

## **HYBRID SYSTEM IN WIND MILL FOR BETTER EFFICIENCY AND MORE PRODUCTION OF RENEWABLE SOURCE OF ENERGY**

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### ***Abstract***

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*In parallel to developing technology, demand for more energy makes us seek new energy sources. The most important application field of this search is renewable energy resources. Wind and solar energy have being popular ones owing to abundant, ease of availability and convertibility to the electric energy. This work covers realization of a hybrid renewable energy system for a domestic application, to utilize the solar and wind power. Power resources and loads in the system are monitored and controlled in real time.*

*The aim of this work is design and implementation of a domestic solar-wind hybrid energy system with piezo material. This work is expected to sustain some part of the daily domestic electricity consumption with an efficient utilization of solar and wind power. This paper presents a theoretical analysis to increase the total power generation of hybrid system that is verified with experimental results.*

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**Key Words:** *hybrid system, wind mill, renewable source of energy*

## 1. Introduction

**1.1 Hybrid System:** Hybrid power systems combine two or more energy conversion devices, or two or more fuels for the same device, that when integrated, overcome limitations inherent in either. Hybrid systems can address limitations in terms of Fuel flexibility, efficiency, reliability, emissions.



*Fig.1 Examples of hybrid power system used in wind mill*

## 1.2 Wind energy

The term "wind energy" describes the process by which the wind is used to generate mechanical energy or electricity. Wind turbines convert the kinetic energy in the wind into mechanical energy. Mechanical energy can be used for specific tasks (such as grinding grain or pumping water) or a generator can convert this mechanical energy into electricity.

## 1.3 How Many Blades and power efficiency?

Most wind turbines use either two or three blades. Research indicates that as more blades are added there is an increase in aerodynamic efficiency, but this efficiency increase actually decreases dramatically with each added blade. For example, increasing the number of blades from one to two can Yield a six percent increase in aerodynamic efficiency, but increasing the blade count from two to three yields only an extra three percent in efficiency. And, of course, there are cost implications too. A German physicist Albert Betz concluded in

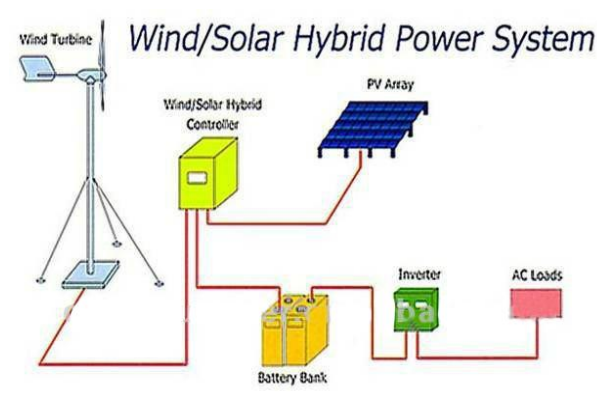
1919 that no wind turbine can convert more than 16/27 (59.3%) of the kinetic energy of the wind into mechanical energy turning a rotor. To this day, this is known as the Betz Limit or Betz' Law. The theoretical maximum power efficiency of any design of wind turbine is 0.59 (i.e. no more than 59% of the energy carried by the wind can be extracted by a wind turbine). The real world limit is well below the Betz Limit with values of 0.35-0.45 common even in the best designed wind turbines. By the time we take into account the other factors in a complete wind turbine system - e.g. the gearbox, bearings, and generator and so on - only 10-30% of the power of the wind is ever actually converted into usable electricity.

#### **1.4 Solar energy**

Solar power systems include several components working together to convert the sun's energy into electrical power that can be connected to a building's standard electrical infrastructure and the utility grid. Solar panels are groups of solar modules connected electrically to generate direct current electricity at the desired voltage and current. A larger grouping of solar panels constitutes a "solar array. The combiner connects multiple wires carrying the electrical current generated by individual solar panels together into a single, larger capacity wire, which then flows to the inverter. The inverter transforms direct current electricity produced by the solar panels into alternating current (AC) electricity

#### **1.5 Energy production using piezo**

Piezoelectricity is the electric charge that accumulates in certain solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in response to applied mechanical stress. The word piezoelectricity means electricity resulting from pressure.



*Fig.2 Experimental set up for hybrid system*

## 2. NEW CONCEPT

We would like to co-relate two examples with this paper:

- 1) When fan is switched off, it will take few time to come back to still position. In that duration the rotational energy is without any electrical energy, we can use that rotational energy.
- 2) When there is heavy weight on bicycle, it will require more energy in starting but once it comes in motion, the weight seems light.

### 2.1 Need of speed in calculating wind power:

$$\text{Power} = \frac{1}{2} \rho A V^3,$$

where  $\rho$  = air density,

$$A = \text{swept area } (A = \pi r^2),$$

$$V = \text{Velocity}, \quad \pi = 3.1416$$

$$\text{Watts} = \frac{1}{2} \left( \frac{\text{kg}}{\text{m}^3} \right) \times (\text{m}^2) \times \left( \frac{\text{m}}{\text{s}} \right)^3 \quad \text{where } \rho \approx 1.2 \frac{\text{kg}}{\text{m}^3}$$

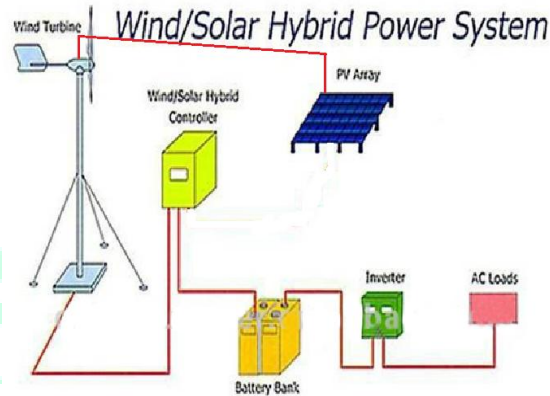
*at standard ambient temperature and pressure*

- Mathematically wind power is directly proportional to speed to the power of three.
- Little change in speed effects wind power considerably even for small amount of time.

### 2.2 How speed is increased??

- In the hybrid system used, electricity produced by wind energy and solar energy are joint together at grids.
- Power produced by wind is much higher than solar panels.
- Assumption:
  - 1) Dynamo is used instead of generator in wind mill.

- 2) The speed of wind shaft due to wind at that particular moment is known as optimum speed.
- If we give electricity produced due to solar panels (when it is fully charged and only for 1-2 minutes till the rotor reaches its maximum speed) to dynamo or dc motor which is placed instead of generator of wind mill, then that system will act as motor for



*Fig. 3 New set up for hybrid system*

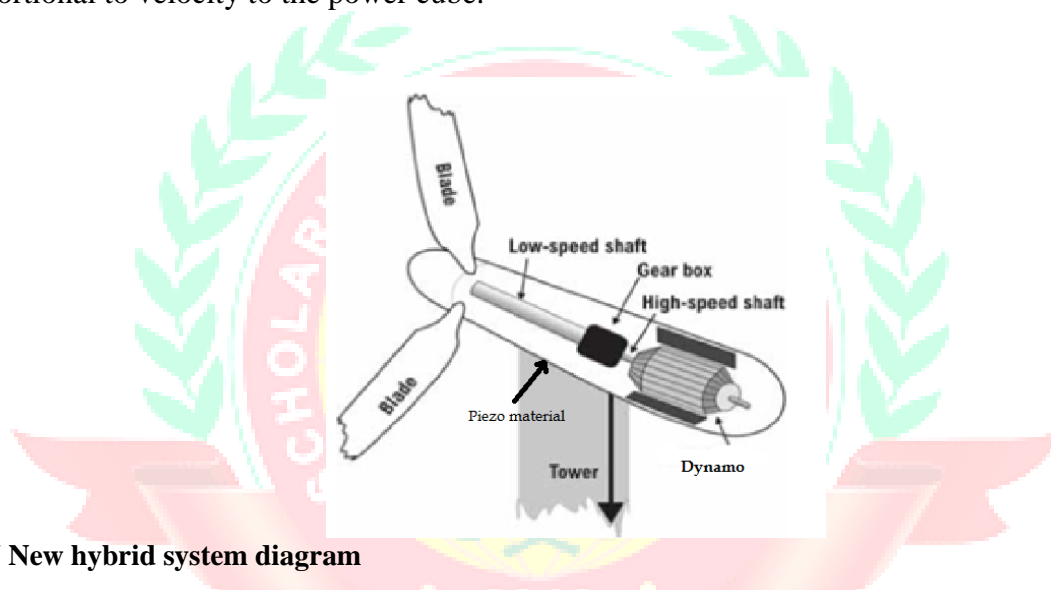
that particular period. The current will rotate the wind shafts as in motor, current rotates the conductor. Wind shaft which is already in motion will gain more velocity due to this phenomenon and reaches its maximum speed in few times. **Maximum speed will be taken into consideration by putting speed limits for prevention from tearing of part in long run for more durability.** As the speed reaches the maximum allowable speed, the dynamo is switched to generator.

- As we know that even a small amount of force on anything already in motion can increase the motion significantly.
  - Again the dynamo is switched back to generator and due to increase in speed the power generated will increase considerably during the period of time maximum speed lowers down to optimum speed of the wind.
- At the support of axle if piezo material is used then due to change in velocity, there is change in pressure at the supporting material i.e. piezo material. As wind blades are very heavy, there large amount of electricity generation. After Implementation hybrid system will be like as shown in figure.

- **Increase in efficiency:**

Energy production is very high due to wind mills, which is in the range of MW whereas energy produced due to solar cells is in the range of KW. Even in the hybrid system used now-a-days, in combining both the energies produced from different sources in grids, there is loss of energy. Solar energy contributes a little in total production of electricity.

Therefore using solar energy to increase the speed of wind blades so that more power is produced for that particular time increases the overall efficiency as power is directly proportional to velocity to the power cube.



**Fig.7 New hybrid system diagram**

Energy produced by piezo material can be used to increase the speed of wind blade too. Both the power from solar as well as piezo is used alternately, to increase the speed resulting in increase in total efficiency, so that the procedure of going from optimum to maximum allowable speed then maximum allowable to optimum speed takes place. Concurrently both can be used to give a start to wind mill if necessary.

### **2.3 MATHEMATICAL EXPERIMENT:**

Let Length of blade is 21m and it completes one rotation in 16.5s then Optimum speed is 8.25 m/s After increasing the speed of wind blade, let it complete the rotation in 10s then Maximum allowable speed is 13.2m/s According to the wind power formula, RMS value must be taken in consideration of power due to maximum allowable speed. After calculations we get the result as, RMS Power at maximum allowable speed = 2.9 \* Power at optimum speed.

As we know that the power produced is in MW and power given by solar and piezo is in KW. Therefore if we use two of them i.e. solar and piezo to increase the efficiency of the wind energy then the total energy produced is greater than the energy produced by all three and combined at later stage, there is power loss in combining too.

**As the saying goes “It’s better to be master of one rather than being jack of all”. Similarly it’s better to use other two sources to increase efficiency of one source rather than using all three individually.**

### **3. Advantages:**

- 1) Have all the advantages of solar, piezo and wind energy.
- 2) Production of renewable source of energy i.e. eco-friendly.
- 3) Increase in efficiency means increase in production.

No power loss in combining different powers of different amplitude and phase at grids

### **4. Conclusion**

In this study, “Solar-piezo-wind hybrid system design” was implemented. A portion of the energy requirement for a home has been supplied with the electricity generated from the wind using solar and piezo power. Real time control of the inputs and outputs is carried out. Also we can conclude that

- Combinations of energy sources will provide more reliable power than any one source alone

Although overall costs are higher. the power is more reliable and easy to use.

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