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Simulation and Analysis of Solar Pv-Wind Hybrid Energy System using Simulink

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Abstract: ***As our nation is growing there is a huge demand of Electricity. This paper deals with the renewable energy production by a hybrid model of Solar PV & Wind energy system for isolated areas. The system of wind and the solar PV are connected through common load. The modelling and simulation of the combined hybrid model is done using SIMULINK/MATLAB. The analysis of the hybrid system is evaluated for different wind speed and under different irradiation levels. From the results we can depict that proposed hybrid system has the power to meet the demand for electricity in isolated areas.***
Keywords: Photovoltaic, Wind energy, Renewable energy, conversion system, hybrid energy system, inverter.

I. INTRODUCTION

Many remote communities around the world cannot be physically or economically connected to an electrical power system . The electricity demand in these areas is conventionally supplied by small isolated diesel generators. The operating costs related to the generators are very high due to fossil fuel costs together with the difficulties for the fuel delivery and maintaining of the generators. In such circumstances, sustainable power sources, for example, sunlight based photovoltaic (PV) and turbine generator turning through wind give a choice to enhance the motor driven generators for electricity generation in off-grid areas. It has been shown that hybrid energy systems can significantly reduce the total life cycle cost of standalone power supplies in many off-grid situations, while at the same time providing a reliable supply of electricity using a combination of energy sources.

Thus, this implies an enormous power and potential in energy generation, which can be achieved for several hundred GW with current renewable energy technologies.

As the cost for building the solar PV–wind model capacity continues to fall over the next four to ten years; there will be a significant scale- up in renewable generation and its very realistic possibility in the developing world. More than thousands of villages across the globe are still exiled from electricity and we can energize these villages by extended grids or by diesel generators alone will be uneconomical. Moreover, with our current resource crunch with government, these villages get low priority for grid augmentation due to lower economic return potential. Independent solar PV–wind hybrid model systems are financially suitable and solid power to such local needs. Solar and wind energy are abundant and are non-depletable, site dependent, non-polluting, and possible sources of alternative energy choices. Numerous countries with an average wind speed within the range of 5–10 m/s and average solar irradiation level in the range of 3–6 KWh/m2 are seeking after the selection of wind and PV framework to limit their reliance on fossil-based non-renewable fuels (Bellarmine & Urquhart, 1996;).

Alone wind systems cannot produce usable energy for a considerable portion of time during the year. This is due to relatively high cut-in wind speeds (the speed at which wind turbine starts producing the energy) which ranges from 3.0 to 4.2 m/s. So, in order to overcome this downtime, the utilization of solar PV and wind hybrid system is needed. These types of systems will be equipped with generators to meet the peak load during the short periods when there will be a deficit of available energy to overcome the load demand .While a drawback common to both wind and solar system is that their unpredictable behavior and dependence on weather and the climatic changes However, by merging of the solar and wind energy system into a hybrid generating system can reduce their individual fluctuations, and will increase overall energy output, and also reduces the energy storage requirement significantly. It has been depicted that because of this arrangement, the overall expense for the renewable energy system will get reduced drastically (Bagul & Salameh, 1996).

The integration of PV and wind system with battery storage and generator backup system is becoming a suitable, cost-efficient approach for the remote areas electrification. Wind and solar models are expandable, additional capacity can be added as per the requirement. Moreover, the mixture of wind and solar PV hybrid system reduces the battery bank requirement and further reduces the fuel consumption. The derivation of power from hybrid energy systems are getting very promotable worldwide (Seeling-Hochmuth, 1997). The utilization of hybrid energy systems also reduces combustion of fossil fuels and consequent CO2 emission which harms our surroundings

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II. HYBRID SYSTEM

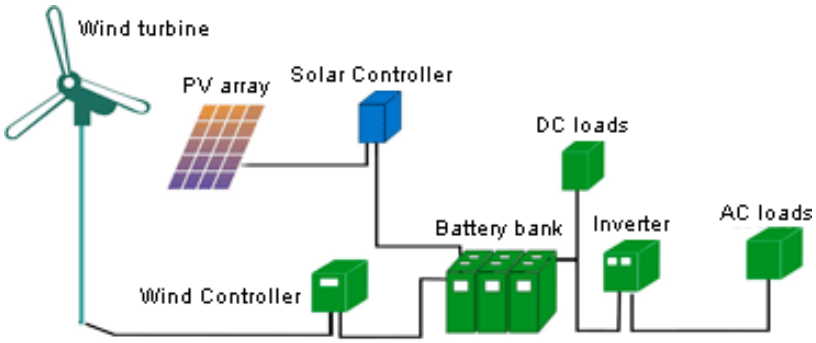

Fig. 1. Schematic diagram of Proposed Hybrid Energy System

Hybrid systems are basically an integration of solar panels and wind turbine, the output of this combination is used to charge batteries, this stored energy can then be transmitted to local power stations. In this system wind turbine can be used to produce electricity when wind is available and solar energy panels are used when solar radiations are available. Power can be generated by both the sections at the same time also. The usage of batteries is to This system requires high initial investment. But the reliability, long-life span and less maintenance make up for that disadvantage. The power output of the wind turbine is providing uninterrupted power supply. AC which is converted to DC with the assistance of a rectifier. The voltage is often stepped up or stepped down with the assistance of a converter.

III.MODELLING OF VARIOUS ENERGY SYSTEM

A. Solar Panels

Solar cells are used to convert solar energy into electrical energy, also known as photovoltaic cell. It is a junction diode which is having two distinct layers of semiconductor material known as p region and n region, the radiations falling on the surface of p-n junction diode can pass through the n side. The current starts flowing when an external load is connected to the terminals of the n and p regions. To make it a solar panel multiple solar cells are connected in series as well as in parallel combinations, they are associated with the end goal that the yield acquired is additive in nature.

We know that solar cell has less power production unit, in this hybrid system to maximize the output of energy generation we use the maximum power point technique (MPPT). Output power of the solar cell can be calculated using the equation: I = IPV – ID

Ipv is the current generated through the incident light, ID is the current of the diode.

B. Wind System

When air flows then it is having some kinetic energy associated with it which is called as wind energy. This kinetic energy is then converted into mechanical energy by wind turbines, which is then used to rotate the shaft of the generators and then electricity is generated. The expense of generation of electricity is slightly less. The initial investment of the system varies depending on the type of turbine used. The best part of producing the electricity with the help of wind energy is that wind is available for almost 24 hrs a day, so there won't be any irregularity with the creation of power. The power captured by the wind turbine is given by the relation

$\boldsymbol{P} = (\rho\, \boldsymbol{AV}^3)\,/2$

A represents the area through which the wind is flowing, ρ is the density of air and V is wind velocity.

C. Three Phase Source

Basically, source is an electrical generator which will be used during adverse conditions. During the night time if the demand increases and if wind alone cannot provide the desired electrical energy then source is used, similarly during the day time if there is absence of wind energy then source helps to meet the desired energy requirement.

D. Three Phase Converter

As we know that the most of our electrical appliances requires AC voltage, so first the DC output of the Solar panels will be converted into AC voltage with the help of a converter and then the combined energy of the system will be transferred to the loads.

E. Loads

A three-phase load is connected through which energy produced can be consumed. We can also place a battery so that we can store the energy for future.

IV. CONTROL OF SYSTEM

The PV module is configured with appropriate irradiance and the temperature. A 3-phase bridge converter is used with PV module to convert the dc input to 3phase output. The wind module is configured with appropriate wind speed ,no of wind turbines , and the pitch angle. A 3-phase transformer is connected with wind system to step up the voltage coming from wind system A 3phase source is present so that in absence of both the generating device it can be used to provide energy to load. Simulation is done to analyze the model.

V. SIMULATION & RESULTS

Following simulation results were obtained for a system with PV Panel through irradiation of 800Wm^{-2} and temperature of 25^{o}C . The Wind Speed is fixed to 15m/s. Figure 2. shows the developed MATLAB/Simulation model of hybrid energy system.

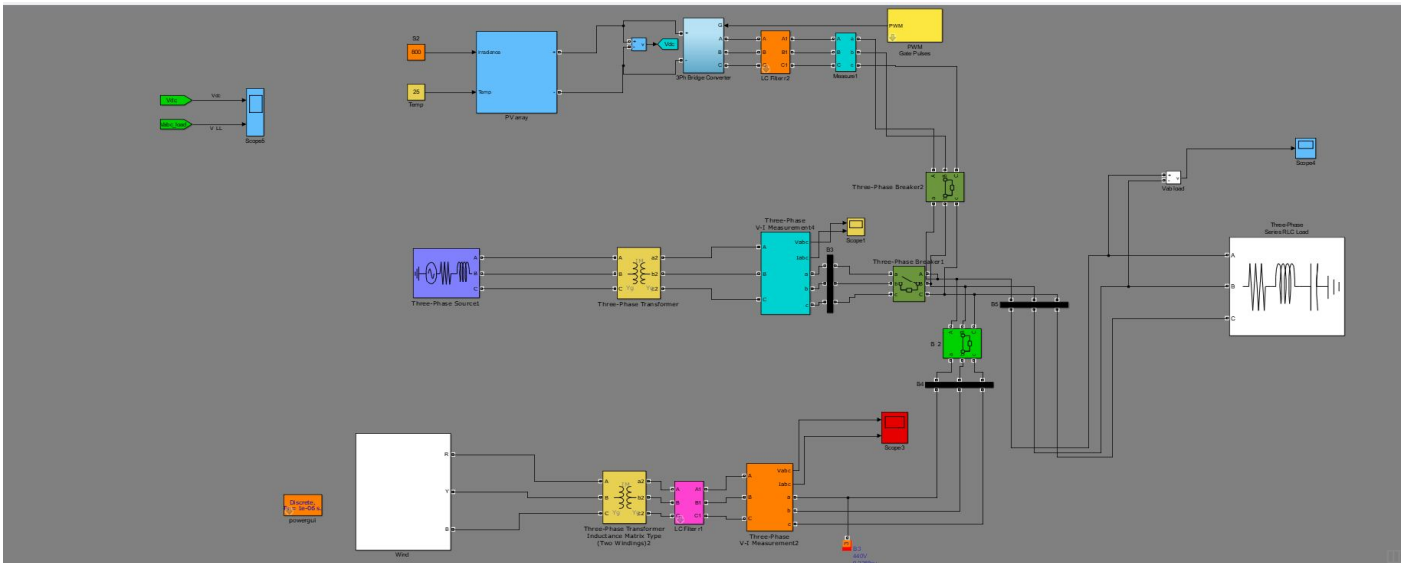

Fig. 2. Simulation Block Diagram

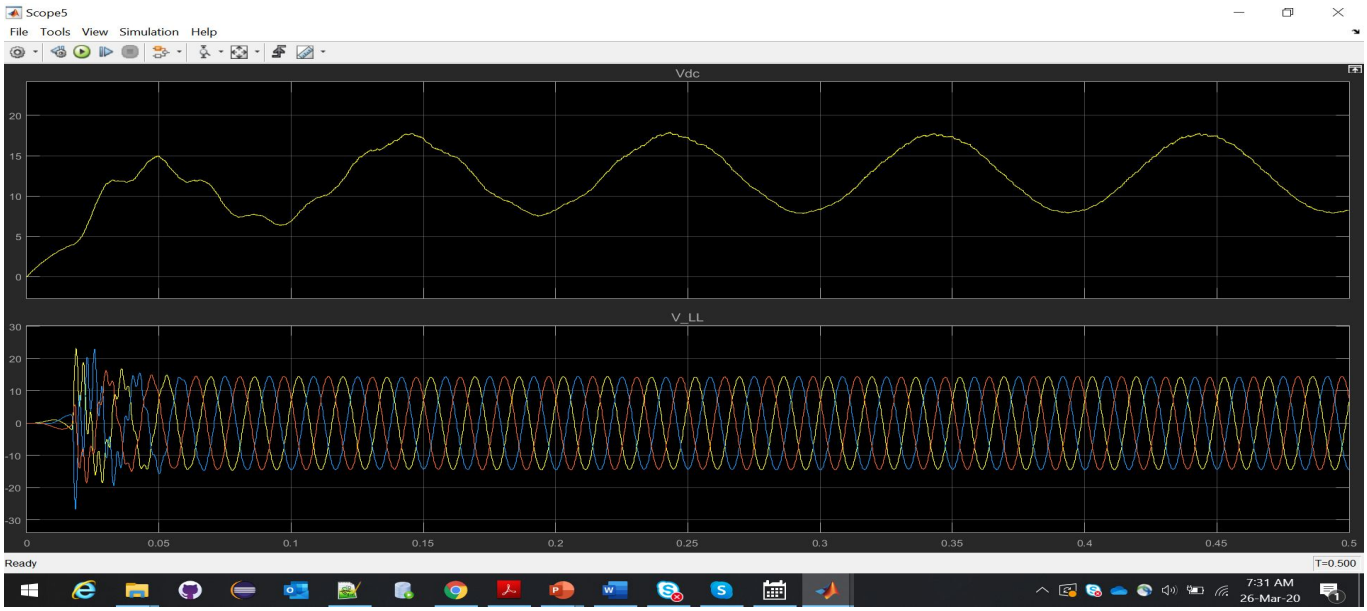

Fig. 3. DC voltage measured across PV and the voltage after converting it to three phase

Fig. 4. Three phase transmission voltage measured across wind model and the current flowing through it

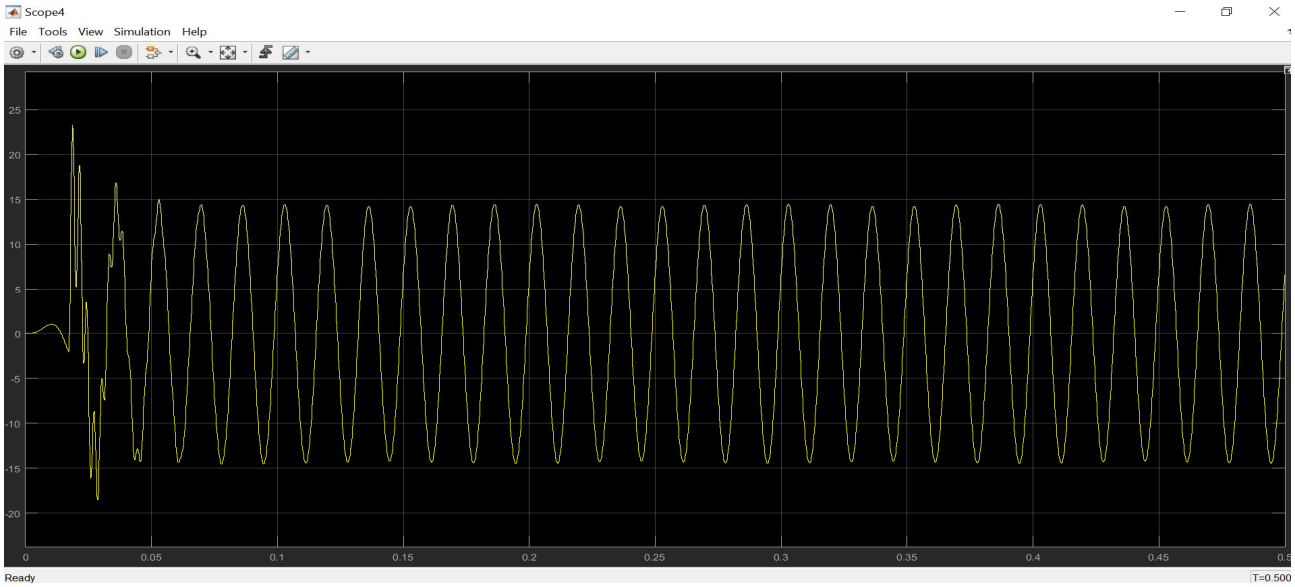

Fig. 5. Voltage measured through the hybrid model

VI. CONCLUSIONS

This paper has clarified a mixture sustainable power source framework with variable speed wind age, PV(photovoltaic) framework. The simulation was conducted in computer using the MATLAB/SIMULINK . In hybrid system, 15 m/s in wind system and 800Wm^{-2} in solar PV system performance has been analyzed. This system can be used to meet up electricity requirement in the remote areas. The exhibition of the created framework is assessed in MATLAB/SIMULINK stage and the outcomes are introduced. It tends to be utilized to perform for a wide range as the wellspring of vitality is free and furthermore bounteous (Sunlight and wind)

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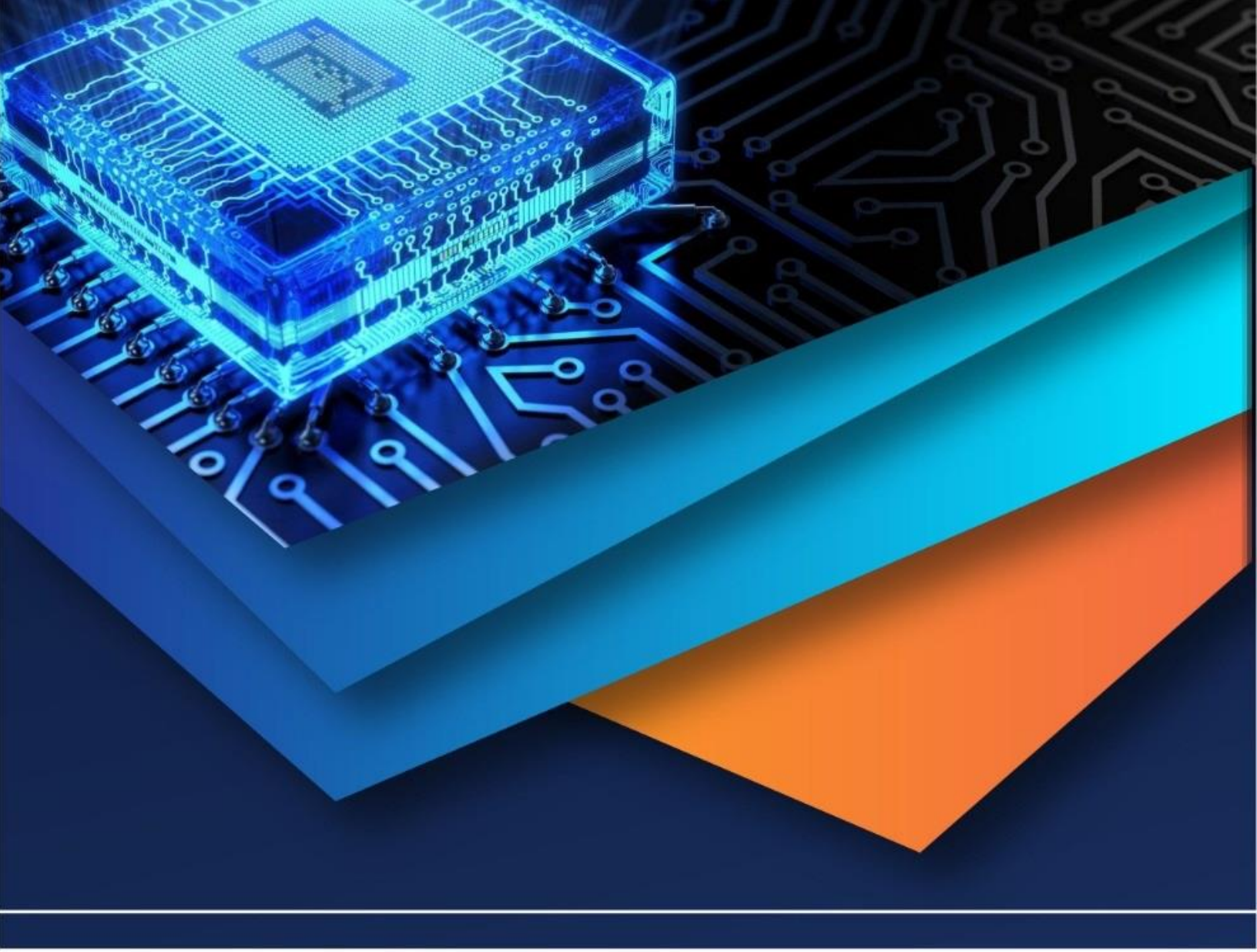

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