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Simulation of Wind-Solar based Hybrid Power Generation System using MATLAB

B. Narmada Reddi
Assistant Professor, Department of Electrical and Electronics Engineering
G. Narayanamma Institute of Technology and Science Hyderabad, India
E-mail: narmada@gnits.ac.in

B. Vindhya, K. Varsha, M. Bindhu, P. Arshiya Khan, T. Swathi Sri
Department of Electrical and Electronics Engineering
G. Narayanamma Institute of Technology and Science Hyderabad, India

Abstract

This project simulates a hybrid power generation system that uses clean, renewable energy sources like the sun and the wind. This system's primary objective is to connect solar PV and wind turbines in order to produce a steady supply of electricity. Since both solar radiation and wind speed vary over the course of the year, neither solar nor wind-based systems can independently produce efficient, dependable electricity. As a result, combining solar and wind energy systems can provide a year-round alternative and stable energy source. Power generation by hybrid systems is more likely to match the inputs that are available. The system is anticipated to produce production that is steady, dependable, and effective.

Keywords: Solar panel, Boost converter, Universal bridge, Wind turbine, Pulse generator, PMSG

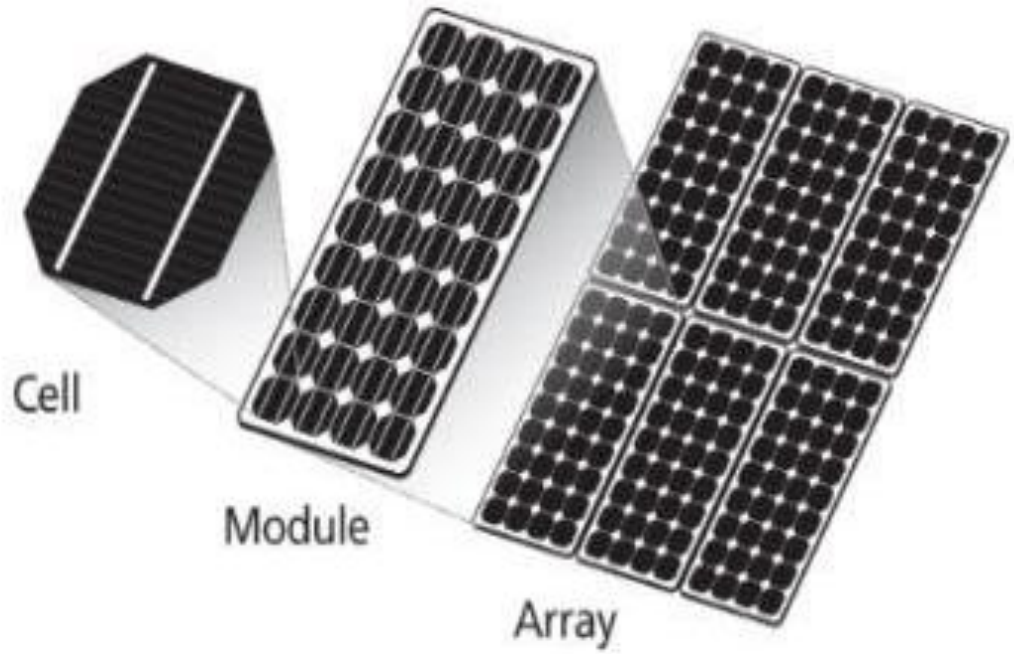
I. Introduction

There is a rise in energy demand. But the supply of fossil fuels is running out. As a result, people are becoming more interested in alternative renewable energy sources like solar, wind, tidal, bio, and geo-thermal. Renewable energy sources are essential and important to electrical networks, and photovoltaic solar energy use is increasing dramatically daily. Solar energy is produced using electrical inverters and photovoltaic panels. In nature, the photovoltaic panels' output power is discontinuous and changes according to the amount of radiation, temperature, the age of the panels, and different orientations. A solar photovoltaic system is more economical and eco-friendly in many

applications, especially in rural areas. The hybrid electric system combines two or more unconventional energy sources.
The solar and wind energy are more significant because they are eco-friendly. The main motive is to produce the energy in an eco-friendly way by using renewable sources. By using these two sources at a time.

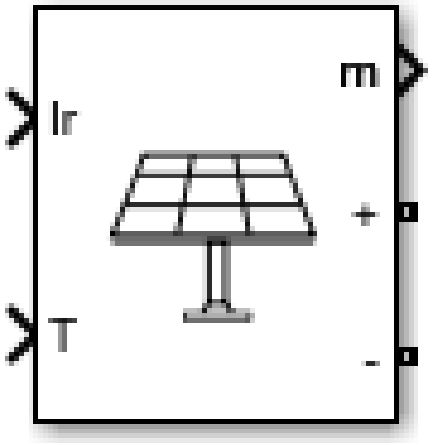
II. PV Array

A photovoltaic array is nothing more than the serial or parallel connecting of several PV modules. The power provided by the modules is insufficient to satisfy the needs of the applications, so the modules are secured in a grid or as an array to meet the load need. Similar to how a module's cells are connected, an array's modules are joined together. When constructing a PV array, the modules are frequently first joined in serial to achieve the correct voltage before being connected in parallel to supply more current as necessary.



Photovoltaic Array

In a photovoltaic (PV) array, temperature and irradiance are two important factors that affect the performance and efficiency of the system. Temperature refers to the temperature of the PV cells themselves. Irradiation that reaches the PV array to optimize the performance of a PV array, it's important to consider both temperature and irradiance. PV arrays should be installed in a location that receives as much sunlight as possible.



PV Array Block

III. Boost Converter

A boost converter, which is also referred to as a step-up converter, is a DC-to-DC power converter that lowers current while raising voltage from its input (supply) to its output (load). It is a member of the switched-mode power supply (SMPS) family, which consists of at least two semiconductors—a diode and a transistor—as well as one or both of the capacitor and inductor energy storage devices, or both individually or jointly. Voltage ripple is often reduced by adding capacitor-based filters to the input (supply-side filter) and output (load-side filter) of such a converter. The boost converter can be powered by any suitable DC source, including batteries, solar panels, rectifiers, and DC generators.

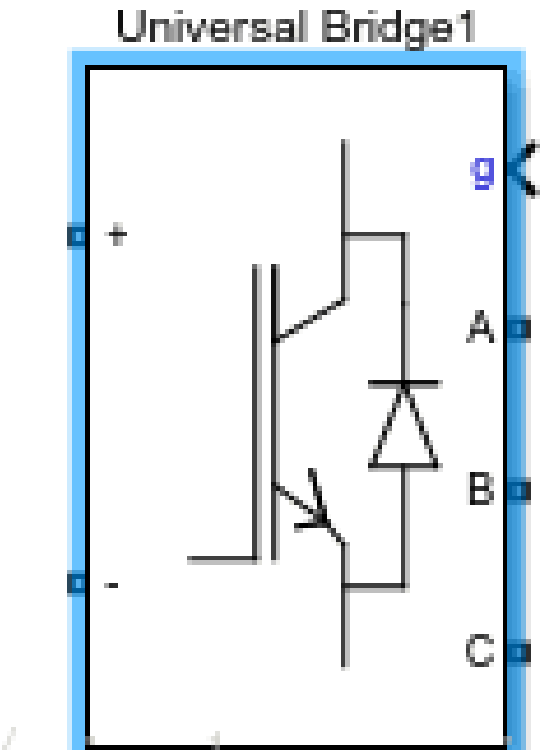
A technique for changing one DC voltage to another is referred to as DC to DC.

Boost Converter

IV. Universal Bridge

Building two-level voltage-sourced converters (VSC) starts with the Universal Bridge block. A universal three-phase power converter made up of up to six power switches coupled in a bridge arrangement is implemented by the Universal Bridge block. The dialogue box allows you to choose the power switch and converter setup types.

Both naturally commuted power electronic devices, such thyristors and rectifiers, and forcedly commuted devices, like MOSFETs, IGBTs, and GTOs, can be used with the universal bridge block.

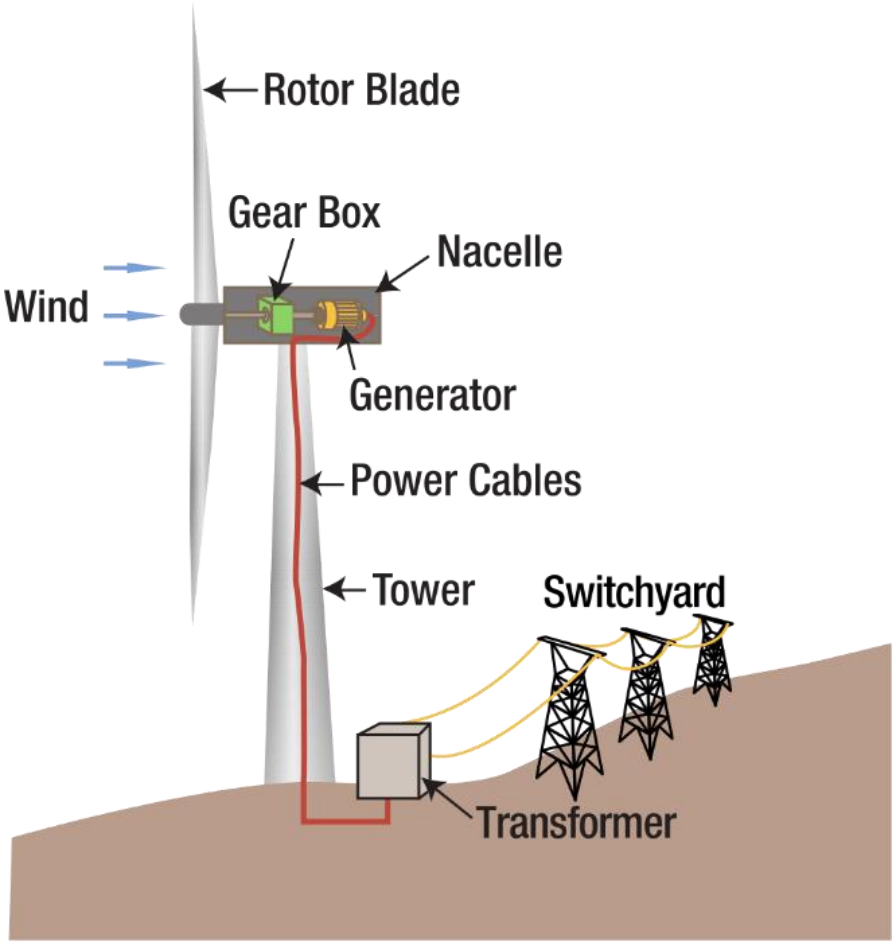


Universal Bridge

V. Wind Turbine

One of the most crucial components of wind energy conversion systems is the wind turbine. A windmill or wind turbine should ideally be placed in an area with steady, dependable winds. Blades that have been particularly constructed to push as readily as possible in the wind are pushed by the air movement. A wind turbine generates electricity by harnessing the force of the wind to power a generator.

A gearbox-generator set is housed inside the nacelle, and a set of rotor blades revolve around a hub. A wind turbine transforms the mechanical power, or spinning motion, of the turbine into the kinetic energy of air, or wind power, which can then be utilised to directly power a device or generator.

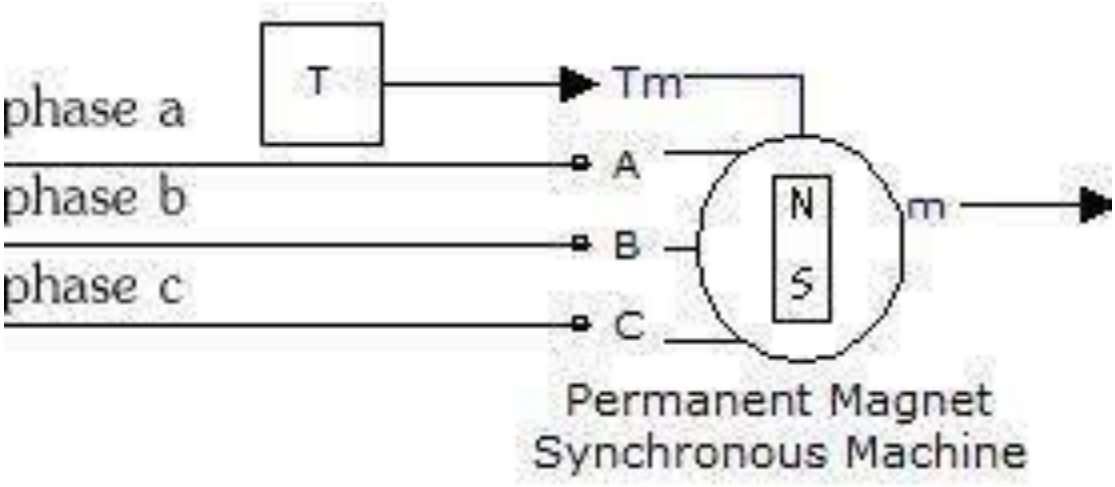


Wind Turbine

VI. Permanent Magnet Synchronous Generator

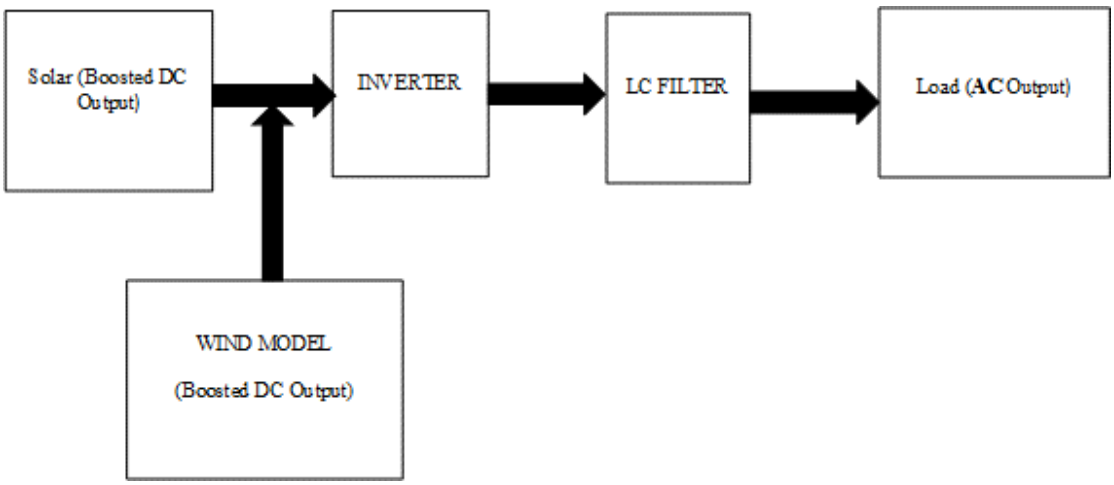
In applications requiring lower speeds, the permanent magnet synchronous generator offers good efficiency. The use of PMSG in WECS produces a lower system size and high power density for a given mechanical specification, resulting in maximum overall efficiency. Typically, a stator and rotor are used in PMSG construction. Permanent magnet technology enables brushless generation of magnetic flux. The lack of rotor windings allows for a machine to be smaller and lighter while still having a high power density.

It uses a permanent magnet synchronous machine that operates on three or five phases. The wind turbine receives the rotor speed (rad/s) as an output as the generator speed. The output is the three-phase voltage.



Permanent Magnet Synchronous Machine

VII. Block Diagram Of Hybrid Simulink Model

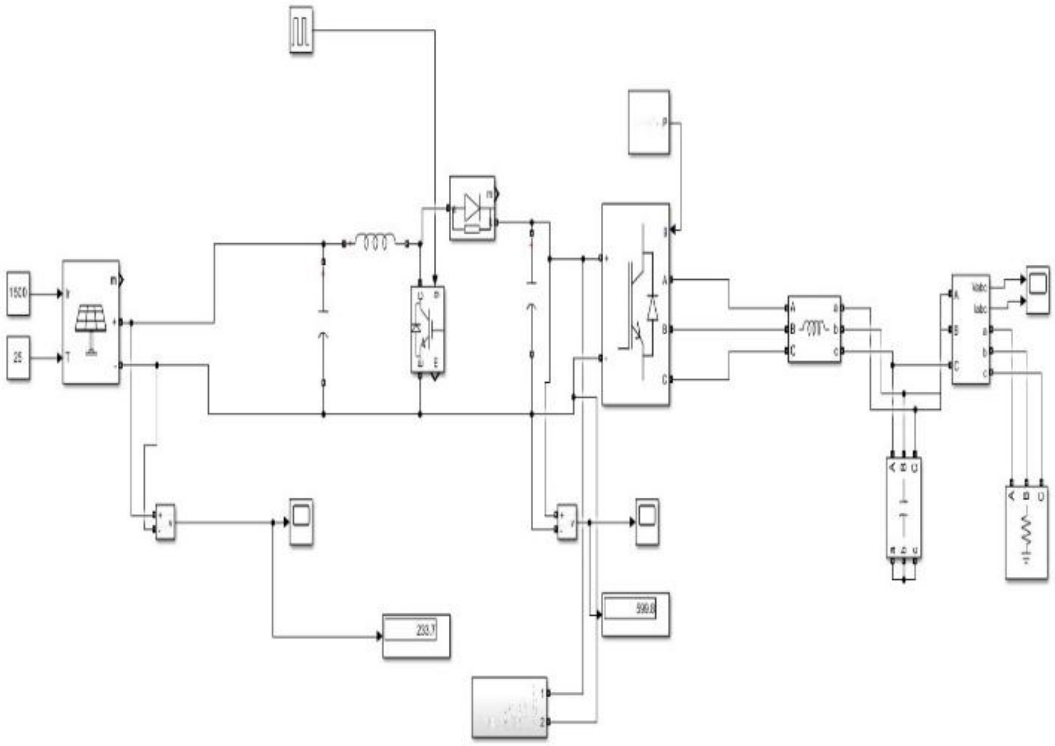


VIII. Hybrid Operation

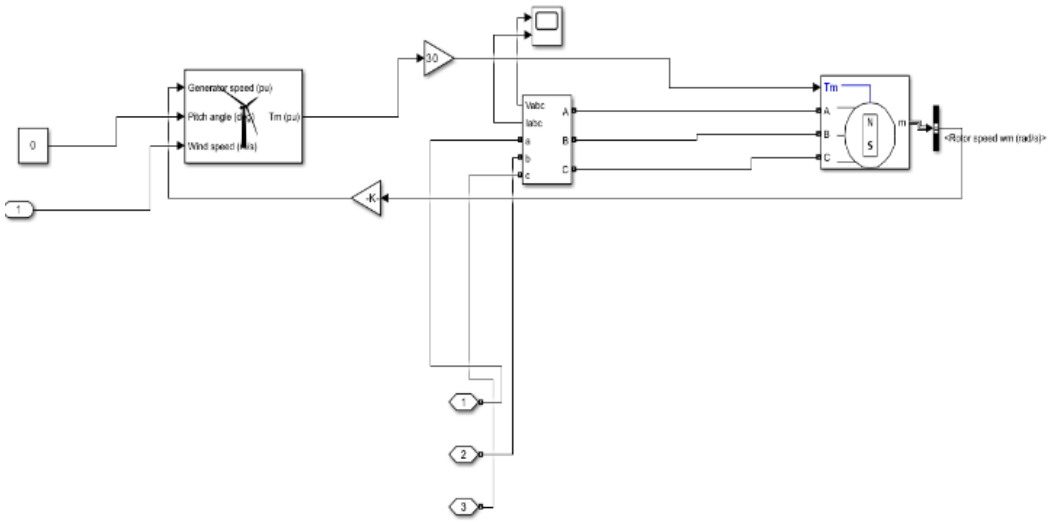
To maximize the capacity sizes of various solar-wind hybrid energy system components, a hybrid solar-wind system was created. A solar photovoltaic module and a wind turbine were mathematically modelled in order to mimic the operation of a solar-wind hybrid energy system. The ideal configuration of a hybrid solar-wind energy system must meet both the requirements for dependability and affordability. Since wind energy is more readily available, it frequently takes precedence in hybrid solar-wind operations. When it is possible to operate wind turbines both during the day and at night, solar PV systems can be used during the day. The blend of these two renewable energy sources produces ac, which is used in small businesses, educational institutions, and other establishments.

IX. Simulation Results

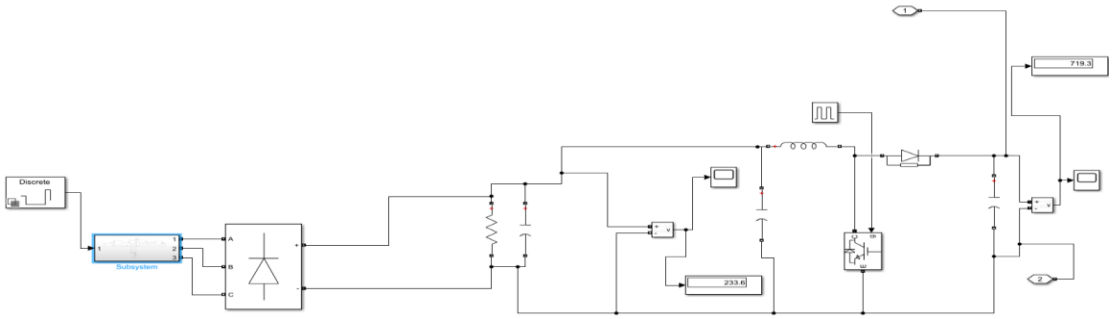
Simulink Diagrams



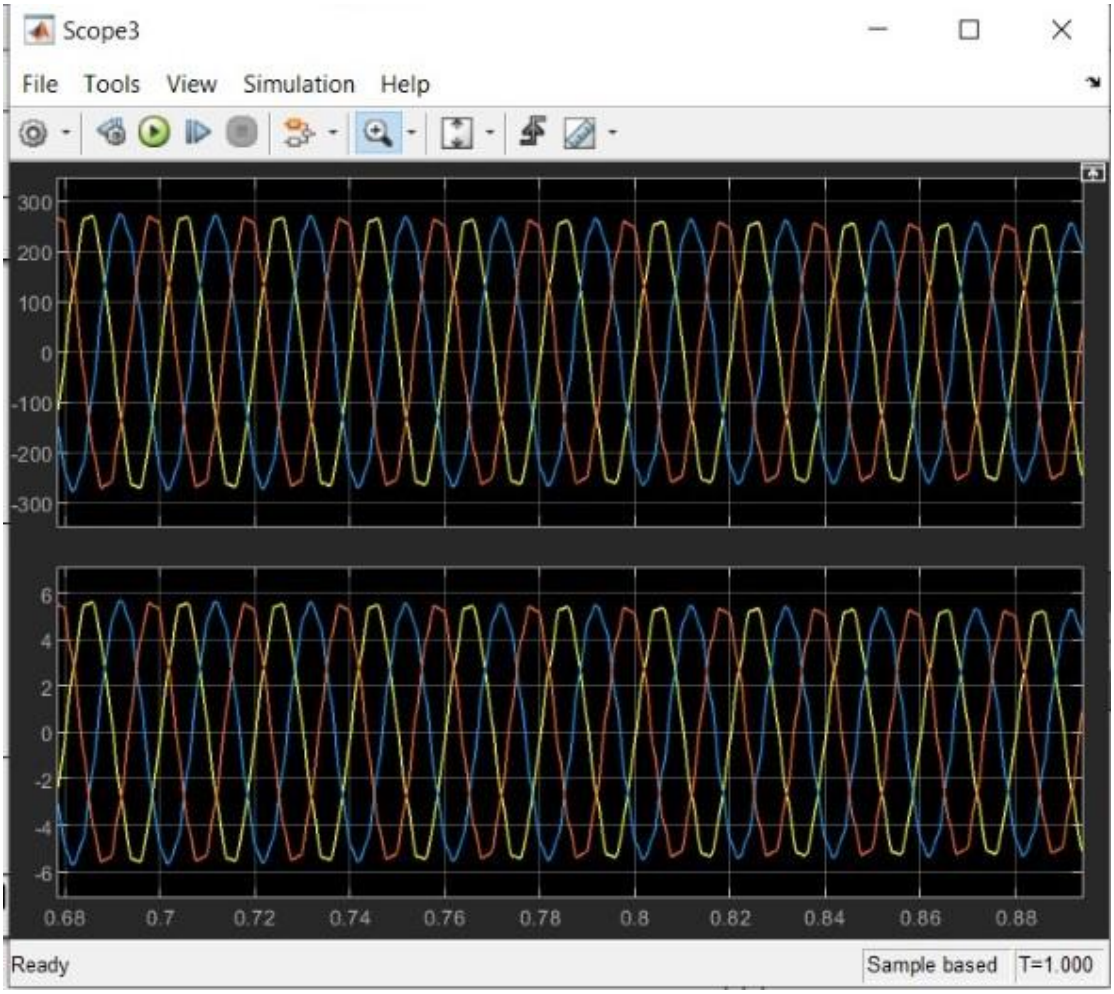
Hybrid Model



MATLAB model for obtaining electrical energy from wind turbine



MATLAB model for converting AC to DC and boosting the voltage



Output voltage and current wave forms

Conclusion:

Concerns about the security of the world's energy supply and its sustainable growth are

felt on a global scale. As a result, the importance of renewable energy has increased. The industrialised world is already making progress towards cutting back on fossil fuel use and expanding the use of renewable energy sources. This study provides insight into the current energy landscape and the potential of renewable energy sources. The utilisation of solar-wind hybrid renewable energy systems is growing daily and has made remarkable strides in the previous few decades for the production of power throughout the world.

The integration of wind with solar system may provide reliable and stable system. Because the seasonal profiles of the solar and wind resources may vary in some reason, whereas the combination of wind and solar performs better. If implemented correctly, it may be the most feasible economical solution in reducing electricity bills.

Future Scope

In this research, we investigate various information regarding solar and wind energy to generate hybrids at a low level, which enables us to investigate many aspects of building a hybrid generation facility at a variety of low cost with highest generating capacity. The energy can be stored in batteries, which can then be used whenever it is required. The use of advanced control techniques, such as a fuzzy logic control scheme, can improve the overall control and operation.

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