POWER GENERATION USING VERTICAL AXIS WIND TURBINE AND SOLAR

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ABSTRACT

Energy today, is the need of 21st century. The renewable energy resources therefore are used in tremendous amount as they are easily available and cost free. But these energies in standalone forms have disadvantages such as unpredictability, availability in all time etc. which can be overcome by hybrid energy systems. They are basically consists of combinations of number of renewable energy resources.
This paper will describe a novel system for generation dispatchable electric power using wind and solar energy combined through compressed air for transmission and storage large area solar air heating collector integrated with high heat capacity thermal storage media. This paper proposes a hybrid energy system, which combines photovoltaic (PV) and wind power as an alternative source small-scale electric power, where the conventional production is not practical. The proposed system is attractive because of its simplicity, ease of control and low costs. Complete descriptions of the proposed hybrid system with the results of detailed simulations, which determine feasibility, are given to demonstrate the availability of the proposed system in this paper.

Keywords:- *Hybrid, Renewable, Less complexity, Economical, Efficient*.

1. INTRODUCTION

For development of any country energy plays an important role. It is very essential part of growth & economy of country. Our primary source of generating energy is from coal, oil and natural gas. As we all know that energy is needed for industrial, agriculture, commercial and domestic purpose. World's energy demand is increasing day by day. There are many sources of generating energy from coal, fossil fuels, oil and other gases [10]. The main function of Hybrid solar energy is that it obtain energy from both sources-solar energy with the help of PV panels & wind energy from wind turbines. Solar panel absorbs the sunrays and convert it into DC current. And wind turbine moves due to the force of wind & its rotor connects with a generator also rotates and gives AC current. This AC current converts into DC with the help of AC-DC converter. Now both the current works simultaneously and goes to the circuit board and charge the mobile phones connected with the help of wires[6].There are many renewable energy sources but wind & solar energy is most prominent. Because if we talk about renewable energy source the first thought is about wind- solar, it is well known source of energy and widely distributed everywhere. Single source of energy such as wind & PV is not totally reliable due to climate change or sunshine in night hours or rainy season and wind speed variation [1]. The wind turbine is a device that utilizes wind energy to generate mechanical or electrical power. Therefore, the idea of implementation of wind turbines along the highways on dividers may bring the revolution in energy sector in future. In the condition that the desired location (highways) will be covered by sunlight in the day time so the solar panel can be included with VAWT for more power output [9].

1.1 Solar Power

Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaics (PV), indirectly using concentrated solar power, or a combination[9]. Concentrated solar power systems use lenses or and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic cells convert light into an electric current using the photovoltaic effect[3].

1.2 Wind Power

Wind energy is a form of solar energy. Wind energy (or wind power) describes the process by which wind is used to generate electricity. Wind turbines convert the kinetic energy in the wind into mechanical power. A generator can convert mechanical power into electricity. Mechanical power can also be utilized directly for specific tasks such as pumping water[10]. Wind farms consists of individual turbines connected to electric power transmission network which produces plentiful, renewable, widely distributed, clean, inexpensive.

1.3 Hybrid Energy System

This system is combination of wind energy and solar energy, used to generate power from each other. Hybrid system is having advantage than system those which are totally depend on single source of energy. Researchers have very tough task to maximize the total energy output from the system with lower cost & reliability [8]. Generally wind-solar hybrid power system consists of wind turbines, photovoltaic array, controller and storage battery.
Wind turbines is used to convert wind energy into mechanical energy and then into electric energy.Whatever electric energy is generating from this system is alternate & unstable. So some controlling units or inverters are used to make it continuous and store into battery. This energy utilize for domestic purpose or other. Photovoltaic array having solar panels through series or parallel, converts solar energy into electrical energy This energy is in DC form, it is stored in battery and controller supply power for AC or DC loads. This system having high daily electricity generation capacity, low fabrication cost, maintenance is low and has other advantages also [10]. Solar-wind power generations are clear and non-polluting. Also they complement each other. It is efficient way of supplying electricity. Wind speed and sun shine is different in different parts of the world. The hybrid system of solar/wind is environmental friendly.to use conventional energy resource rays to electrical energy. The solar system basically consist of following parts, Solar PV panel, Wind Turbine, Controller, Invertor, Battery, Load.

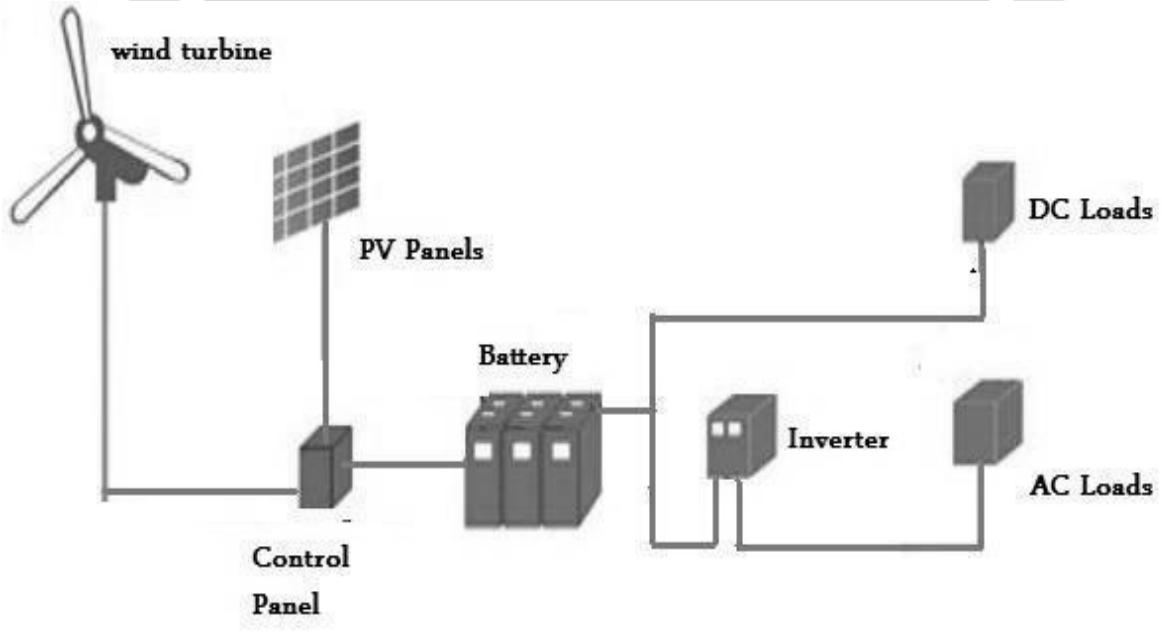

Fig.1 Solar-Wind Hybrid System

1.3.1 PV Panels

A number of PV panels connected in series and/or in parallel giving a DC output out of the incident irradiance. Orientation and tilt of these panels are important design parameters, as well as shading from surrounding obstructions[9].

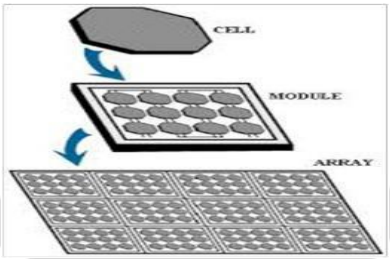

Fig.2: Solar Cell

1.4 Construction of Photovoltaic (P.V) Tracking Solar Modules

The photovoltaic cells are called as "solar-cell"or "photocell" because they are made up of several solar cells (silicon material) which are whether proof in nature. The solar cell basically is diode which converts incident rays to electrical[4].

1.5 Solar Tracking Control System

Our system basically consists of PV panel which is having dimensions of 12*20cm. It is placed on the triangular shaped stand of height 36cm and base is of 20cm. The 2 LDR sensors are placed on the two corners of the PV module which are placed equidistant from the axial holding of the stand . They control themselves by using the bridge wave rectifier[11].

Principle of Working

Whenever the light falls on the LDR sensor, its resistance decreases and thus the large amount of current flows through the diodes .Which results into rotation of the motor and thus enables the tracking of the panel. Thus it adjusts itself to the direction of the intensity of the sun[7].

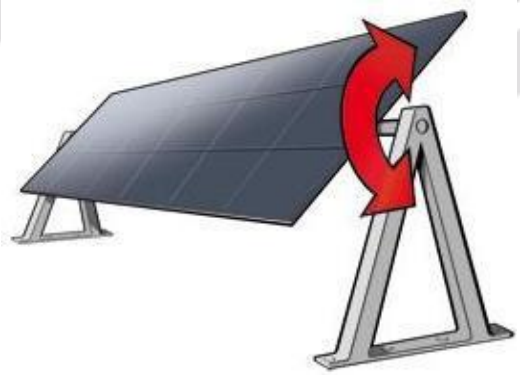

Fig.3: Solar PV Cell

1.6 Wind Turbines

Wind turbine is a machine for converting the kinetic energy in wind into mechanical energy. Wind turbine can be separated into two basic types based on the axis about which the turbine rotate. Turbines that rotate around a horizontal axis are more common. Vertical axis turbine are less frequently used. Wind turbine can also be classified by the location in which they are used as Onshore, Offshore, and aerial wind turbines[7].

Fig.4 : Wind Turbines

2. COMPONENTS

2.1 Dynamo

We have used the dynamo for generation purpose. The operating principle of electromagnetic generators was discovered in the years 1831–1832 by Michael Faraday. The principle, later called Faraday's law, is that an electromotive force is generated in an electrical conductor which encircles a varying magnetic flux. A dynamo is an electrical generator that produces direct current with the use of a commutator. Dynamos were the first electrical generators capable of delivering power for industry, and the foundation upon which many other later electric-power conversion devices were based, including the electric motor, the alternating-current alternator, and the rotary converter.

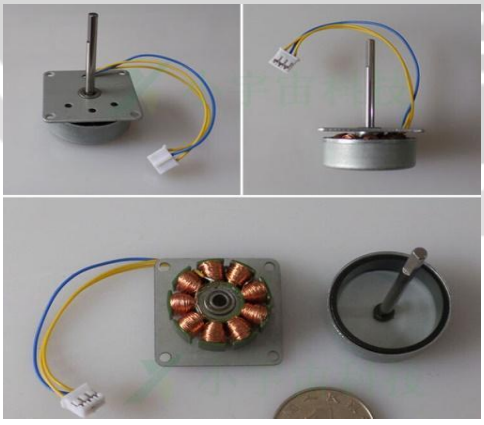

Fig 5: Dynamo

2.2 loads

They stand for the various AC and DC appliances that get electricity from the power system.

2.3 Solar Controller and Wind Controller

Control battery bank charge and discharge reasonable and safety.

2.4 Inverter

They are used to obtain AC and DC supplies as per need.

2.5 Battery

There can be a single battery or multiple batteries connected together to create essentially one large battery of the required voltage and amp-hour capacity. An electric battery is a device consisting of one or more electrochemical cells with external connections provided to power electrical devices such as flashlights, smartphones, and electric cars[3].

2.6 WORKING

Solar and wind hybrid power systems are designed using solar panels and small wind turbine generators for generating electricity. Generally, solar wind hybrid systems possess small capacity. Typical power generation cannot exceed more than 1kW to 10kW. Solar power system includes solar panels, solar photovoltaic cells, and batteries for storing the converted energy[5]

In this project we using solar panel ,dynamo, battery, inverter are assembled for the production of energy by natural mean. In this project we discuss the working , when the wind pass through the turbine blades, turbine will rotate and thus kinetic energy is generated by these rotations which can be converted to electrical energy, which is coupled with dynamo, due to rotating action of dynamo it will produce direct current, which is stored in battery[3]. Also solar panel is mounted on the turbine which is also produce dc energy when the sunlight falls on the solar panel by allowing photons, or particles of light, to knock electrons free from atoms, generating a flow of electricity[2]. Solar panels actually comprise many, smaller units called photovoltaic cells. Which energy is also stored in battery and then this dc energy is converted to ac energy by inverter[4].

Minimum wind speed required for connection of the generator to the power grid is known as cut in speed while, maximum wind speed required for the generator for disconnecting the generator from the power grid known as cut off speed[12].

Generally, wind turbines are accessible to the range of speed between cut in and cut off speeds. Wind turbine is a device consist three blades which on rotation produces the electricity in such a way that that the axis of rotation must be perpendicular to the direction of blowing wind[6].The generator are placed place at the base level in vertical axis turbine and Nacelle is not required (where nacelle having propeller gear).

These solar panels are available at the output ratings like 5 watts, 10 watts, 20 watts, 100 watts etc. Hence we can select the solar panel as per our need. During normal sunlight a panel which has 12 volt 20 watt can produce 1.15 ampere current[3].

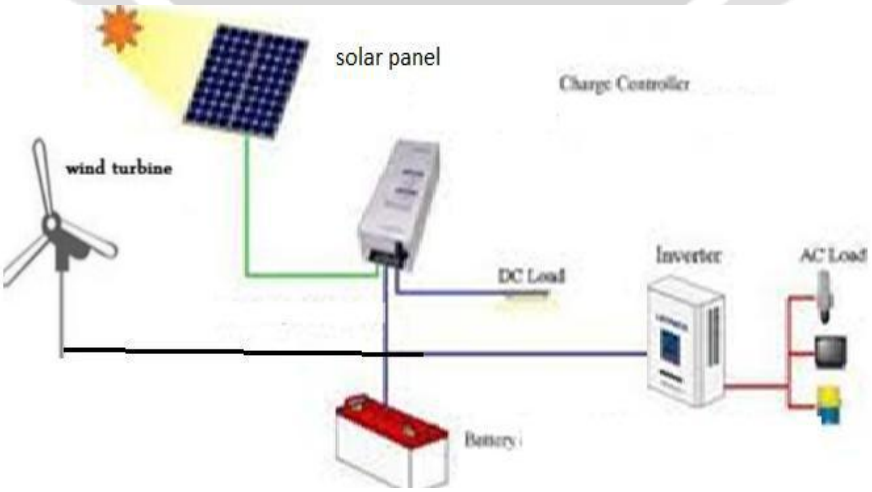

Fig.6: Hybrid Solar-Wind Power Generator

3. CALCULATION

3.1 Proposed Calculation

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.

3.2 Calculations for wind energy

The power generated by wind energy is given by,

Power = (density of air * swept area * velocity cubed)/2

$$\mathbf{PW} = {}^{\mathbf{1}}/_{\mathbf{2}}\,\boldsymbol{\rho}(\mathbf{A})(\mathbf{W})\mathbf{V}^{\mathbf{3}}$$

Where,

P is power in watts (W)
ρ is the air density in kilograms per cubic meter (kg/m³)
AW is the swept area by air in square meters (m²) V is the wind speed in meters per second (m/s).

3.3 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.

The overall efficiency is given by,

Eff(pv)= H * PR

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

C. 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 efficiently work with the conventional energy sources. When accounted for a lifetime of reduced or avoided utility costs. The cost of the system is based on the factors such as 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 minimized using non-conventional energy sources.

4. APPLICATIONS

1) Ideal for cell phone recipient station.
2) Farm house, guesthouse, Hospital, Hotels, Street light, Traffic light.
3) Remote and Rural village Electrification.
4) Transmission and communication Tower and many more application.
5) Home Applicants.

5. ADVANTAGES

6) Design for easy to operate, servicing and maintenance where required.
7) No pollution and Long term Warranty.
8) No recurring fuel costs, highly reliable and consistent power supply.
9) Accept wind from any angle.
10) Components can be mounted at ground level.
11) Low Height required.

6. DISADVANTAGES

12) Poor self-starting capabilities.
13) At night, we can't use solar energy.
14) The efficiency of solar cell is less.
15) Rotor are generally ground where wind is poorer.

7. CONCLUSION

The use of solar–wind hybrid renewable energy system is ever-increasing day by day and has shown incredible development in last few decades for electricity production all over the world. By using this development of new technologies and researches in the field of solar wind hybrid renewable energy system, a new difficulty arises, which become much more easily solved with new techniques. The presented review paper reported the different techniques and ideas about the HRES and its energy utilization.

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