# Developing Hybrid Wind and Solar Powered Irrigation System

**Divyesh Chandra[1], Pankaj Kumar[2] Appu Singh[3], Tauhid Alam[4], Ramniwas Bishnoi[5], Ajit Kumar Singh[6]**

[1, 2, 6]*Department of Agricultural Engineering, NIMS University, Jaipur, Rajasthan, INDIA*

[3, 4, 5]*Department of Mechanical Engineering, NIMS University, Jaipur, Rajasthan, INDIA*

**ABSTRACT**

***Developing infrastructure for the water resources and their effective management have been the common policy agenda in many developing economies, particularly in the arid and semi-arid tropical countries like India. India is perceived as a developing country, but it is developing at a pace that is not matched by many others. We have experienced significant economic growth, yet the fact remains that our growth is constrained by energy supply and availability. The projection for irrigation water demand basically depends on irrigated area, cropping pattern, effective rainfall, water quality and availability of energy. Providing adequate and quality power to farmers for irrigation purpose remains one of the major challenges before the country due to their remote location hinders any access to a grid. Further, there is also an increasing concern to depend upon fossil fuels in meeting power needs and opting for sustainable fuels instead. Considering the above problem, this paper discusses ways to achieve an economical renewable energy powered Hybrid Wind and Solar System (HWSS) is developed. Hybrid Wind and Solar System is modular in construction and consists; (200 watt) vertical axis wind turbine at rated speed, (100 watt) PV solar system, hybrid charge controller cum inverter, an energy storage unit and a centrifugal pump. All modules are indigenously developed, these modules are easy to operate and maintain. Adding on-farm uses for the excess wind and solar energy during irrigation period to produce valuable crops on the farm enhances the prospects of a profitable system.***

***Keywords: Hybrid wind and solar system, Renewable Energy, Vertical axis wind turbine, Irrigation, crop***

## 1. INTRODUCTION

Nowadays, electricity is most common power source in human life. As the living standard is improving, the dependence on electricity becomes stronger. Non renewable are the ones that decades partially or vanish with the time such as coal, oil, natural gas, woods and radioactive

material. These sources are harmful for climate due to this temperature of earth is increasing day by day. Renewable energy source are the ones that are persistently available and renewing itself with time. There is a growing awareness that renewable energy such as photovoltaic and wind power has an important role to play in order to fulfil the requirement. More than 200 million people live in rural areas without access to grid-connected power. In India there are many villages' remains to be un-electrified and the supply of electricity due to inherent problem of location and economy. The cost to install and service the distribution lines are considerably high for remote areas and due to increase in transmission line there will be losses in power supply. India is characterized by severe energy deficit. In most of the remote and non-electrified sites, extension of utility grid lines experiences a number of problems such as high capital investment, high lead time, low load factor, poor voltage regulation and frequent power supply interruptions. Hybrid power systems can be used to fulfil the requirement of electricity. This system is cost effective as well as none polluting and very useful for rural areas *[(1) First Report of the committee on Non-conventional Energy to Power Rural Telephony].*

In the present study, a double stage vertical axis wind turbine is preferred to make it useful in low wind density area. Double stage of wind turbine improved RPM of turbine even at low wind speed.

## 2. SOLAR - WIND HYBRID POWER SYSTEM

Hybrid Wind-Solar System for the rural exchanges can make an ideal alternative in areas where wind velocity of 5-6 m/s is available. Solar-wind power generations are clear and non-polluting. Also they complement each other. During the period of bright sunlight the solar energy is utilized for charging the batteries, creating enough energy reserve to be drawn during night, while the wind turbine produce most of the energy during monsoon when solar power generation is minimum. Thus the hybrid combination uses the best of both means and can provide quality, stable power supply for sustainable development in rural areas *[(3) H. P. Garg, J. Prakash]*.

Photovoltaic power system is the system which converts the solar energy into electricity through the solar panel, then charges the batteries through controller, then supply electricity to consumer through inverter. The advantage of the system is with high reliability, low maintenance cost; the disadvantage is of high cost.

The wind power system is the system which convert the wind energy into electricity through wind turbine generator, then charge batteries through controller, then supply the electricity to consumers through inverter. The advantage of the wind system is with higher energy production, low system cost and maintenance cost, the disadvantage is the reliability of domestic small wind turbine generators remaining unsolved.

Besides, the common disadvantage of the wind system and photovoltaic system is the uncertainty of the resources leading the unbalance between energy production and load consumption and both being in need of batteries for stabilizing the power supply.

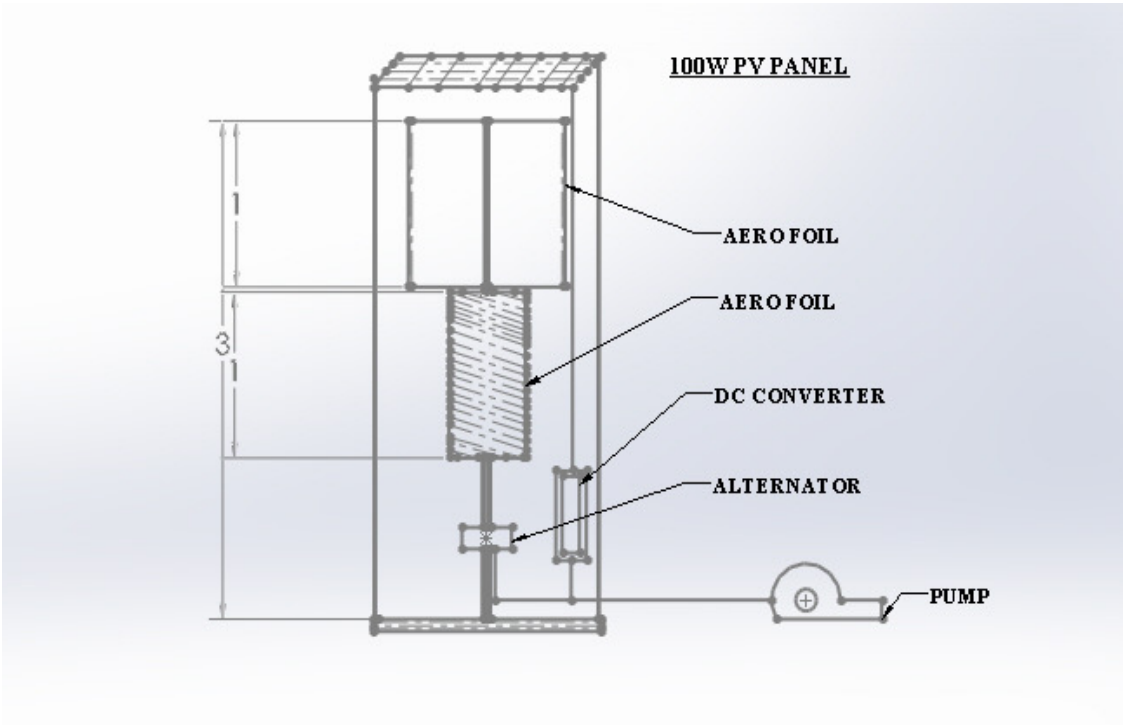


**Fig- 1: Double stage Vertical axis wind turbine with solar panel**

Figure 1 show Double stage hybrid wind turbine consists of a wind turbine with its support system, alternator, and charge controller, PV solar panel. A description of the above mentioned parts is as follows *[(4) G. Willeke, 1987, G. Grassi, Photovoltaic Power Generation, D. Reidel Publishing Co, Holland]*:

- Double stage Vertical axis wind turbine
- Alternator
- Pump
- DC converter
- PV solar panel

As the complementary between solar energy and wind energy, the wind/photovoltaic hybrid power system can overcome some shortcomings of the stand-alone wind power system and photovoltaic

power system in aspect of resources. Meanwhile the battery bank and the inverter can be shared, so the wind/photovoltaic hybrid power system can reduce the cost and make the cost more acceptable.

The wind/photovoltaic hybrid power system can be rationally configured based on the load and resources condition, which can ensure the reliability of power supply and reduce the cost of the power system. Whatever the environment and load pattern, the wind/photovoltaic hybrid system can is optimum in design to meet the demand of the users. It could be said, the wind/photovoltaic hybrid power system is most rational stand-alone power system. At present, the biggest obstacle of promoting wind/photovoltaic hybrid system is the reliability of the small wind turbine generators.

## 3. DESIGN AND DEVELOPMENT OF HWSS (HYBRID WIND AND SOLAR SYSTEM)

**Fig 2: Double stage hybrid wind turbine used for present study**

A unique, double stage hybrid wind turbine developed in NIMS University campus, the main benefits obtained are improved performance at lower wind speeds (*Bishnoi R.N. et al, 2013*) and a lower rpm regime at higher wind speeds resulting in a silent turbine suitable for residential environments and rural area

In general, a local cost-efficient, safe, and durable PV-wind hybrid system is composed of the core part (PV modules and wind turbine); PV modules mounting and wind turbine tower; DC-AC inverter; safe equipment such as fuses, disconnects, and lighting arrestor; meters and instrumentation; batteries, charge controller regulator and backup power resource for battery storage systems; and also connection wires, switching, and wall socket

**Photovoitaic (PV) modules** convert sunlight into direct current (dc) electricity. Modules can be wired together to form a PV array that is wiring modules in series the available voltage is increased. However either way, the power produced is the same since watts (power) equals voltage time's amperes. A typical PV module measures about 0.5 square meters (about 1.5 by 3.5 feet) and produces about 75 watts of DC electricity in full sum.

**Wind turbine** works the opposite of a fan. Instead of using electricity to make wind, like a fan, use wind to make electricity. Most turbines have either two or three blades. These vertical axis wind turbine works on low dens air and at low pressure region

**Double stage Vertical axis wind turbine** is a type of wind turbine where the main rotor shaft is set vertically and the main components are located at the base of the turbine. Among the advantages of this arrangement are that the alternator and breaks can be placed close to the ground, which makes these components easier to service and repair, and that these system is not need to be pointed into the wind (*Sandra et al. 2008*). Fig.1 &2 depicts wind turbine consists of a circular shaft made up of mild steel with double stage of total four airfoils made of aluminium for light weight. This shaft is supported by a rectangular stand as shown in made up of cast iron. At the end of the shaft, space is provided for attaching the alternator and breaks

To acquire torque we took the watts we are expecting, or HP, and divide out the RPM to convert the power output of torque. A tipped sideways, with the axis perpendicular to the wind streamlines, functions similarly to vertical axis wind turbine.

**Charger cum Inverter** in power converter shown in fig.3 as the battery charger for the stand-alone wind turbine is proposed. The proposed power converter can harvest the maximum power from the wind turbine while generating pulsating current for the battery bank to improve the charging

efficiency. The maximum power point tracking (MPPT) function is realized by the circuit parameter design of the power converter and the characteristics of wind turbine. The pulsating battery charging current is implemented by the discontinuous conduction mode (DCM) operation of the proposed power converter with constant on-time control. Also, the over-speed protection of the wind turbine can be naturally achieved when high power output occurs. Simplicity is one of the major advantages of the proposed power converter. Hardware experimental results from a 400 W prototype circuit are presented to verify the performance of the proposed power converter.

Battery chargers convert 120 volt AC power to 12 or 24 volt DC. There are a few different varieties available. In our opinion this is the least desirable option for charging batteries in a remote power application, but is often the only option if you are not willing to tinker with antique or home built equipment.

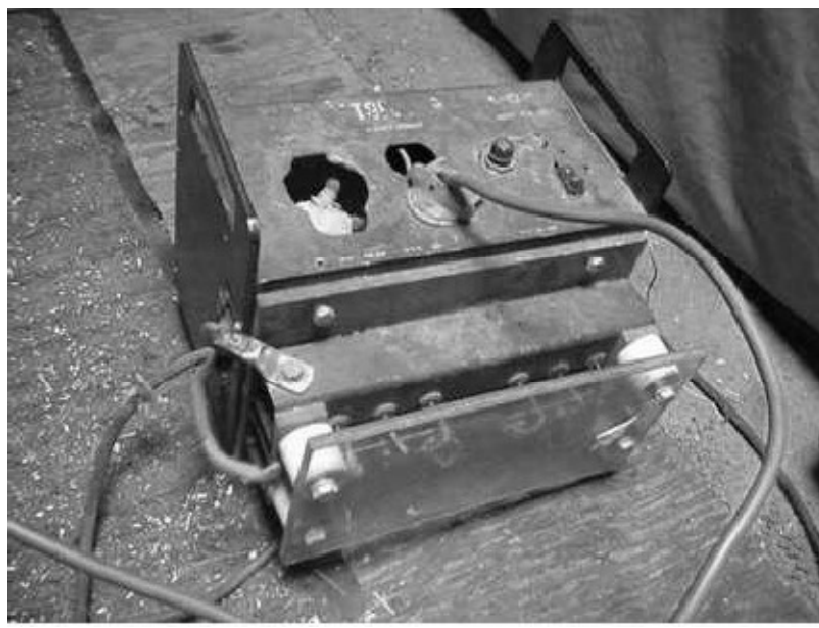

**Fig.4 the charger used in hybrid system**

## 4. APPLICATION OF SOLAR-WIND HYBRID SYSTEM FOR IRRIGATION PURPOSE

There is increasing demand for the use of alternate or renewable energy sources to achieve clean and low-cost electricity for agricultural water pumping requirements. This system may be proved beneficial for advanced and precision irrigation systems like sprinkler as well as drip irrigation system for small scale farming condition requiring less water requirement. This technique is

especially suitable for region with less water availability and good wind speed like Rajasthan in India.

Studies have been carried out on wind-solar hybrid system to analyse its effectiveness and economic aspect for irrigation purpose. The cost of the system should be minimized for the specific purpose to enhance its feasibility.

Design & integration of renewable energy hybrid system also involves the process of selecting the best components and its sizing to provide cheap, efficient, reliable and cost effective renewable energy. The major advantage of wind – solar hybrid energy system is that when used together, the reliability of the system is enhanced.

This purposed system shown good results in all weather conditions, it can pump water with discharge of 5LPM (Litres per minute) and at significant pressure enough to irrigate around 20000 $ft^2$ area.

**REFERENCE**


[1] First Report of the committee on Non-conventional Energy to Power Rural Telephony, 2008

[2] Bishnoi, R.N. et al, Nano Capacity Hybrid Wind and Solar System for rural India, International Journal of Applied Engineering Research, Vol. 8 No. 8, 2013 ISSN: 0973-4562

[3] H. P. Garg, J. Prakash, 2002, Solar Energy Fundamentals and Applications, 1st Edition, Tata McGraw-Hill Publishing Company Ltd, New Delhi.

[4] G. Willeke, 1987, G. Grassi, Photovoltaic Power Generation, D. Reidel Publishing Co, Holland.

[5] Technical brief on Wind Electricity Generation: Retrieved from www.windpower.org

[6] (2009).

[7] E.E. Iheonu, F.O. A. Akingbade, M. Ocholi Wind Resources Variations over selected sites in the West African sub-region. *Nigerian J. Renewable Energy*, **10**, 43-47(2002).

[8] W.W.S. Charters. "Solar and Wind Power Technologies for Remote Applications". CSC Technical Publication Services No 187, Commonwealth Science Council. (1985).

[9] S.I. Iwuoha. Wind Powered Horizontal Maize Grinder, *NJRE*, **11,** 46-57(2003).

[10] Kunal Kumar et al. " Advanced Utilisation of Irrigation Pumping by Using Sustainable Energy**.**

[11] Brian D. Vick USDA-Agricultural Research Service Conservation and Production Research Laboratory Bushland, TX - Developing a Hybrid Solar/Wind Powered Irrigation System for Crops in the Great Plains.

[12] Yandra Shivrath 1, P. Badari Narayana 2, Srikanth Thirumalasetty 3, Dr.E.Laxmi Narsaiah- Design & Integration of Wind-Solar Hybrid Energy System for Drip Irrigation Pumping Application.

[13] Sandra, E., H. Bernhoff and M. Leijon, 2008, Evaluation of different turbine concepts for wind power. Renewable Sustainable Energy Rev., 12: 1419-1434.