

HYBRID POWER GENERATION USING SOLAR AND WIND ENERGY

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ABSTRACT

Energy is critical to the economic growth and social development of any country. Indigenous energy resource needs to be developed to the optimum level to minimize dependence on imported fuels, subject to resolving economic, environmental and social constraints. This led to investments in renewable energy industry in search of ways to meet demand and to reduce dependency on fossil fuels. Solar and wind energy are becoming popular owing to abundance availability and ease of harnessing for electrical power generation. This project focuses on an integrated hybrid renewable energy system consisting of solar and wind energy. The focal point of this project is to propose and evaluate a solar-wind hybrid power generation system for a selected location / use. Solar power generation systems make use of solar PV similarly, wind turbine and wind mill is used to produce electricity. This electrical power can utilize for various purpose. Generation of electricity will be takes place at affordable cost. This project deals with the generation of electricity by using two sources combine which leads to generate electricity with affordable cost without damaging the nature balance.

Keywords: Solar Energy, Wind Energy, Hybrid energy, PV Solar panels. VAWT

1. INTRODUCTION

Electricity is most needed for our day to day life. There are two ways of electricity generation either by conventional energy resources or by non-conventional energy resources. Electrical energy demand increases in word so to fulfill demand we have to generate electrical energy. Now a day's electrical energy is generated by the conventional energy resources like coal, diesel, and nuclear etc. The main drawback of these sources is that it produces waste like ash in coal power plant, nuclear waste in nuclear power plant and taking care of this wastage is very costly. And it also damages he nature. The nuclear waste is very harmful to human being also. The conventional energy resources are depleting day by day. Soon it will be completely vanishes from the earth so we have to find another way to generate electricity. The new source should be reliable, pollution free and economical. The non-conventional energy resources should be good alternative energy resources for the conventional energy resources. There are

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many non-conventional energy resources like geothermal, tidal, wind, solar etc. the tidal energy has drawbacks like it can only implemented on sea shores. While geothermal energy needs very larger step to extract heat from earth. Solar and wind are easily available in all condition. The non-conventional energy resources like solar, wind can be good alternative source. Solar energy has drawback that it could not produce electrical energy in rainy and cloudy season so we need to overcome this drawback we can use two energy resources so that any one of source fails other source will keep generating the electricity. And in good weather condition we can use both sources combine.

Since the sources of both individual solar and wind energy are not stable and often inconsistent. It is required to hybridize the power generation of wind and solar energy source with batteries bank as the storage to overcome the periods without wind or solar energy supplies a stable and constant power generation. However, in the case of wind power, it is totally different to the conventional fossil fuel, nuclear power plant and hydroelectric power station. Meanwhile, wind energy is one of the least expensive renewable energy technologies currently. PV cells or photovoltaic is commonly known as solar cells, it able to convert the thermal energy from sunlight into direct current electricity. Solar energy offered major advantages which are better than other renewable energy such as no noise pollution during the power generation and insignificant periodic maintenance required.

2. HYBRID ENERGY SYSTEM

Hybrid energy system is the combination of two energy sources for giving power to the load. In other word it can defined as “Energy system which is fabricated or designed to extract power by using two energy sources is called as the hybrid energy system.” Hybrid energy system has good reliability, efficiency, less emission, and lower cost. In this proposed system solar and wind power is used for generating power. Solar and wind has good advantages than other than any other non-conventional energy sources. Both the energy sources have greater availability in all areas. It needs lower cost. There is no need to find special location to install this system.

3. SOLAR ENERGY

Solar energy is that energy which is gets by the radiation of the sun. Solar energy is present on the earth continuously and in abundant manner. Solar energy is freely available. It doesn't produce any gases that mean it is pollution free. It is affordable in cost. It has low maintenance cost. Only problem with solar system it cannot produce energy in bad weather condition. But it has greater efficiency than other energy sources. It only need initial investment. It has long life span and has lower emission.

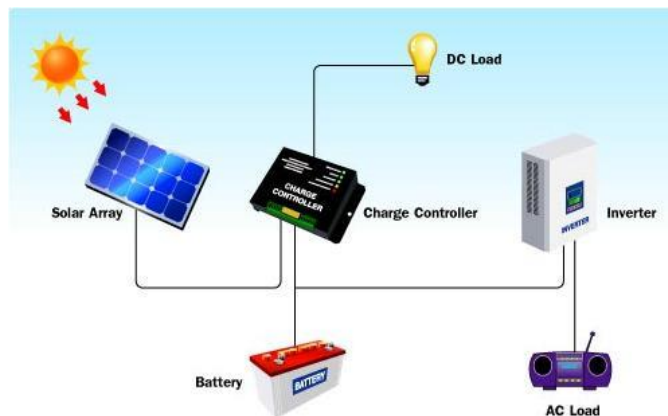


Figure 1 Solar PV System

4. WIND ENERGY

Wind energy is the energy which is extracted from wind. For extraction we use wind mill. It is renewable energy sources. The wind energy needs less cost for generation of electricity. Maintenance cost is also less for wind energy system. Wind energy is present almost 24 hours of the day. It has less emission. Initial cost is also less of the system. Generation of electricity from wind is depend upon the speed of wind flowing. The major disadvantages of using independent renewable energy resources are that unavailability of power for all time. For overcoming this we use solar and wind energy together. So that any one source of power fails other will take care of the generation. In this proposed system we can use both sources combine. Another way is that we can use any one source and keep another source as a stand by unit. This will leads to continuity of generation. This will make system reliable.

The main disadvantages of this system are that it needs high initial cost. Except that it is reliable, it has less emission. Maintenance cost is less. Life span of this system is more. Efficiency is more. A main advantage of this system is that it gives continuous power supply.

5. DESIGN CALCULATIONS OF HYBRID ENERGY SYSTEM

For design of the hybrid energy system we need to find the data as follows:

A. Data required for Solar System:

1. Annual mean daily duration of Sunshine hours
2. Daily Solar Radiation horizontal (KWH/m²/day)

B. Data required for Wind System:

1. Mean Annual Hourly Wind Speed (m/sec)
2. Wind Power that can be generated from the wind turbine

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,

$$P_T = (N_w * P_w) + (N_s * P_s)$$

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

5.1. Calculations for wind energy

The power generated by wind energy is given by,

$$\text{Power} = (\text{density of air} * \text{swept area} * \text{velocity cubed})/2$$

$$P_w = \frac{1}{2} \cdot \rho (A_w) (V)^3$$

Where,

P is power in watts (W)

ρ is the air density in kilograms per cubic meter (kg/m³)

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A_w is the swept area by air in square meters (m^2)

V is the wind speed in meters per second (m/s).

5.2. Calculations for solar energy

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

$$P_s = I_{ns}(t) * A_s * \text{Eff}(pv)$$

Where,

$I_{ns}(t)$ = isolation at time t (kw/m^2)

A_s = area of single PV panel (m^2)

Eff_{pv} = overall efficiency of the PV panels and dc/dc converters.

Overall efficiency is given by,

$$\text{Eff}(pv) = H * PR$$

Where, H = Annual average solar radiation on tilted panels. PR = Performance ratio, coefficient for losses.

5.3. 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)*

$$C_T = (N_w * C_{WT}) + (N_s * C_{SP}) + (N_B * C_B)$$

Where,

C_T is the total cost in Rs.

C_{WT} is the cost of single wind turbine in Rs.

C_{SP} is the cost of single solar panel in Rs.

C_B is the Cost of single Battery in Rs.

N_w is the number of wind turbine used

N_s is the number of solar panels used

N_B is the number of Batteries used in Battery Bank.

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.

6. WORKING PRINCIPLE

6.1. SOLAR ENERGY

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produce any gases that mean it is pollution free. It is affordable in cost. It has low maintenance cost. Only problem with solar system it cannot produce energy in bad weather condition. But it has greater efficiency than other energy sources. It only need initial investment.

It has long life span and has lower emission. Photovoltaic directly convert solar energy into electricity. They work on the principle of the photovoltaic effect. When certain materials are exposed to light, they absorb photons and release free electrons. This phenomenon is called as the photoelectric effect. Solar panels work by absorbing sunlight with photovoltaic cells, generating direct current (DC) energy and then converting it to usable alternating current (AC) energy with the help of inverter technology. AC energy then flows through the home's electrical panel and is distributed accordingly.

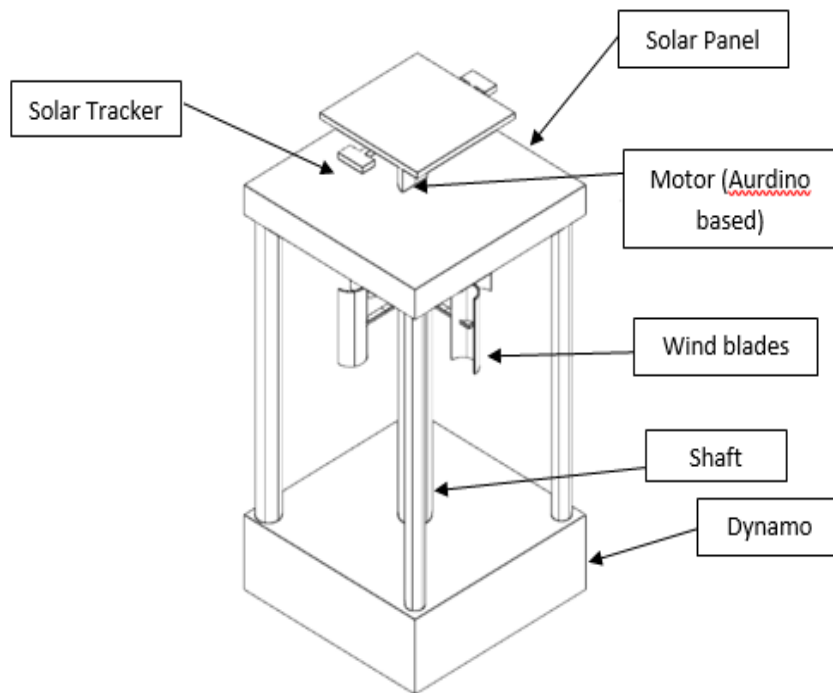


Figure 2 Experimental Diagram of Hybrid Power System

7. WIND ENERGY

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8. MATERIAL SELECTION & ITS SPECIFICATIONS

The proper selection of material for the different part of a machine is the main objective in the fabrication of machine. For a design engineer it is must that he be familiar with the effect, which the manufacturing process and heat treatment have on the properties of materials. The choice of material for engineering purposes depends upon the following factors.

Table 1 Raw Materials and its Specifications

S.no	Part name	Material	Quantity	Description										
1	Shaft	Mild Steel	1	DIA 25x450MM										
2	Arduino Tracker	-	2	NIL										
3	Solar Panel	Silicon	1	12V, 20W										
4	Dynamo	-	1	6V										
5	Wind Blades	PVC	4	DIA 50x150MM	6	Nut, Bolt, Washer	Mild Steel	12	M10	7	Gear Motor	-	1	12V, 30RPM
6	Nut, Bolt, Washer	Mild Steel	12	M10										
7	Gear Motor	-	1	12V, 30RPM										



Figure 3 Fabrication Hybrid Power System

9. MERITS, DEMERITS & APPLICATIONS

MERITS

- Producing much more efficiency as two or more renewable energy generation system working together in the terms of electrical energy generation.
- Since, the system doesn't have microcontroller or microprocessor the complexity of system testing and understanding became easy in terms of difficulties.
- System maintains is remarkably reduced and becomes easy.
- Renewable energy sources like, sun, wind,. Are utilized so, no waste production.
- Producing clean, friendly to environment, renewable energy.
- Once the system is designed and developed or manufactured, the installation of system is easy.
- Within certain time period the installation cost gets covered.
- If the system gets damaged in case, no need of changing entire system or subsystem. Just, changing a damage component will work out.

DEMERITS

There's no system without having a disadvantage. So as, the system have disadvantages as follow:

- The first time installation cost is huge in terms of finance.
- The circuit designing complexity is more as there in no micro-computer for controlling action.

9.1. APPLICATIONS

- Both energy can be used for different purposes like solar water heater, wind power generation, streetlight, Powering up for communication system.
- Pump irrigation Systems.

10. CONCLUSION

Hybrid power generation system is good and effective solution for power generation than conventional energy resources. It has greater efficiency. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. Cost reduction can be done by increasing the production of the equipment. People should motivate to use the nonconventional energy resources. It is highly safe for the environment as it doesn't produce any emission and harmful waste product like conventional energy resources. It is cost effective solution for generation. It only need initial investment. It has also long-life span. Overall, it is good, reliable and affordable solution for electricity generation. As the awareness of non-renewable sources and pollution causes by them, the clean energy production with renewable sources is widely preferred and day by day implementation of such sources going on, so, research and resources are also increasing for such plants and projects. As the first time installation cost is higher due to design and manufacturing perspective. The system can be monitories using graphical user interference on computer. So, the whole information will be available to user and/or stored regarding further applications and development.

REFERENCES

- [1] T.S. Balaji Damodhar and A. Sethil Kumar, "Design of high step up modified for hybrid solar/wind energy system," Middle-East Journal of Scientific Research 23 (6) pp. 1041-1046, ISSN 1990-9233, 2014.
- [2] Rakeshkumar B. Shah, "Wind solar hybrid energy conversion system- literature review," International Journal of Scientific Research, Vol. 4, Issue 6, ISSN 2277-8179, June 2014.
- [3] A Textbook of "*Non-Conventional Energy Sources and Utilization*," by Er. R.K. Rajput, 4th Edition – 2009.
- [4] Manwell, J.F., McGowan, J.G. and Rogers, A.L. (2009). Wind Energy Explained: Theory, Design and Application, John Wiley & Son Ltd.
- [5] Leake, E.W. (2010). Genset-Solar-Wind Hybrid Power System of Off-Grid Power Station for Rural Applications: Sustainable off-grid power station for rural applications. IEEE journal 5(2), 98-102.
- [6] <https://www.energy.gov> > [buying-and-making-electricity](#)
- [7] <https://www.ge.com> > [renewableenergy](#) > [hybrid](#)
- [8] <https://upriseenergy.com>