GRID INTERCONNECTION FOR HYBRID RENEWABLE ENERGY SOURCE REMOTE AREA ELECTRIFICATION IN INDIA

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ABSTRACT
In India, huge amount of population lives in remote area which are connected to the separate Grid interconnection or no availability of grid connection. On grid hybrid renewable energysystems use for remote areas has become effective solution.Some consumer requires bulk amount of energy. These demands are for professional need or remote area electrification. Due to limited availability of conventional energy sources i.e. fossil fuels and use of this adverse effect environment. For the use and generation of electric power it is necessary to use Renewable Energy sources (RES). Hybrid renewable energy system (HRES) with conventional energy sources is the ideal system for rural electrification and to provide reliable for of energy to consumer. This paper discussed the HRES for rural electrification & advantages of RES over the Conventional energy sources also control of power flow fed to the load.

KEYWORDS: Renewable energy system, Hybrid,Rural electrification, PV, Wind

INTRODUCTION
There are many remote places, especially in developing countries, where grid supply has not reached yet but still with more availability of solar-wind hybrid systems.In India there are many places where the grid supply is not available due to geographical restriction. Thelarge amount of dependence of economy on depleting fossil fuels and the adverse environmental effects of conventional power generation systems created renewed interest in renewable energy sources toward building a sustainable energy economy.
Solar and wind energy are renewable energy sources, nonpolluting, and potential sources of alternative energy in meteorological conditions are important. The operation of solar and wind mostly depends on the weather condition and the location of that specific area. The power generated by a PV system is highly dependent on weather conditions. For example, during cloudy periods and at night, a PV system would not generate any power. Wind and solar systems are becoming more popular for stand–alone power generation applications, due to advances in renewable energy technologies and subsequent rise in prices of petroleum products.

SUMMARY OF INDIAN VILLAGE/REMOTE AREA ELECTRIFICATION
Availability of electricity in Remote area which is adversely affected since last some year especially due to poor operational and financial health of SEB's. Although more than 85% of villages electrified over the years, nearly more than 18452 villages are yet in the dream of light; whereas the electrified once is badly suffering heavy power cuts ranging from 10-12 hours a day in needed hours. If we look at present rural electrification status of India given in Table 1.

Table no.1. - Status of rural electrification in India

Variables	Value
Total number of villages	5,87,258
Villages electrified	5,08515
Villages to be electrified	78,743
Total number of households	13,83,71,559
Electrified households	13,83,71,559
Un electrified households	7,40,07,840

PROPOSED SYSTEM

The proposed system consists of RES connected to the dc link of a grid-interfacing inverter as shown in Figure 1. This configuration is fit for the stand-alone hybrid power system used in remote area. Before reaching towards load centers, the conversion of electricity from wind and solar are carried out. The two energy sources are connected in parallel to a common DC bus line through their individual converters. Then such a DC power is converted back to AC power at fundamental grid frequency of 50 Hz by using multi-level inverter.

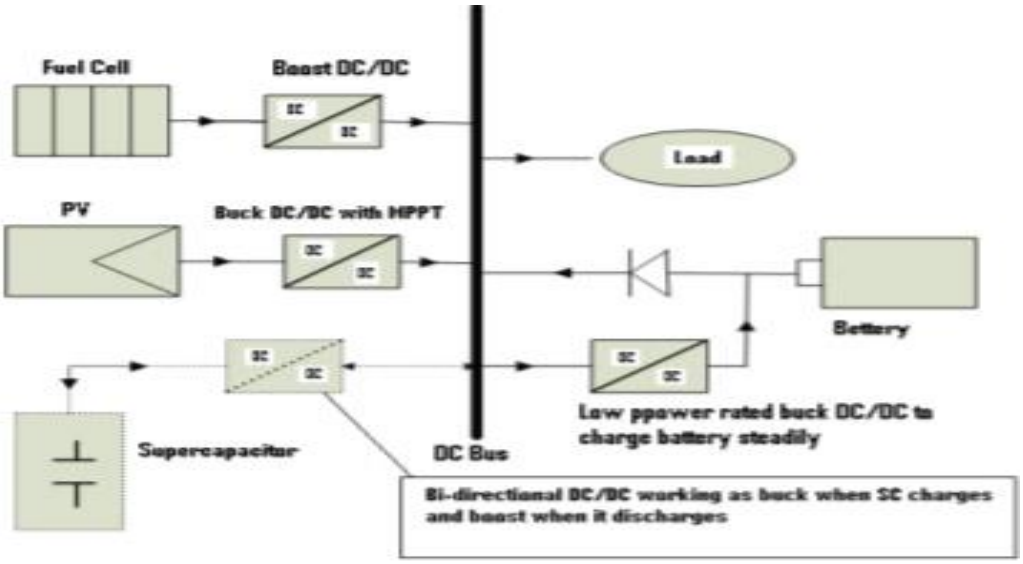

Figure no.1.Proposed Hybrid System

COMPONENT OF HYBRID POWER SYSTEM

A PV–Wind power system, which is a combination of a photovoltaic array integrated with a wind generator. The system consists different component such as, PV array, wind generator, a battery bank, a charge controller and a DC/AC or AC/DC converter. Depending upon requirement it can be used.

A.PV SYSTEM

Sizing of PV system can be depending on different factors these are;

1. Solar radiation of the site.
2. The daily power consumption (Wh) and types of the electric loads
3. The storage system to contribute to the system's energy independence for a certain period of time.

The PV generator is oversized it will have a big impact in the final cost and the price of the powerproduced and in the other hand, the PV-generator isundersized, problems might occur in meeting thepower demand at any time.

B. WIND ENERGY

Energy sources have the potential to significantly reduce fuel costs, greenhouse gas emissions, and natural habitat disturbances associated with conventional energy generation. Wind turbine generators are an ideal choice in developing countries where the most urgent need is to supply basic electricity in rural or isolated areas without any power infrastructure. Wind energy has become competitive with conventional forms of energy. Wind energy is a potential choice for smaller energy producers due to relatively short installation times, easy operating procedures, and different available incentives for investment in wind energy.

Storage Bank

Batteries are the basic component of an energy storage system. Which is used as a back for the power supply for the system?

Power Electronic Devices

Different power electronic devices are used in this system as per the requirement such as AC-DC or DDC-AC converter, DC-DC converter.

MATLAB SIMULATION MODEL OF PV & WIND SYSTEM

A. Modelling of Solar (PV) System

A PV generator consists of an assembly of solar cells, connections, protective parts, supports etc. Solar cells are made of semiconductor materials (usually silicon), which are specially treated to form an electric field, positive on one side and negative on the other. Then solar energy hits the solar cell, electrons are knocked loose from the atoms in the semiconductor material, creating electron-hole pairs. If electrical conductors are then attacked to the positive and negative sides, forming an electrical circuit, the electrons are captured in the form of electric current.[1]

basic Equation from the theory of semiconductors that mathematically describes I-V characteristics of PV cell is;

$$I = I_{pv.cell} - I_D$$

Where $I_{pv.cell}$is the current generated by incident light and I_D is the diode current.

The equation for saturation current I_0 given below;

$$\frac{\text{Iscn} + \text{KI}\Delta\text{T}}{\exp(\text{Voc} + \text{Kv}\Delta\text{T})\ /\text{aVt}) - 1}$$

Equation for photovoltaic panel $I_{pv}$is given below;

$$I_{pv}=(Ipvn+ K_I\Delta T)G/Gn \qquad (3)$$

Figure-4 shows the mathematical model for current I_m shown in the following equation

$$I_m= I_{pv}- I_0[\exp (V+IRs/aVt) - 1] \qquad (4)$$

Where:

k - Boltzmann constant (1.3806 10^{-23} J/K);

T - Reference temperature of solar cell;

q - Elementary charge (1.6021 10^{-19}As);

V - Solar cell voltage (V);

I0 - saturation current of the diode (A);

I_{pv}- Photovoltaic current (A).

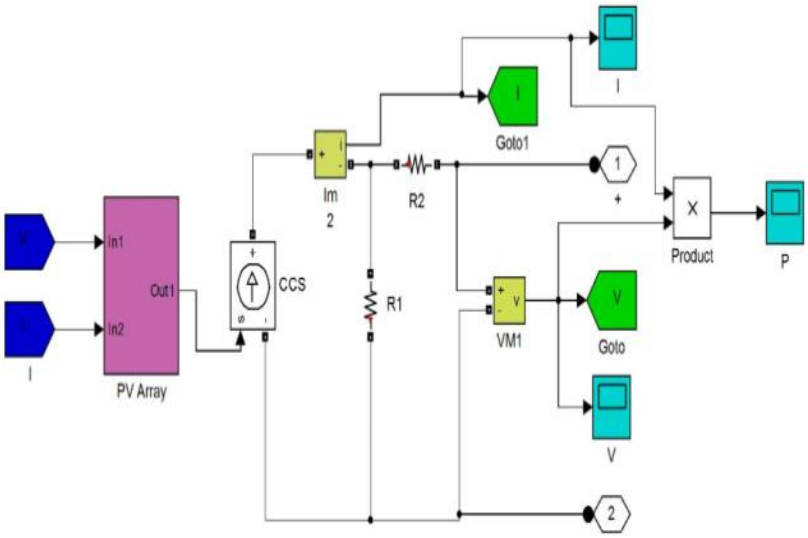

Figure no.3.The MATLAB Simulink modelof PV array

B. Modelling of Wind Power System

Modeling the wind energy converter is made considering the following assumptions

- Friction is neglected;

- Stationary wind flow;
- Rotation-free flow;
- Free wind flow around the wind energy converter

Wind energy systems harness the kinetic energy of wind and convert it into electrical energy or use it to do other work, such as pump water, grind grains, etc. The kinetic energy of air of mass m moving at speed v can be expressed as

$$E_b = \frac{1}{2} mv^2 \qquad (5)$$

Where ρ is the density of air (kg/m^3).

Based on the above two equations, the wind power

$$P = \frac{1}{2}\varrho A v^3 (6)$$

We have;

$$P = \frac{1}{2}\varrho A v^3 C_p \qquad (7)$$

Cp is called the power coefficient of the rotor or the rotor efficiency. It is the fraction of the upstream wind power, which is captured by the rotor blades and has a theoretical maximum value of 0.59. In practical designs, maximum achievable Cp is between 0.4 and 0.5 for high-speed, two blade turbines and between 0.2 and 0.4 for low-speed turbines with more blades.

In this hybrid system Solar PV system gives a power output of 3000 W at voltage 220V, Wind energy System gives power output 2000 W at 250 V and battery bank capacity is 5000 W. The voltage at the common dc bus is maintained at V. A multilevel inverter is used to get a supply voltage at 240 V 50 Hz with a power capacity of 6500 W.

Table no.2- Modeling parameters

Elements	**Installed Capacity/Demand**
Solar	3000 W
Wind	2000 W
Battery Bank	5000 W
Village peak Load	5980 W

A MATLAB Simulink model based on the equations mentioned above, was developed for the wind generator module. This model is shown in below figure.6.[5]

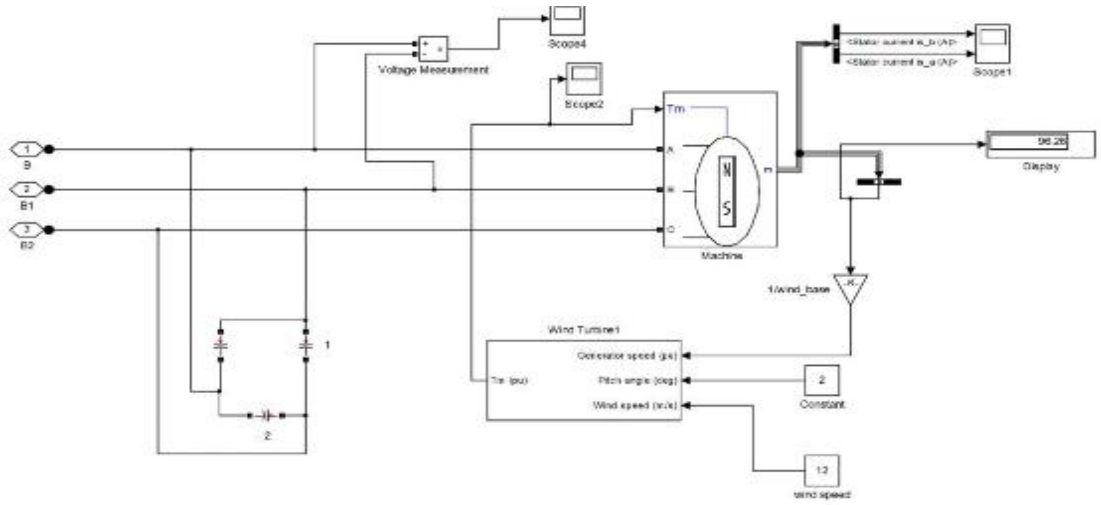

Figure no.4.wind turbine Induction generator module

SOLAR –WIND HYBRID POWER SYSTEM

Using the RegenSim. Library a renewable energy hybrid system shown in Fig.5Had developed. As shown, the simulation system contains power generation blocks from renewable energy sources such as sun, wind, battery blocks (providing the energy storage), measurements blocks for electrical parameters (voltage, current etc.), inverter blocks (for power generation in DC voltage), energy consumer block

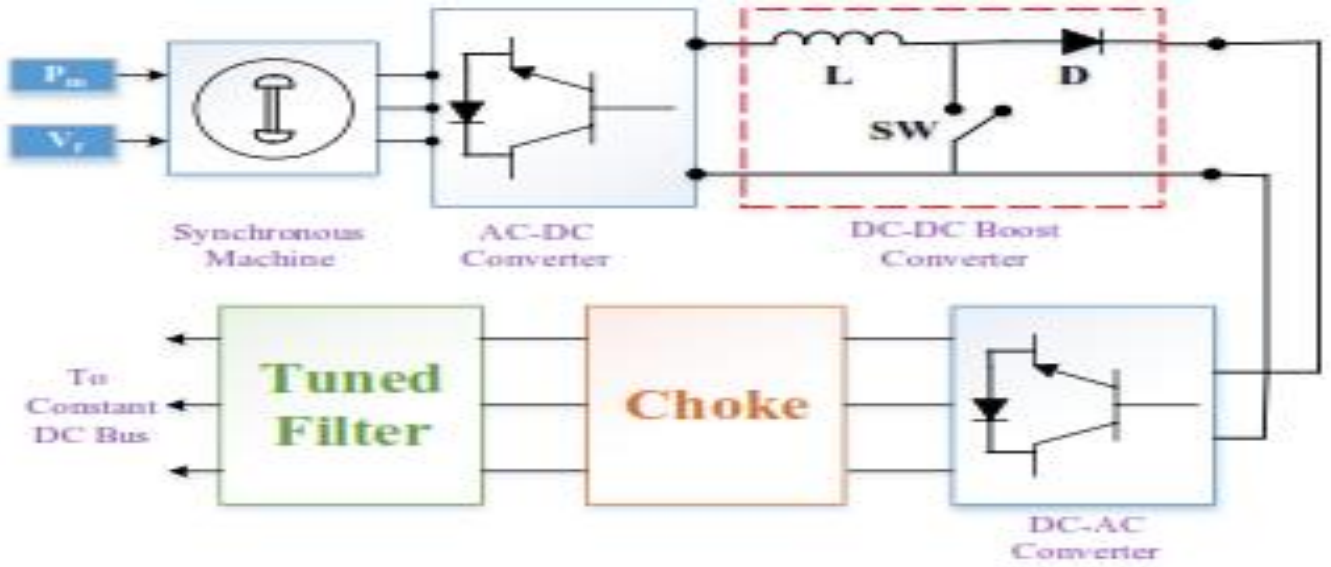

Figure no.5- The MATLAB Simulink model of the solar-windHybrid power generation system.

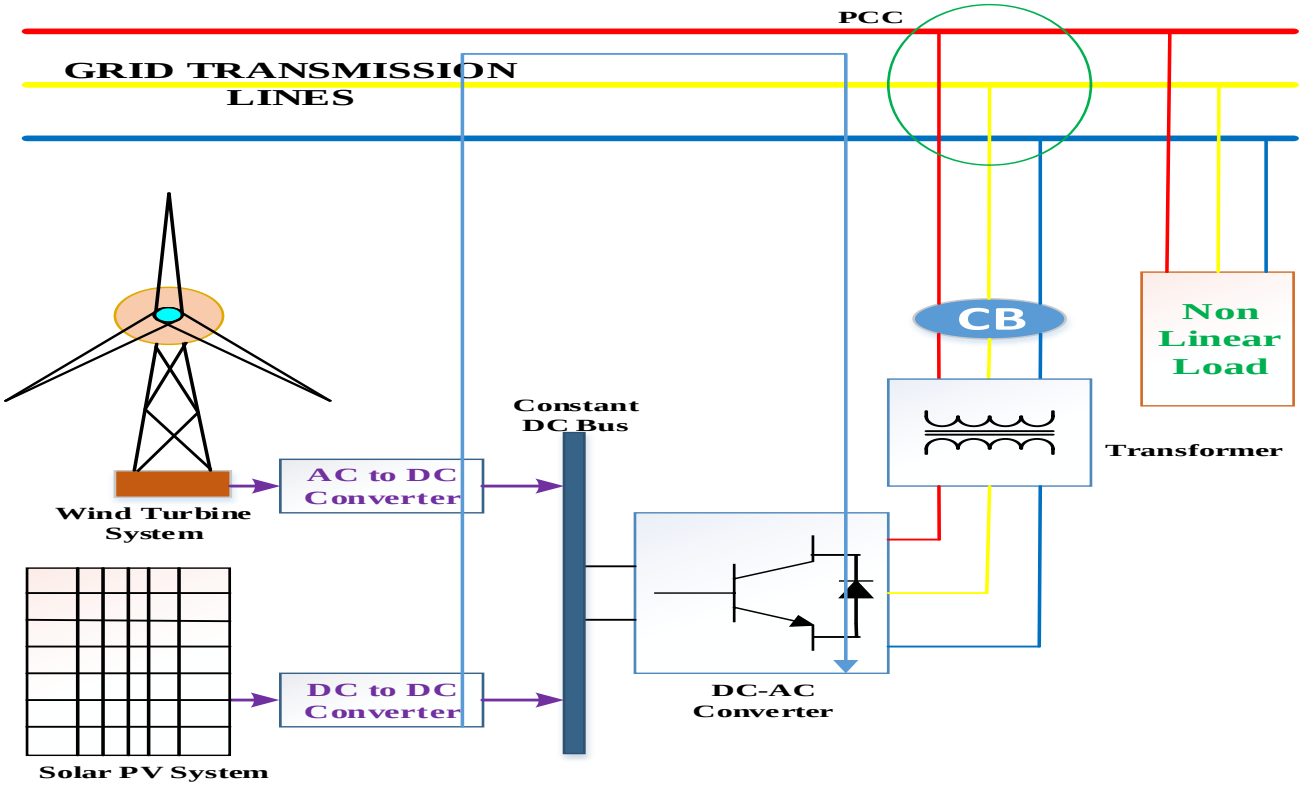

Figure no.6: -wind turbine Induction generator module

A MATLAB Simulink model based on the equations mentioned above, was developed for the wind generator module. This model is shown in below figure.6.[5]

RESULTS

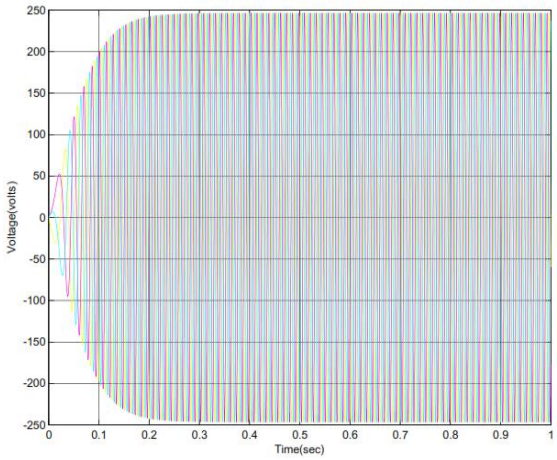

Figure no.7. Voltage waveform of wind System

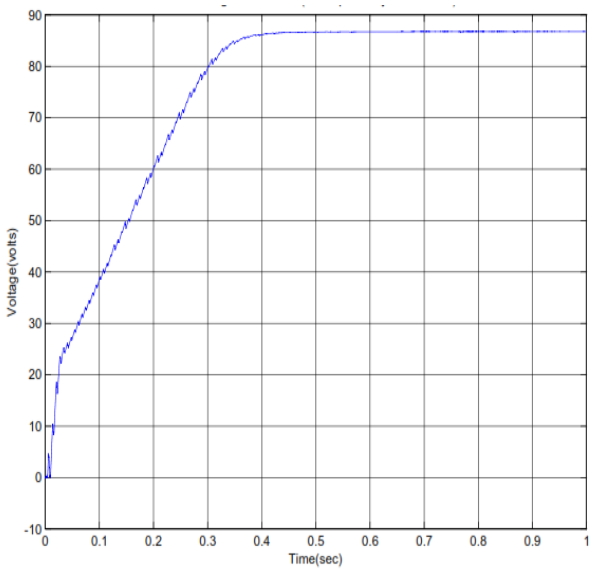

Figure no.8. Common DC Link Voltage Waveform

CONCLUSION

Hybrid renewable energy system gives excellent environment for remote area electrification in India. The hybrid renewable energy system gives continues form of energy to consumer And relief the grid to some extend during peak load. Also simulation result's shows that it gives better quality of voltage waveforms. By combination of all the sources continuity of the supply is maintain at any climate condition if any one of the source from solar or wind.

REFERENCES

I. Yogesh Tiwari and Chitesh Dubey "To design solar (photovoltaic) - Wind hybrid power generation system", International Journal of Emerging Trends & technology in computer science (IJETTCS), Volume 1, Issue 4, November – December 2012,ISSN 2278-6856.

II. M. R. Patel, "Wind and Solar Power systems, Design, Analysis and Operation", 2nd ed. Taylor & Francis, New York, 2006.

III. W.D.Kellogg, M. H. Nehrir, G.Venkataramanan, And V. Gerez, "Generation Unit Sizing And Cost Analysis For Stand-Alone Wind, Photovoltaic, And Hybrid Wind/Pv Systems," IEEE Transaction Energy Conversion., vol. 13, No. 1, Pp. 70–75, Mar. 1998.

IV. F. Valenciaga and P. F. Puleston, "Supervisor Control for a Stand- Alone Hybrid Generation System Using Wind and Photovoltaic Energy," IEEE Transaction Energy Conversion, vol. 20, no. 2, pp. 398-405, June 2005Samson Gebre "M. Optimal Load Sharing Strategy in a Hybrid Power System based on PV/Fuel Cell/ Battery/Super-capacitor", Undeland (IEEE Fellow).

V. Rohit G. Ramteke and Dr. U. V. Patil, "Design and Comparative study of Filters forMultilevel Inverter for Grid Interface", IEEE International Conference on Power,Automation and Communication (INPAC-2014), Government College of Engineering,Amravati on 06th-08th October-2014. ISSN 978-1-4799-7169-5/14.

VI. N. Pandiarajan and RanganathMuthu," Mathematical Modeling of PhotovoltaicModule With Simulink", International Conference On Electrical Energy Systems (ICEES 2011), 3-5 Jan 2011