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A Novel Method for Hybrid Solar/Wind/Battery Power Generation for Rural Electrification System

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Abstract: The term wind cross breed framework depicts any blend of twist vitality with at least one extra wellsprings of power age (e.g. wind and sunlight based or a generator utilizing petroleum derivatives). Half and half framework is regularly utilized for remain solitary applications at remote destinations. The blend of sustainable power source advancements permits a more adjusted power supply amid day/night and occasional changes: At most destinations wind speed is low, when the sun is sparkling and achieves higher esteems on overcast days. In this manner the measure of vitality produced by wind vitality achieves its most extreme in the winter months, while the yield of PV-cells is altogether higher in the late spring. Other essential cases are Wind-Diesel frameworks frequently utilized as a part of remote territories. A diesel generator will be utilized as reinforcement, if the power request cannot be secured by the introduced wind turbines. Control and change of the accessible vitality sources is a focal issue arranging a breeze crossover framework. Numerous half breed frameworks are utilizes as remain solitary off-grid applications.
Keywords: Solar system, Wind Turbine hybrid, Rural Electrification, Battery.

I. INTRODUCTION

Large parts of our countryside remain dark in the night due to the power cut or unconnected electricity lines. The need of electricity for the basic amenities and education in these remote parts are common topics for discussion. For a long time now, renewable energy mainly wind power and solar power based electricity are being considered and tried out for remote area electrification. Wind power

on other hand available in only 40% area of our country, has been found to be more attractive than the solar power plant in term of initial investment, payback period and cost of electricity produced. Hence the wind turbine is cheaper than photovoltaic. In other words, if a well designed good quality wind turbine is available, abundant quantity of electricity can be generated at low cost in the right areas. Solar and wind power plants are uncontrolled sources. On the other hand, electricity should be produced exactly at the time it is needed. Keeping this in mind in the proposed project the wind and solar power plants are combined together as a hybrid power plant to obtain maximum efficiency by operating them at an optimum point [1].

II. OBJECTIVE

A. To design the hybrid power plant for rural electrification.
B. This plant is especially intended for home lightening system.

III. METHODOLOGY

A. Existing System

Normally wind turbines and solar panels are coupled together for the construction of the hybrid system for any stable power supply. It is a well known fact that wind speed fluctuates during different seasons of the year and in the winter season the wind speed is very low. The main drawback in the existing system is the speed of the wind is not constant throughout the year and the wind speed is not common for all the areas [2].

B. Proposed System

To overcome this, a new system is proposed which will generate electricity from the wind turbine at low wind speed. In the proposed system, power is generated at low wind speed. This idea is applicable for roof top wind mill only, in which the blades are placed inside the duct. When the air flow through the duct the velocity is decreased and the pressure is increased which makes the blades to rotate even at low wind speed. The convergence method is used in the wind turbine. In convergence, when air flows through the duct, the pressure is increased. The simulation of convergence wind turbine is done using Nozzle Simulator and the observed results are shown in fig.1. In the simulation the pressure free stream is given and the exit pressure is shown in fig.1

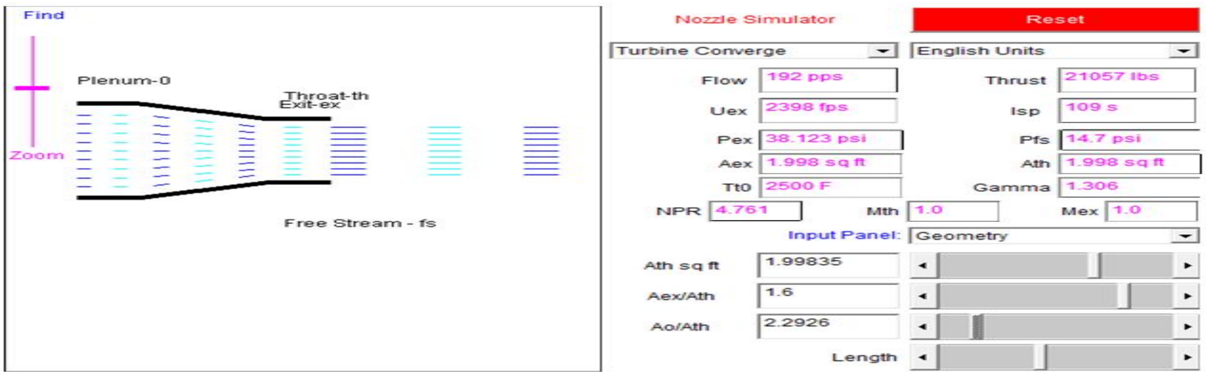

Fig.1. Simulation of wind turbine convergence

According to Bernoulli's principle, when pressure is increased the velocity tends to decrease. Similarly when velocity is increased the pressure tends to decrease. This concept is used in the proposed system to generate power even at low wind speed. If
the air flows through the duct the pressure of the wind is increased and the velocity is decreased, which in turn increase the number of rotation of blades. In addition to this arrangement the solar panel is merged to obtain a constant output

IV. BLOCK DIAGRAM

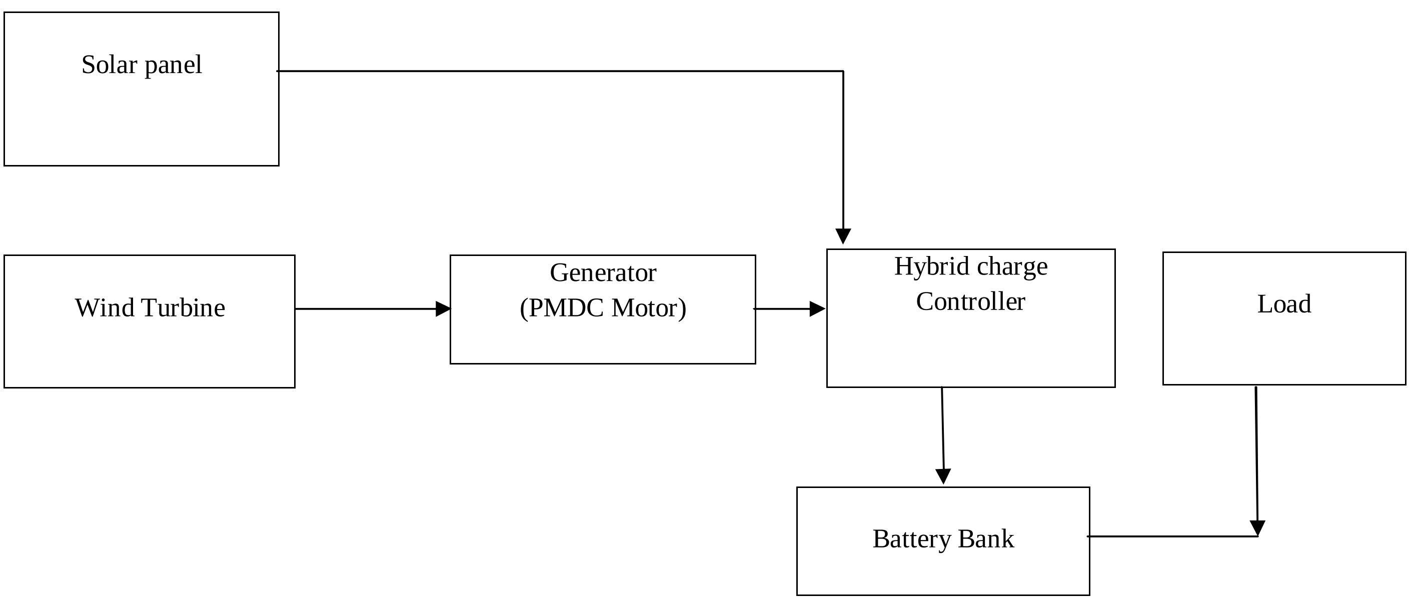

Fig.2. Overall block diagram of the hybrid system

Fig.2. shows the overall block diagram of the hybrid system. The components of the block diagram is explained below

A. Solar Panel

Solar panel is used to generate electricity from direct sunlight. A solar cell or a photovoltaic cell is a large area electronic device that converts solar energy into electricity.

B. Wind Turbine

C. The exploration of the HAWT (Horizontal Axis Wind Turbine). A turbine is a device which has a set of two or three blades attached to a hub. This assembly is known as the rotor, when the wind blows the rotor rotates and turns an alternator which produces AC electricity.

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D. Generator

A dc motor as the generator is used for this wind turbine. The dc motor is permanent magnet type and it has four poles.
It is 13 amp motor and starts to charge at 28 rpm. If motor runs until 1500 rpm, full power will be generated. As the motor spin in back direction, 20A blocking diode is set up in phase cable. Then, motor flow in one direction [3].

E. Hybrid charge controller:

The power generated from solar panel and wind turbine is not constant. To provide a constant output, hybrid charge controller is used.

1) Battery bank

Battery bank is used to store the power generated from solar panel and wind turbine. Output power is used to charge one lead-acid battery. The power stored in the battery is directly connected to the load [4].
Fig.3 shows the annual wind and solar radiation of the year. During the month of January to May the solar radiation is higher than wind speed. From May to September the wind speed is higher than solar radia2tion. So, from the fig.3 it is observed that the hybrid power system is suitable to provide a constant output throughout the year [5].

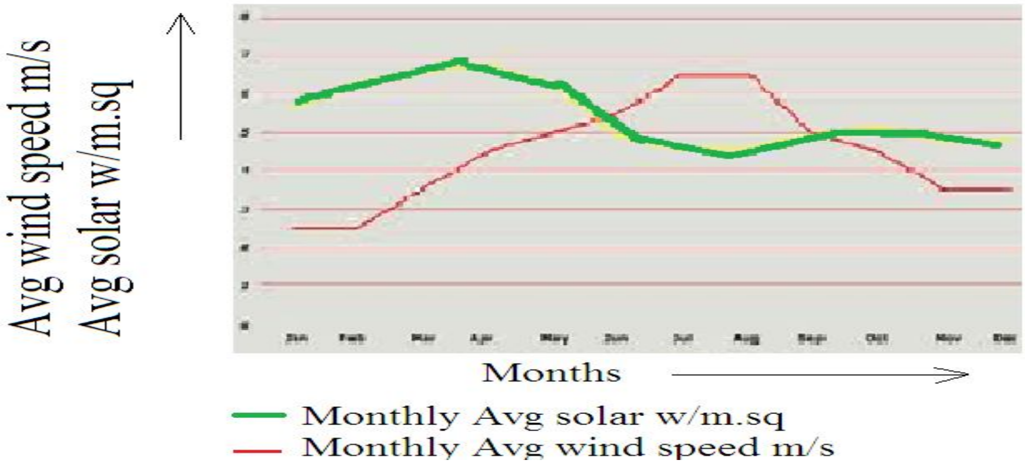

Fig.3. Annual wind speed and solar radiation.

V. CALCULATION

A. Design Of Gear Box

1) Speed in gear box

a) Measured Specifications

N1/N2 = D2/D1
Where N1=Input speed to the gearbox in rpm
N2=Output speed from the gearbox
D2=Diameter of the generator gear 60mm
D1=Diameter of the main gear 195mm
N2= (D2/D1) * N1

B. Design of ball bearing

Bearing no.6202
Outer diameter of Bearing (D) =35mm
Thickness of Bearing (B) =12mm
Inner diameter of the bearing (d) = 15mm
Maximum speed = 14,000 rpm
Mean diameter (d_m) = (D+ d)/2
= (35+15)/2=25

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C. Ideal wind power calculations:

Wind power (P) is calculated by the following general equation (the proof for which will be derived in the following equation)[5]:

$P = Cp * \frac{1}{2}\, \ell * A * V^3$

Where Cp is the power coefficient

ℓ is the density of the oncoming air

A is the swept area of the rotor

$A = (\pi . d^2)/4$

V is the velocity of the wind

The actual power is further reduced by two more inefficiencies, due to the gear box losses and the generator efficiency.

The total power of the wind stream

$Pt = 1/2\, \ell A v^3$ watts

Where m is the mass flow rate kg/s

V is the incoming velocity m/s

$m = \ell A V$

Cp is the coefficient power

$Cp = P/Pt = P/\ (1/2) * \ell A v^3$

VI. SIMULATION

A. Simulation Setup

Matlab version 7.10 is used as simulation software. Hybrid system is modeled using simulink and is shown in fig 4.1. The three phase source is given as input to wind turbine. Then it is given to rectifier to convert ac to dc and it is given to battery. The output of photovoltaic array is given to battery.

The output of rectifier and photovoltaic array is given to invertor to convert dc to ac and it is given to grid. Fig 4.2 shows the hybrid power plant output in grid. Fig 4.3 shows the hybrid power plant output in battery. Fig 4.4 shows the wind turbine output.

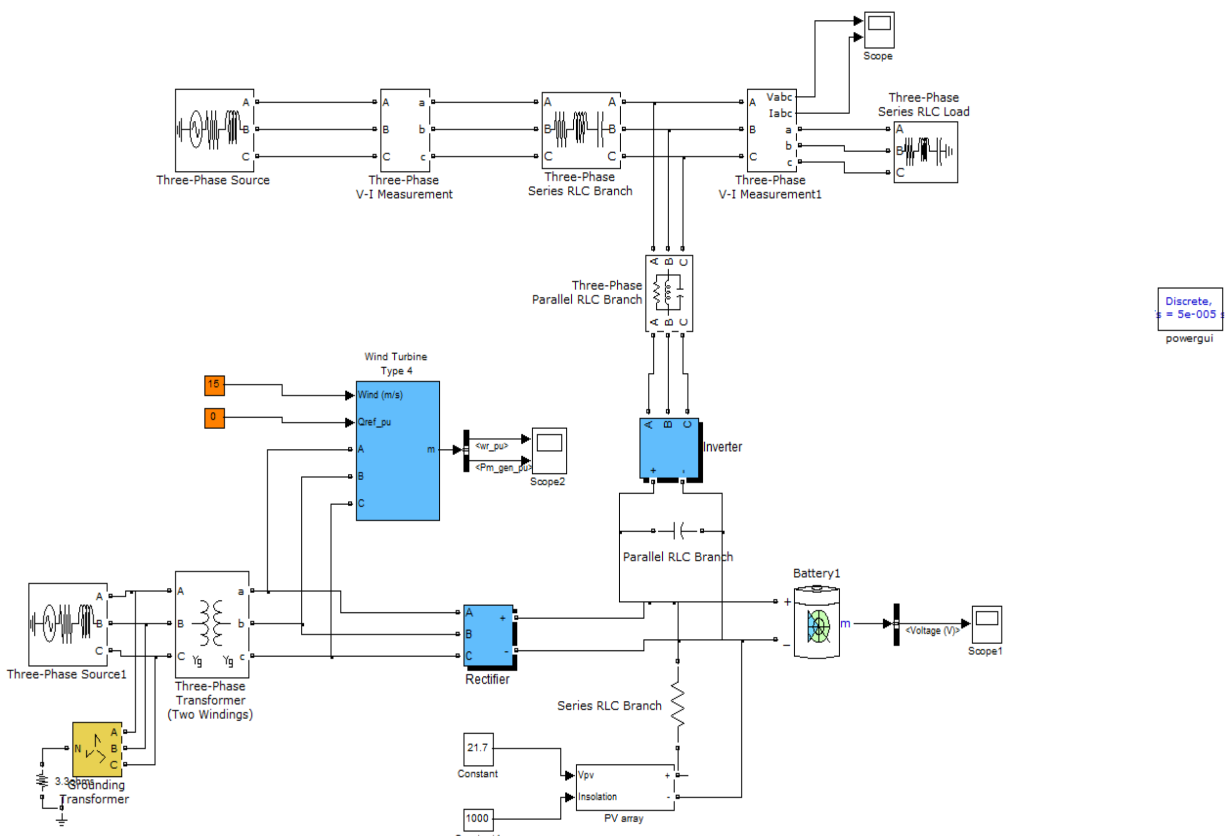

Fig.4.1 Simulation Block Diagram of Hybrid System

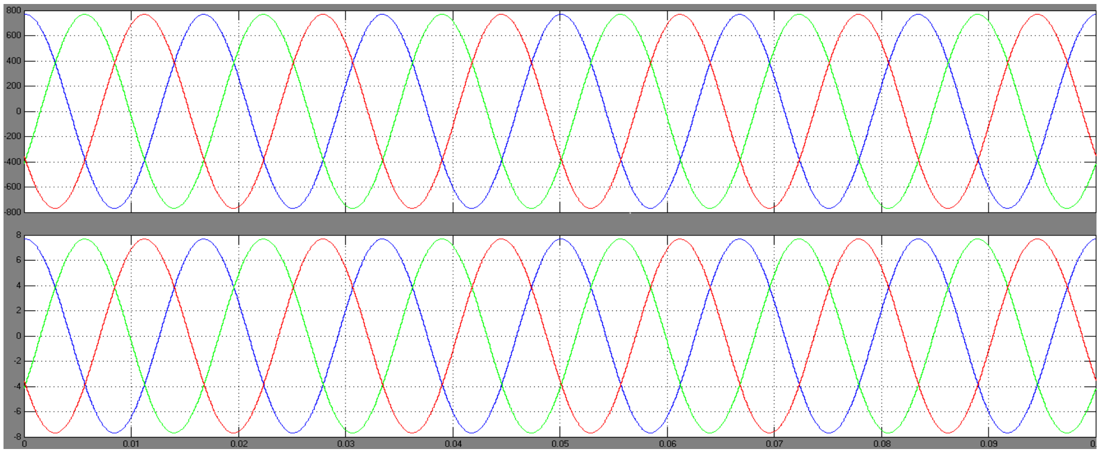

Fig.4.2. Hybrid power plant output in grid

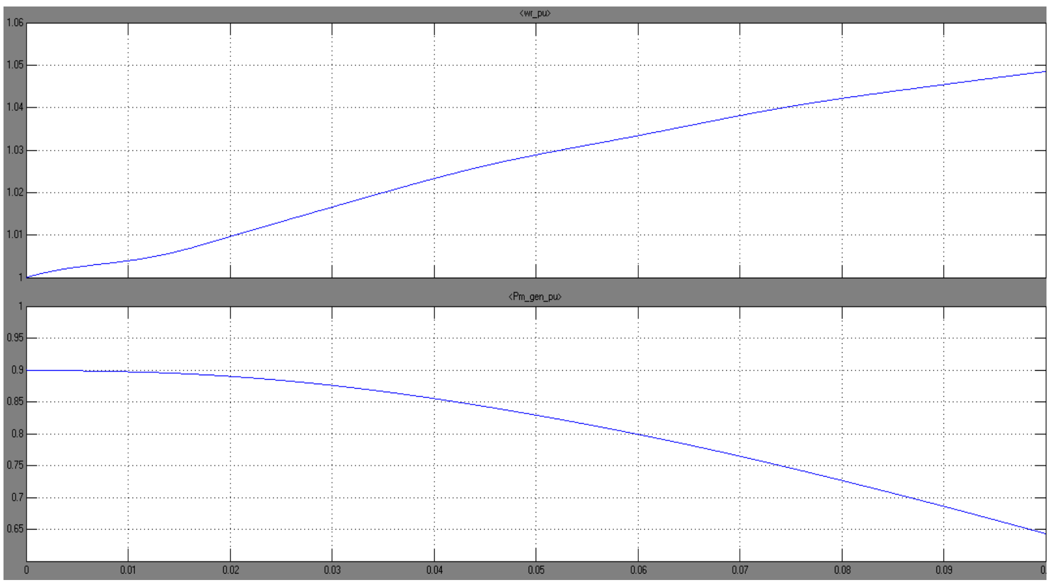

Fig.4.3. Wind turbine output

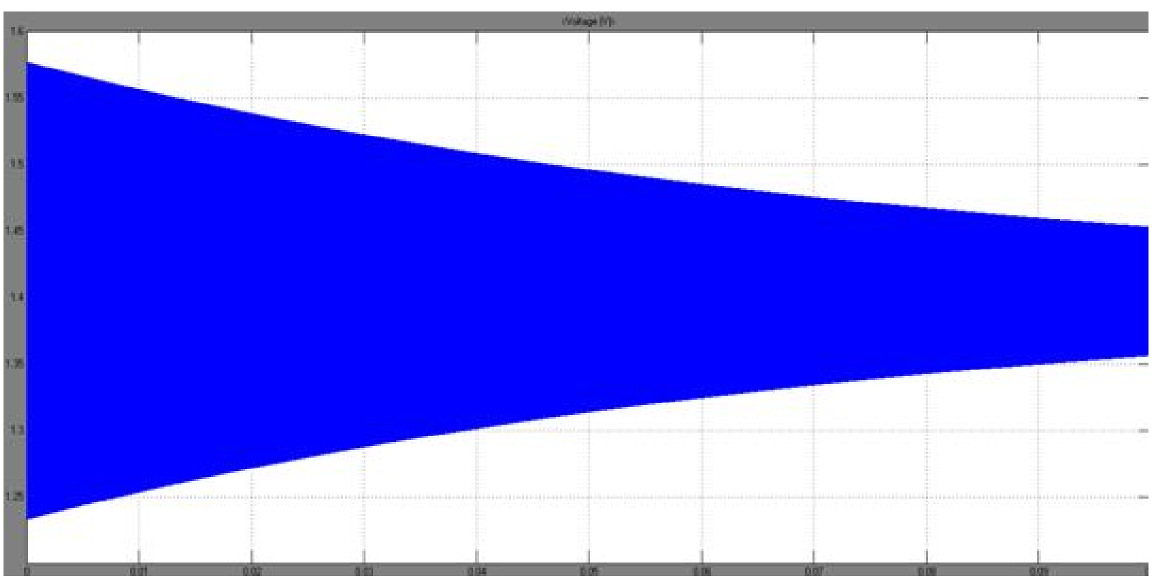

Fig.4.4. Hybrid power plant output in battery

VII. CONCLUSION

The convergence method for the wind turbine is simulated using Nozzle simulator. From the simulation it is known that the exit pressure is increased and it is greater than the inlet pressure. The hybrid power system is simulated using MATLAB version 7.10. The simulation results show that the hybrid power system is capable of generating 440V, 50Hz, 5A and 2200W. Hence, from the simulation results, it is known that the hybrid power system is suitable for residential load. With the aid of simulation results, the hardware can be implemented.

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