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DESIGN OF FUTURE TREE TO HARVEST SOLAR AND WIND ENERGY

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***Abstract*—Renewable energy sources i.e. energy generated from solar, wind, biomass, hydropower, geothermal and ocean resources are considered as a technological option for generating clean energy. But the energy generated from solar and wind alone is much less than that produced by fossil fuels, however, electricity generation by utilizing PV cells and wind turbine together is increasing rapidly in recent years as an alternative source. This paper presents the Solar-Wind hybrid Power system that harnesses the renewable energies of Sun and Wind to generate electricity using the concept of the PVC pipe material based VAWT blades with an l/d ratio of 1 and PV cells of 3 watt. System control relies mainly on microcontroller. It ensures the optimum utilization of resources and hence improve the efficiency as compared with their individual mode of generation. Also it increases the reliability and reduces the dependence on one single source. This hybrid solar-wind power generating system is suitable for domestic areas.**

Keywords—Solar-wind hybrid energy, renewable energy, electricity generation, PV solar cells, PVC pipe blade VAWT.

I. INTRODUCTION

Renewable energy sources have attracted increasing applications in domestic as well as industrial areas such as solar water heaters, solar energy plants, wind energy plants, hydroelectric power plants, etc. As it is known that, fossil fuels sources are getting exhausted rapidly, therefore there is major need to find alternate and efficient renewable sources of energy.

We use energy everyday in our lives – our electronic appliances need electricity for power, streetlights need the same for lighting, vehicles need gasoline and diesel. We fuel our homes with domestic oil, propane or electricity from national or local grid for lighting, heating and for powering our devices. Hence, in this project we have decide to use combination of renewable energy sources for the power generation. We have made use of solar energy and wind energy for efficient production of energy as we get a lot of solar energy during day time. But during night time, solar system becomes a drawback as no sunrays are received during night period. So in order to keep the system running, it is necessary to develop a hybrid technology that makes use of two or more energy sources and keeps the system running all the day. During summer, the winds travel slower than that in winter season. Thus, these differences in the wind speed i.e. the behavior of wind speed on seasonal basis have direct effect on the generation of energy. As power generated from these stations cannot be stored for long time, it has to be utilized and hence there comes limitations on wind power alone too.

As the peak operating times for wind and solar systems occur at different times of the day along the year, hybrid systems are more likely to produce power when you need it. According to many renewable energy experts, a small "hybrid" electric system that combines wind electric and solar electric (photovoltaic or PV) technologies offers several advantages over either single system in much areas of the India. Wind speeds are low in the summer when the sun shines brightest and longest. The wind is strong in the winter when less sunlight is available. Because the peak operating times for wind and solar systems occur at different times of the day and year, hybrid systems are more likely to produce power for most of the time in a day.

Many hybrid systems are stand-alone systems, which operate "off-grid" -- not connected to an electricity distribution system. For the times when neither the wind nor the solar system are producing, most hybrid systems provide power through batteries and/or an engine generator powered by conventional fuels, such as diesel. If the batteries run low, the engine generator can provide power and recharge the batteries. Adding an engine generator makes the system more complex, but modern electronic controllers can operate these systems automatically. An engine generator can also reduce the size of the other components needed for the system. Keep in mind that the storage capacity must be large enough to supply electrical needs during non-charging periods. Battery banks are typically sized to supply the electric load for one to three days.

Combining latest wind turbine with PV (Solar) panels gives the best of both worlds for greater independence from costly grid electricity bills. From apartments to street lighting, hybrid systems are starting to bring consistent power to areas worldwide, turbines/wind mills are an ideal solution to the traditional wind turbine, which need very high structures to allow room for their massive blades.

A. The solar-wind hybrid energy future tree system:

There are wind turbines available which works only on wind energy and there are solar panels available which works only on solar energy. But our motto is to use both the energy sources combined as a hybrid source for electricity energy generation. Normally, lots of messy and expensive solar batteries are used to store energy when the sun goes down or if the wind stops blowing. Due to air/ground temperature difference, when the sun goes in ground wind instantly increases. So the Exclusive hybrid system produces power day

and NIGHT! In any wind corridor, Island or Coastal region you would expect to have electricity 24/7 without interruption.

B. Solar power:

Solar power is the conversion of sunlight into electricity, either directly using photovoltaic (PV), or indirectly using concentrated solar power. Concentrated solar power systems (Unified Solar) use lenses or mirrors and tracking systems to focus a large area of sunlight into a small beam. Photovoltaic convert light into an electric current using the photovoltaic effect.

Photovoltaic were initially solely used as a source of electricity for small and medium-sized applications, from the calculator powered by a single solar cell to remote homes powered by an off-grid rooftop PV system. As the cost of solar electricity has fallen, the number of grid-connected solar PV systems has grown into the millions and utility-scale solar power stations with hundreds of megawatts are being built. Solar PV is rapidly becoming an inexpensive, low-carbon technology to harness renewable energy from the Sun.

C. Wind Power:

Wind is known to be another form of solar energy because it comes about as a result of uneven heating of the atmosphere by the sun coupled with the abstract topography of the earth's surface. With wind turbines, two categories of winds are relevant to their applications, namely local winds and planetary winds.

The latter is the most dominant and it is usually a major factor in deciding sites for very effective wind turbines especially with the horizontal axis types. These winds are usually found along shore lines, mountain tops, valleys and open plains.

The former is the type you will find in regular environments like the city or rural areas, basically where settlements are present.

Wind power is the use of air flow through wind turbines to mechanically power generators for electricity. Wind power, as an alternative to burning fossil fuels, is plentiful, renewable, widely distributed, clean, produces no greenhouse gas emissions during operation, consumes no water, and uses little land. The net effects on the environment are far less problematic than those of non-renewable power sources.

Wind farms consist of many individual wind turbines which are connected to the electric power transmission network. Onshore wind is an inexpensive source of electricity, competitive with or in many places cheaper than coal or gas plants. Offshore wind is steadier and stronger than on land, and offshore farms have less visual impact, but construction and maintenance costs are considerably higher. Small onshore wind farms can feed some energy into the grid or provide electricity to isolated off-grid locations.

II. Problem Statement

To design, develop and install a solar and wind future tree that supplies efficient power for domestic as well as industrial use.

III. Objective

- The media has been focusing on this issue and many green movements have started to try and reduce our "carbon footprint".
- There are only a few types of energy that do not produce carbon dioxide. These are nuclear power and renewable energy sources such as wind, solar and hydro power.
- Renewable energy sources are the cleanest from of these sources, because there is no waste formation as a by-product from these sources.
- This project focuses on the utilization of wind and solar energy together as a hybrid source of renewable energy source. And also the aim of this major qualifying project is to design and implement vertical axis wind turbine system that has ability to operate in both high and low speed conditions.
- Our choice of this project is to showcase its efficiency in varying wind conditionals compared to traditional horizontal axis wind turbine and contribute to its steady growing popularity for the purpose of mass utilization in the near future as a reliable source of power generation.
- Due to air/ground temperature and pressure difference, when the sun goes in ground wind instantly increases. So the exclusive hybrid system produces power Day and Night.

IV. Literature Review

1) Mr SthitaPrajna Mishra, Dr S.M.Ali, Ms Prajnasmita Mohapatra, Ms Arjyadhara Pradhan:

"A Hybrid System (Solar and Wind) Energy System for Remote Areas", states that the collection of the solar panel was enhanced by 68.5% from that of the single panel with the help of reflectors and tracking. Further energy obtained using the windmill with addition of dedicated wind sensor and altered design together adds to an increase in the efficiency by an overall margin of above 50%.

2) J.Godson, M.Karthick, T.Muthukrishnan, M.S.Sivagamasundari:

"Solar PV-Wind Hybrid Power Generation System" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, states that A portion of the energy requirement for a private house, farm house, a small company, an educational institution or an apartment house depending on the need at the site where used has been supplied with the electricity generated from the wind and solar power. It reduces the dependence on one single source and has increased the reliability.

3) Ashish S. Ingole, Prof. Bhushan S. Rakhonde:

"Hybrid Power Generation System Using Wind Energy and Solar Energy", states that 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 non-conventional 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.

4) Deshmukh and Deshmukh:

They discussed the methods of modelling and designing hybrid renewable energy systems, and also issues involved in increasing the penetration of such systems.

5) S P Sukhatme:

"Electricity for India's Future Growth –The Renewable Energy and Nuclear Energy Options".

6) Jyoti Wavhal, Rachana Kulkarni, Prasannati Kulkarni, Sheetal Gore:

"Wind Power Generation", Renewable power generation systems have been recently getting more and more attention due to the cost competitiveness, and are environment friendly as compared to the fossil fuel and nuclear power generation. Besides the conventional renewable power generation such as hydro and pumping storage, wind power generation has been considered as the most cost effective with developing potential. The increase of unit size and enhancement of performance with higher loading factor and reliability have made wind power generation more attractive and its unit generation cost becomes very competitive as compared to traditional fossil generation.

7) Shekhanabi B Chalageri, Akash M Deshpande, Manjunath S Banad, Anoop S Pavate, Prof. Sujata Eresimi:

"Generation of Electricity by Wind Tree" Energy from wind is the fastest growing source of electricity in the world. In this project wind energy is used to generate electricity with the help of aero leaves. Several leaf shaped aero leaves are placed in the form of tree, called Wind Tree. Wind Tree uses tiny blades housed in the aero leaves to generate power from wind energy. These wind trees are able to generate power regardless of the wind direction and with minimum wind speed of 7Kmph. In this project we have used tree shaped structure, covered with leaf shaped mini turbines called aero-leaves which are of savonius type turbine and designed to produce the power which will catch the wind from all the directions. All cables and generators are integrated into the leaves and branches.

8) Bedri Kekezoğlu, Muğdeşem Tanrıöven, Ali Erduman:

"A New Wind Turbine Concept: Design and Implementation"

Electrical energy demand has been continuously increasing. Depleting fossil fuel reserves, environmental concerns, and insufficiency of conventional generation techniques in meeting growing demand, renewable energy use has been widely adopted in the world. When considering the application of renewable energy sources in the world, it can be seen that wind energy is mostly preferred over other renewable energy sources. In this study, a new prototype wind energy conversion system suitable for urban use is designed and manufactured.

9) V. Renugadevi:

"An Approach to Solar Power Tree" Recently with the rising population and energy demands, we should get an option of renewable energy source and that energy source should not cause pollution and other natural hazards. For this condition the Solar Energy is the best alternative for us. A Solar Power Tree is the best innovative way, which requires very less place to produce energy efficiently. We can also use the "Spiralling Phyllataxy" to improve the efficiency of the plant. It is much better than traditional solar PV system in area point of view and also more efficient. So this will be a very good option and should be implemented.

V. DESIGN, CALCULATIONS & READINGS

The below fig shows the actual design model of the future tree. In which it shows there are two solar plate and two wind turbine which are used to generate the energy by using the solar and wind.

Figure 1 Design Model of Future Tree

The above fig shows the Catia Model of the solar plate and wind turbine future tree which is drawn into Catia software. The above fig shows is the final assembly part of the future tree. In that tree model there are various parts are draw by the different part drawings and finally it assemble.

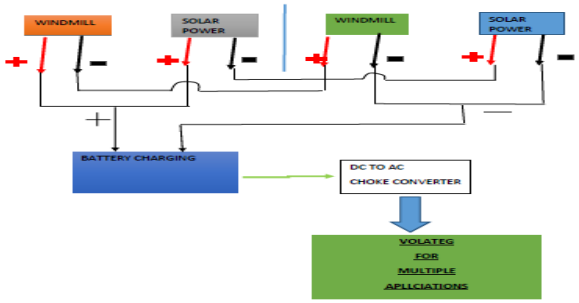

Figure 2 Circuit Connection for Project

A. Turbine design

After a thorough research into both sub types of vertical axis wind turbine rotors configurations, it has been decided to base turbine design on the Darrius model.

In this project modified version of Darrius type of wind turbine is designed and the final rotor blades design is pictured in figure.

Number of blades used in this prototype is two to avoid turbulence. Each separated from one another by 180°, once the wind blows one blade should come after each rotation. Each blade having a curvature of 180° to harness wind from all direction.

a) Design of Wind Turbine

Reference model in benchmark

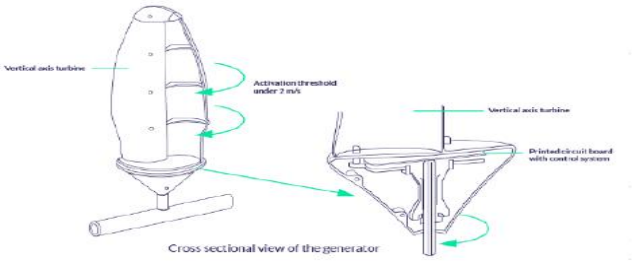

Figure 3 Reference model

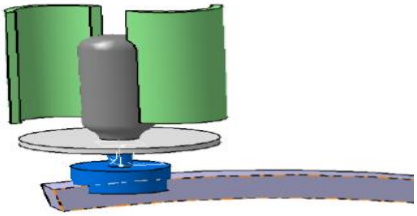

Figure 4 Turbine design model

Total weight of turbine = 0.8 kg
Area = w × h
w = width
h = height
We know w = 10 cm and h = 20 cm,
So:
Area = 10× 20= 200cm^2.

So this area we getting, this is catchment area of turbine. We have selected the plate diameter 20cm, to hold the turbine blades.

The wind power increases as velocity is cube function of the wind and this power is calculable with respect to the area in which the wind is present as well as the wind velocity. When wind is blowing the energy available is kinetic due to the motion of the wind, so the power of the wind is related to the kinetic energy.

We know,
Kinetic Energy = ½ (MV) ^2

The volume of air passing in unit time through an area A, with speed V is AV and its mass M is equal to the Volume V multiplied by its density ρ so:

M = ρAV

Substituting the value of M in equation above we get:

Kinetic Energy=1/2 (ρAV) V^2
Kinetic Energy=1/2 ρAV^3

To convert the energy to kilowatts, a non-dimensional proportionality constant k is introduced where,

K = 2.14×10^−3

Therefore,

Power in KW (P) = 2.14 ρAV^3×10^−3

Where:

Air Density (ρ) = 1.2 kg/ 3/2.33 x 10^−3 slugs/f 3
Area (A) = Area swept by the blades by the turbine

- Wind Speed: This is a very important parameter for the productivity of a windmill. The wind turbine generates power due to wind energy. The wind force makes the blade rotate about the axis (horizontal or vertical) and causes the shaft on the generator to sweep past the magnetic coils creating an electric current.
- Blade Length: This is an important parameter because the length of the blade is directly proportional to the swept area. Larger blades have a greater swept area and thus catch more wind with each revolution. Because of this, they may also have more torque.
- Base Height: The height of the base affects the windmill immensely. The higher a windmill is, the more productive it will be due to the fact that as the altitude increases so does the wind speed.
- Base Design: Base is an important parameter in the construction of the windmill because not only do they have to support the windmill, but they must also be subject to their own weight and the drag of the wind. If a weak tower is subject to these elements, then it will surely collapse. Therefore, the base must be identical and strong so as to insure a fair comparison.

B. Solar Panel Specification

Watt, 8.7 Volt, 270mA Solar Panel for Home, Village, Garden Lighting DIY Projects , Hobby Electric or Electronics School & College Projects Small Solar Equipment like DC Fans, Lanterns, Home & Garden Lights

Pmp: 3 W
Voc(V): 10.5 V
Isc(A): 0.31 A
Vmp(V): 8.7V
Imp(A): 0.27A
No. of Cell: 18
Weight: 470 Grams
Frame: Aluminium, Top Cover -Glass
Dimension - 19.5 Cm (L) X19.5 Cm (W) X1.7 Cm (H)
Made In India.

VI. CONCLUSION

The hybrid energy systems are recognized as a viable alternative to conventional power supplies all over the world. Hybrid energy system combining variable speed wind turbine and solar PV cell array generating system can be integrated to supply continuous power to the load with optimal design of hybrid controller.

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