power generation. Besides being free, they are free of recurring costs.

With increasing concern of global warming and the depletion of fossil fuel reserves, many are looking at sustainable energy solutions to preserve the earth for the future generations. Other than hydro power, wind and photovoltaic energy holds the most potential to meet our energy demands. Alone, wind energy is capable of supplying large amounts of power but its presence is highly unpredictable as it can be here one moment and gone in another. Similarly, solar energy is present throughout the day but the solar irradiation levels vary due to sun intensity and unpredictable shadows cast by clouds, birds, trees, etc. The common inherent drawback of wind and photovoltaic systems are their intermittent natures that make them unreliable.

They also offer power supply solutions for remote areas, not accessible by grid power supply today around 30,000 wind turbines and more than 1,00,000 off-grid solar PV systems are installed all over the world. Wind and solar hybrid model with proper storage system have been keen interest for the last few years. In this project report a hybrid model of solar-wind is developed using the battery. The prototype model develop by us includes all realistic components in the system.

1.2 Objective .

We know that the power generated by individual sources i.e. wind and solar is neither sufficient nor reliable, as their individual efficiency is less than 50%. Therefore, our objective is to analyze the hybrid (solar and wind) power generation system which is more reliable, efficient and provides power output irrespective of weather conditions.We have worked on following gaps-

- Use of PLC (Programmable Logic Controllers) circuit
- Aerodynamic blade use in wind turbine
- Using simple gear mechanism to reduce the friction between gear
- Using MPPT charger controller

METHODOLOGY

2. Solar Power .

Solar panels are the medium to convert solar energy into the electrical energy. Solar panels can convert the energy directly or heat the water with the induced energy. PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies.

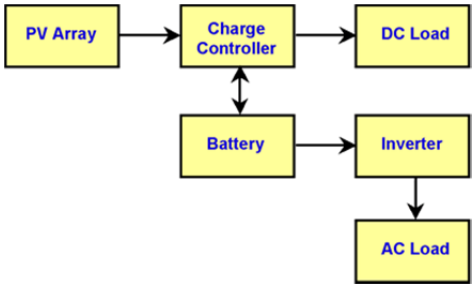


Fig. 1: Block Diagram of basic Solar Power System

Sun rays are absorbed with this material and electrons are emitted from the atoms .This release activates a current. Photovoltaic is known as the process between radiation absorbed and the electricity induced. Solar power is converted into the electric power by a common principle called photo electric effect. The solar cell array or panel consists of an appropriate number of solar cell modules connected in series or parallel based on the required current and voltage.

Storage batteries as shown in Fig.3.2 provide the backup power during cloudy weather to store the excess power or some portion of power from the solar arrays. This solar power generating system is used for domestic power consumption, Meteorological stations and entertainment places like theatre, hotel, restaurant etc.

Traditional p-n junction solar cells are the most convenient of the solar energy harvesting technologies. The basic physics of energy absorption and carrier generation are a function of the materials characteristics and corresponding electrical properties (i.e. band gap). A photon only need greater energy than 2eV that of the band gap in order to excite an electron from the valence band into the conduction band. However, the solar frequency spectrum approximates a black body spectrum at ~6000K, and as such, much of the solar radiation reaching the Earth is composed of photons with energies greater than the band gap of silicon. These higher energy photons will be absorbed by the PV cell, but the difference in energy between these photons and the silicon band gap is converted into heat rather than into usable electrical energy. For a single-junction cell this sets an upper efficiency of ~20%. The current research path of implementing complex, multi-junction PV designs to overcome efficiency limitations does not appear to be a cost effective solution. Even the optimized and developed PV materials are only operational during daylight hours and require direct (perpendicular to the surface) sunlight for good efficiency

2.1. Selection of Solar panel .

Panel - 100 Watt

Charging Time - 8 hrs.

Current - 5 A

AH Produced - 40 AH

Requirement - 35 AH

Therefore, Our Design is safe.

3. Wind turbine .

The wind energy is a renewable source of energy. Wind turbines are used to convert the wind power into electric power. Electric generator inside the turbine converts the mechanical power into the electric power. Wind turbine systems are available ranging from 50W to 3-4 MW. The energy production by wind turbines depends on the wind velocity acting on the turbine. Wind power is able to feed both energy production and demand in the rural areas.The wind turbine is made up with the wastage material taken.An alternator is taken from the car and the pulley type structure on which the belt is mounted is taken from washing machine.

Fig. 3: Wind turbine

The power available in the wind is proportional to the cube of its speed. This means that if wind speed doubles, the power available to the wind generator increases by a factor of 8 (2 x 2 x 2 = 8) Since wind speed increases with height increases to the tower height can mean enormous increases in the amount of electricity generated by a wind turbine.

4. Parameters used .

Alternator - 350 Watt

RPM - 1500

Alternator Pulley Diagram - 2 cm

Pulley Diagram - 25 cm

Gear Ratio - 1:14

Required RPM to produce Power - 1500

5. Selection of Fan .

RPM - 125 to 150
Swept Area - 1 m2 (10000 Sq. Cm)
Dia. of fan - 1 to 1.5 m

In Case of two fans to be mounted

Swept Area of each Fan - 0.5 m2 (500 sq. cm)
Diameter - 1 to 1.5

6. Swept Area Rule of Thumb .

Rules of thumb for the selection of a site for a wind turbine or a wind park contain simplified variations of the basic equations of wind power and wind energy production. As professional wind measurement is expensive and needs a long period of time to gain reliable data, especially for the siting of small wind turbines it could be sufficient to use available data and to estimate wind speeds in higher altitudes and related energy outputs by rules of thumb.

7. Selection of Battery .

Battery Requirement - 88 AH

AH reqd. by light - 25 AH

Battery capacity used - (25/88)*100 = 28 % approx.

Requirement capacity of Battery - 70%

8. Selection of controller:

Capacity - 12V/24V, 20 A

8.1 Advantages of Charge Controller .

- **Charge controller** ensures that device is not damaged because of excess voltage.
- Allow wind turbine and Solar panel to be connected.
- It does not allow battery to be discharged beyond 40% remaining capacity.

9. LED lights .

Selection of Light:

Type of Light - LED (DC Source)

Power of Light - 30 Watt

Working Time - 10 hrs.

Current reqd. by Light - 2.5 A

Calculated AH - 2.5*10 = 25 AH

10. Calculations for solar energy .

To determine the size of PV modules, the required energy consumption must be estimated. Therefore, the power is calculated as

$$PS = Ins(t) * AS * Eff(pv)$$

Where,
INS (t) = isolation at time t (kW/ m2)
AS = area of single PV panel (m2)
Effpv = overall efficiency of the PV panels and dc/dc converters.
Overall efficiency is given by, $Eff(pv) = H * PR$
Where,
H = Annual average solar radiation on tilted panels
PR = Performance ratio

4.2 Calculations for wind energy .

The power generated by wind energy is given by, Power = (density of air * swept area * velocity cubed)/2

$$PW = \tfrac{1}{2}. \rho (AW) (V) 3$$

Where,
P is power in watts (W)
ρ is the air density in kilograms per cubic meter (kg/m^3)
AW is the swept area by air in square meters (m^2)
V is the wind speed in meters per second (m/s).

4.3 Calculations for Hybrid Solar-Wind energy .

The total power generated by this system may be given as the addition of the power generated by the solar PV panel and power generated by the wind turbine.
Mathematically it can be represented as,

$$PT = NW * Pw + Ns * PS$$

Where,
PT is the total power generated
PW is the power generated by wind turbines
PS is the power generated by solar panels
NW is the no of wind turbine
Ns is the no of solar panels used

11. Cost .

The total cost of the solar-wind hybrid energy system is depend upon the total no of wind turbines used and total no of solar panels used. Therefore the total cost is given as follows:-

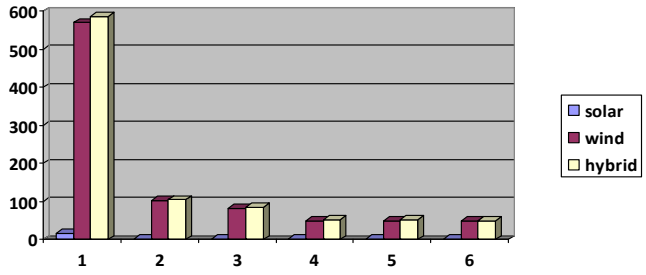
Total cost = (No. of Wind Turbine * Cost of single Wind Turbine)
+ (No. of Solar Panels * Cost of single Solar Panel)
+ (No. of Batteries used in Battery Bank * Cost of single Battery)

$$CT = (NW * CWT) + (NS * CSP) + (NB * CB.$$

Where, CT is the total cost in Rs
CWT is the cost of single wind turbine in Rs
CSP is the cost of single solar panel in Rs
CB is the Cost of single Battery in Rs
NW is the number of wind turbine used
NS is the number of solar panels used
NB is the number of Batteries used in Battery Bank**.**
Solar-wind hybrid energy systems needs only initial investment. It will compete well in generation with the conventional energy sources. When accounted for a lifetime of reduced or avoided utility costs. The cost of the system depends on the system chosen, wind resource on the site, electric costs in the area, and the battery bank required. Cost of the Wind-Solar Hybrid system is to be minimized. For minimize the cost of the system we need to increase the use of non-conventional energy sources. So that production of solar and wind power generator will be increase. That will reduce cost of the whole system.

11. Graphical Representation of the Effect of Hybridization .

This graph shows us the effect of hybridization of the two energy sources in different parts of India. It is based on the given data in the graph, which shows that it is more suitable in generating energy than individual energy sources.



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