iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** VIII **Month of publication:** August 2021

DOI: https://doi.org/10.22214/ijraset.2021.37448

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

Solar PV-Wind System Integration with Power Grid System

Miss. Dhanashree S. Patil[1], Prof. Shiwani S. Rasekar[2]
[1]PG Scholar, Electrical Engineering Department, Ballarpur Institute of Technology, Ballarpur
[2]Assistant Professor, Electrical Engineering Department, Ballarpur Institute of Technology. Ballarpur

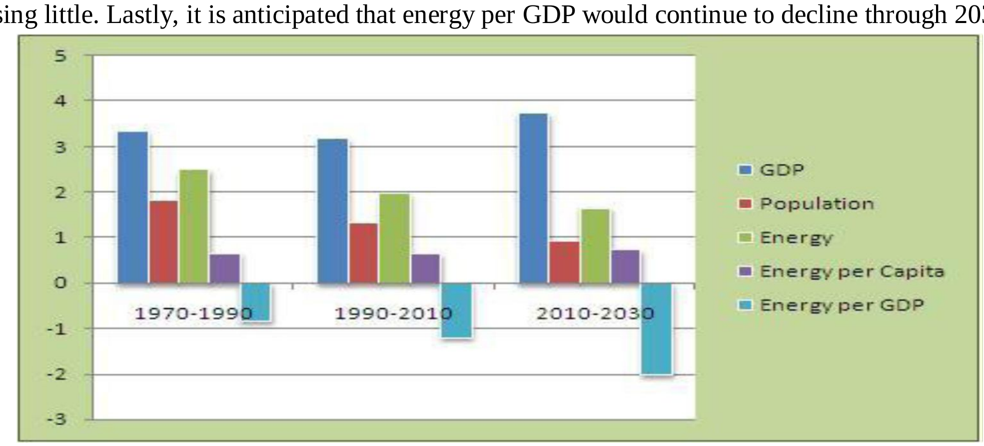
Abstract: This paper describes a photovoltaic (PV) and wind hybrid power system that is equipped with a Diode Clamped Multi-Level Inverter and LC filter for the generation of renewable energy. Due to their environmental friendliness and availability, wind and solar energy are ideal for hybrid systems in India. Due to fluctuations in the output voltage, equipment that require a consistent supply will be damaged by hybrid power systems that are completely dependent upon intermittent renewable energy sources. Matlab Simulink is used to create a model of the hybrid system using a Diode Clamped Multi-Level Inverter and an LC filter. Before merging a DC voltage hybrid system with the main grid of the power system, blocks such as the wind model, solar model, Diode Clamped Multi-Level Inverter, and LC filter are developed independently.... The input parameters for the project simulation include different irradiance values and varied wind speeds. Initially, a DC voltage hybrid system with the main grid of power system is constructed separately, taking into account the characteristics of the wind and photovoltaic models developed, as well as the simulation results for hybrid systems with and without Diode Clamped Multi-Level Inverters and LC filters. The input parameters for the project simulation include different irradiance values and varied wind speeds. Present are the wind and photovoltaic model characteristics, as well as simulation results for a hybrid system with and without a Diode Clamped Multi-Level Inverter and LC Filter. The results suggest that hybrid systems are more reliable in terms of generating output voltage than solo systems in this study. As well as this, the hybrid system's Diode Clamped Multi-Level Inverter and LC Filter can reduce output voltage fluctuations.

Keywords: Solar PV system, Wind Turbine System, Hybrid Power system

I. INTRODUCTION

A. Global Energy Scenario

Everyone is familiar with the word energy, which mathematically refers to the amount of power consumed in a specific period of time. A man's everyday needs use energy in one form or another from the first hour of the day to its final hour. Without electricity, people today can't even comprehend what their lives would look like. People with major physical disabilities are called handicapped, and the world without energy is like one that has been crippled.The human race continues to develop, and the world's population continues to grow. A byproduct of this rapid modernization and population growth is a substantial increase in the total energy need as well. This means that by 2030 there will be a 40 percent increase in the total energy demand According to a survey, the main energy demand is growing at a rate of 1.5 percent each year.t is estimated that world energy consumption climbed by 2.5 percent in 2011, which is smaller than the 5.1 percent growth seen last year, but in line with historical averages. Fig, 1 show that the GDP (Gross Domestic Product) has risen from 1970 to 2010 and will continue to rise in 2030 and beyond. Nevertheless, the population is declining, and it is expected that this trend will continue into the future. Energy consumption is declining, but energy per capita is increasing little. Lastly, it is anticipated that energy per GDP would continue to decline through 2030.



Fig, 1 Global growth rate from 1970 to 2030

©IJRASET: All Rights are Reserved

B. Indian Energy Scenario

A developing country, India is today considered one of the world's leading economies. 121 crores people make up 17 percent of the world's population in 2011. India's population grew by 17.64 percent between 2001 and 2011. This population growth will result in an average annual rise in power consumption of 3.3 percent in India through 2035. To meet this demand, the country's overall generation capacity should be boosted by 235 megawatts (MW). India's current per capita energy usage is 531.34 kWh, and it is expected to continue to rise as the country continues to modernize.

As a developing country, India currently ranks among the world's most powerful nations, according to the United Nations. Fig. 2 shows that coal-fired thermal power plants generate the majority of India's electricity. One-fifth and nine-fifths of the total power generated comes from coal, respectively. About 12 percent of India's electricity comes from renewable sources, while the remaining 19 percent and 2 percent come from hydropower and nuclear power, respectively.

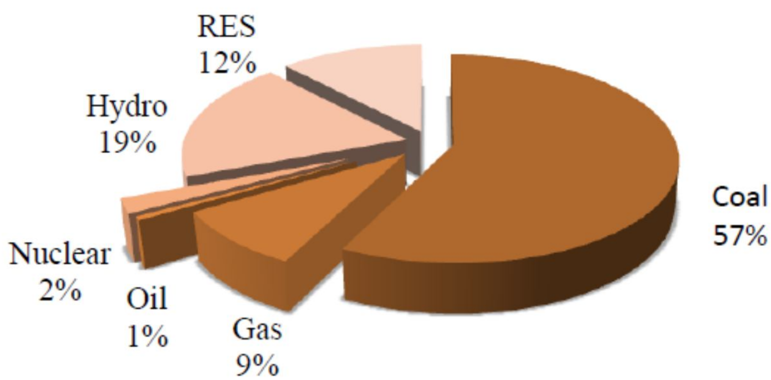


Fig. 2 Fuel-wise installed capacity in India

TABLE I
Region-Wise Power Generation In India (All Units Are In Mega Watt)

Region	Thermal				Nuclear	Hydro	R.E.S.	Total
	Coal	Gas	DSL	Total		Renewable		
Northern	30823.50	4671.26	12.99	35507.75	1620.00	15423.75	4437.65	56989.15
Western	43099.50	8254.81	17.48	51371.19	1840.00	7447.50	8146.69	68805.98
Southern	23782.50	4962.78	939.32	29684.60	1320.00	11338.03	11769.32	54111.95
Eastern	22337.88	190.00	17.20	22545.08	0.00	3882.12	410.71	26837.91
N. Eastern	60.00	824.20	142.74	1026.94	0.00	1200.00	228.00	2454.94
Islands	0.00	0.00	70.02	70.02	0.00	0.00	6.10	76.12
All India	120103.38	18903.05	1199.75	140206.18	4780.00	39291.40	24998.46	209276.04

Table I shows the actual installed power generation capacity in India. That India is heavily dependent on coal for power generation is illustrated by the fact that renewable technologies are used far less than coal for power generation. Here, coal, a non-renewable fuel, provides the majority of the power. On October 31, 2012, India's total power generation was 209276.04MW, with coal accounting for 57 percent, gas accounting for 9 percent, diesel contributing 1 percent, hydro contributing 19 percent, nuclear contributing 2 percent, and renewable energy contributing 12 percent.

In spite of this high level of electricity generation, India's power shortfall is widespread. The average energy deficit in India is 8.5 percent, with the worst conditions in the western and north-eastern regions, respectively, at 11.4 percent and 9.5 percent, respectively [7]. Energy must be generated at a higher pace in order to fulfil the ever-increasing demand. A rapid depletion of conventional sources has reduced their availability.As a result, renewable energy sources enter the picture. Renewable sources are needed now to save conventional sources and meet the ever-increasing demand for power.

Now, let's get to the economics. Electricity generated from renewable sources is more expensive than electricity generated from non-renewable sources. An engineer, on the other hand, should constantly think from a business perspective. As a result, the project should be economically viable in terms of generation, transmission, distribution, and consumption of electric power.A good engineer will choose generating, transmission, and distribution methods that are both convenient and affordable. This is another case where the project must be environmentally friendly in order to qualify for government funding.

©IJRASET: All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

Economic load dispatch comes into play in this situation. Diverse system restrictions should also be reduced as a result of the plan for meeting indigenous' electricity needs the engineer should also take into account the fact that every year, the price of almost every commodity on the market increases. Difficulty and cost of maintaining the project will increase day by day as a result of this. In order to achieve the highest possible power generation, moreover keeping in mind the various benefits of hybrid system like eco-friendly technology, quick installation of components, inexhaustible fuel etc. hybrid system is chosen for this thesis.

II. PROPOSED METHODOLOGY

A. Wind Energy System

Solar energy is a one of the largest sources of energy. All renewable energies (except geothermal and tidal energy) and even fossil fuels ultimately come from the sun. The sun radiates 174,423,000,000,000 kilowatt hours of energy onto the earth every hour. The earth receives 1.74 x 1017 W of power. Wind energy has been used for a variety of mechanical energy applications for thousands of years. But the use of wind energy as a pollutant-free energy supply is the latest attraction in wind energy. They have been produced to generate electricity from wind power since the end of the 19th century. Small wind turbines have been manufactured since the 1930s and today, despite the current low cost of fossil fuels, it is one of the most cost-effective and affordable methods of generating electricity. This technology is being improved day by day to make it increasingly reliable in the decades to come. The range of these wind turbines is varied, from a few tens or hundreds of watts for small machines to 5 megawatts of power for very large turbines. The schematic diagram of the wind energy system is manifested in fig 3, below.

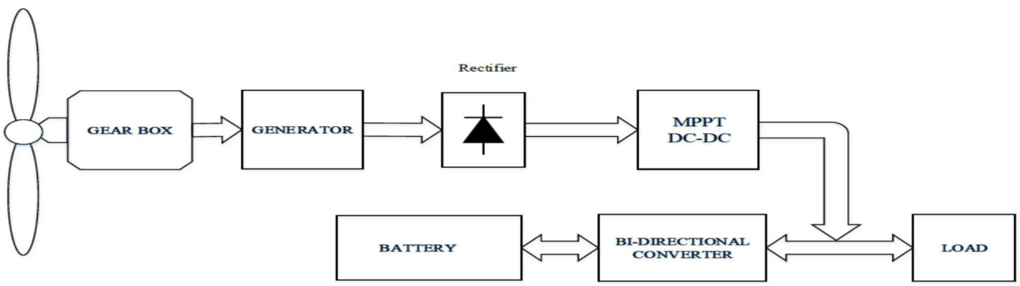


Fig.3. Overall Block diagram of wind energy system

In this system, wind energy is converted into rotating motion by a wind turbine. A generator then converts mechanical energy into electrical energy by converting ac voltage to direct current (dc), a rectifier then converts ac voltage to direct current, and a controllable dc-dc converter then traces the maximum power point.

B. Wind Turbine

Generally, a wind turbine consists of a set of rotor blades rotating around a hub, a gearbox-generator set placed inside the nacelle. The basic components of a wind turbine system are shown in fig, below.

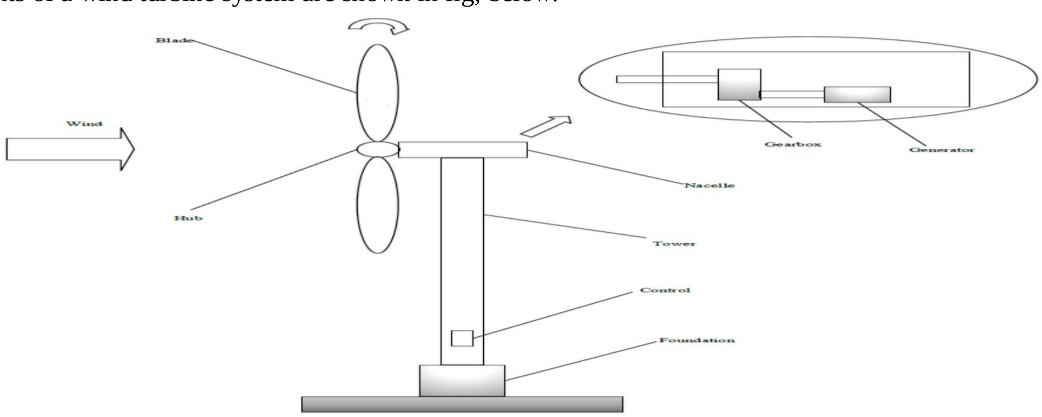


Fig.4.Major turbine components

Based on axes the wind turbines are categorized into two kinds: the vertical axis wind turbine and the horizontal axis wind turbine

©IJRASET: All Rights are Reserved

C. Horizontal Axis wind Turbines

The horizontal axis wind turbine is the most common form of wind turbine in use today. The blades on these machines are similar to those on areophane props. In general, wind turbines with horizontal axis (HAWTs) contain 2 to 3 blades, or a lot of blades. Multiblade wind turbines used for water pumping on farms are known as high-solidity devices. Instead of being filled with substantial material, the sweep area of wind turbines with 2 or 3 blades appears to be largely barren. The term "low-solidity device" is used to describe these devices. Modern horizontal axis wind turbines with low-solidity rotors often include 2 to 3 blades with wing-like designs. They are nearly universally accepted as a form of transportation. Some single-bladed horizontal axis wind turbines are also manufactures for experimentation purposes.

Fig.5. Blade HAWT from Riva Calzoni, central Italy, 1998.

The above picture, in Fig.5 shows a typical horizontal axis wind turbine with single blade. This wind turbine is situated in Italy.

D. Vertical Axis wind Turbines

Blades on Vertical Anis Wind Turbine (VAWT) wind turbines are oriented vertically. Savonius and Darrieus are the two most prevalent varieties of these turbines. It is not necessary to move the rotor when the wind direction changes with these turbines. As with a spinning rope, Darrieus wind turbine blades have a curved curvature. However, the blades are difficult to make, ship, and install since they are formed in a unique way.H-type vertical axis and V-type vertical axis wind turbines.

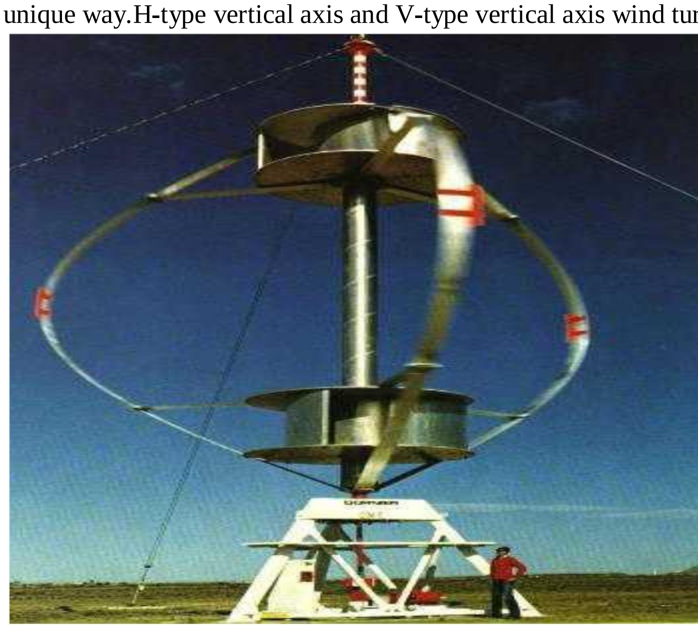


Fig.6.A 3-blade Darrieus VAWT in Germany

The above picture, in Fig. 6 shows a typical vertical axis wind turbine situated in Germany.

©IJRASET: All Rights are Reserved

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

III. PROPOSED HYBRID POWER SYSTEM

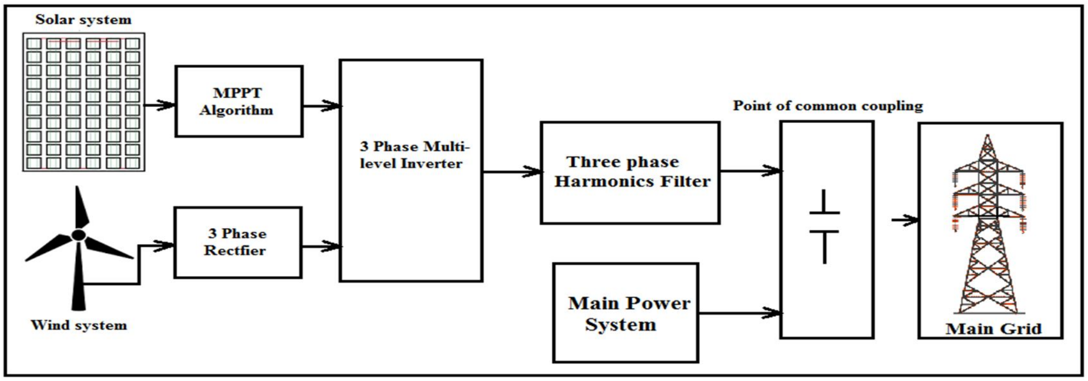


Fig.7. Block diagram of proposed Hybrid power system

In a combined wind-PV hybrid generation system, electric power is generated using both solar and wind resources. Unpredictable random behavior is characteristic of wind and sun renewable energy sources as individuals. Due to the sun's strength and the unpredictable shadows cast by clouds, birds, trees, etc., solar irradiation levels vary throughout the day. Due of this, solar energy is unreliable and is used less frequently. The wind is a kind of solar energy, as is the sun itself. As a result of the sun's uneven heating of the atmosphere, wind flow is created. The patterns of wind flow are altered by the earth's geography, bodies of water, and vegetation. Using a generator to rotate, the wind turbine transfers the kinetic energy in the wind into mechanical and electrical energy, respectively. As a result of its unpredictable nature, wind is capable of generating significant amounts of power. A lack of reliability and a low level of utilization are the result of this notion. A hybrid power system is therefore preferable to separate wind or PV generation systems. So, it is overcome the demerits of individual system. Grid interface of hybrid generation system improves the system reliability. There is a wind turbine in this system, and its output powers a permanent magnet synchronous generator. Wind turbines produce an alternating current (AC), which must be converted to direct current (DC) by using an ac to dc converter. For PV systems, a dc-dc boost converter raises the output voltage to a desired level. With a shared DC link voltage, the PV and wind power outputs are connected as well. With the help of the DC to AC converter, the output of the inverter is synchronized with the grid voltage. As the name implies, this inverter converts DC power from PV arrays and wind turbines into AC power, while maintaining grid voltage and frequency. Due to the intermittent nature of the energy source, a standalone PV or wind power system is unable to supply enough power to the associated demand. A hybrid system with energy storage is designed to meet all energy needs and provide consumers with stable output power. During the wind turbine power system's conversion from AC output to DC output, an AC-DC rectifier is connected to the AC output. The PV power system, on the other hand, is connected to a DC-DC converter, which increases the power produced. To supply loads, both outputs will be pooled at the DC bus. Any extra energy will be stored in the battery.

IV. MATLAB MODEL AND RESULTS

A. Hybrid Power System

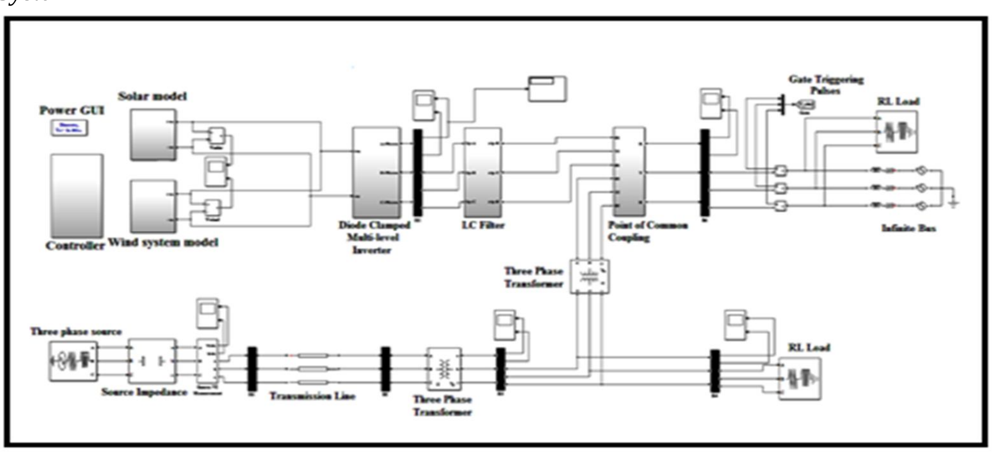


Fig..8.MATLAB simulation model of proposed hybrid power system

©IJRASET: All Rights are Reserved

B. Controller Subsystems

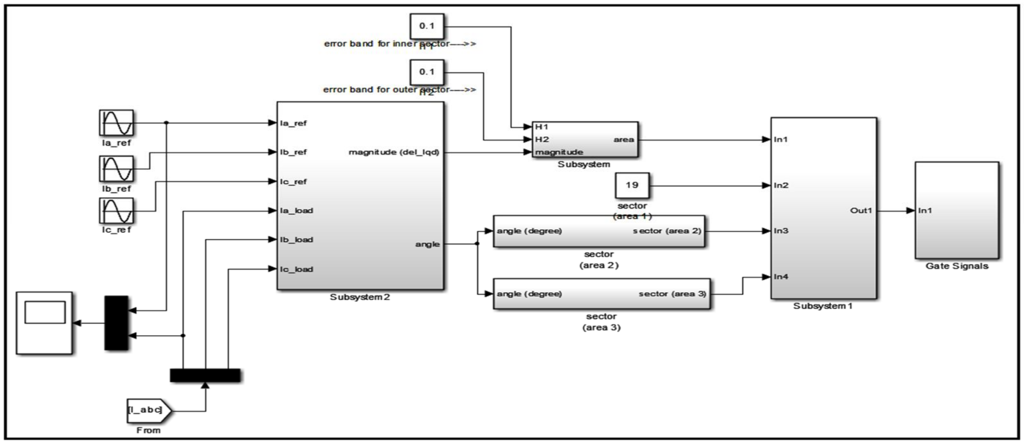


Fig.9. Controller subsystem in MATLAB simulation

C. Real and Imaginary Current Signals

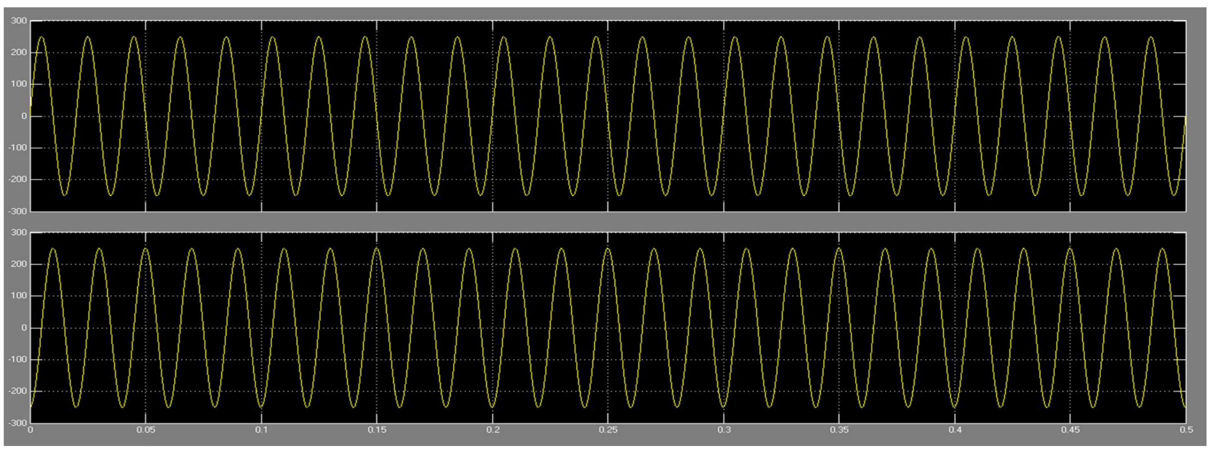


Fig.10. Real and imaginary current signals in controller

D. Controller Subsystem for Area Magnitude Calibration Model

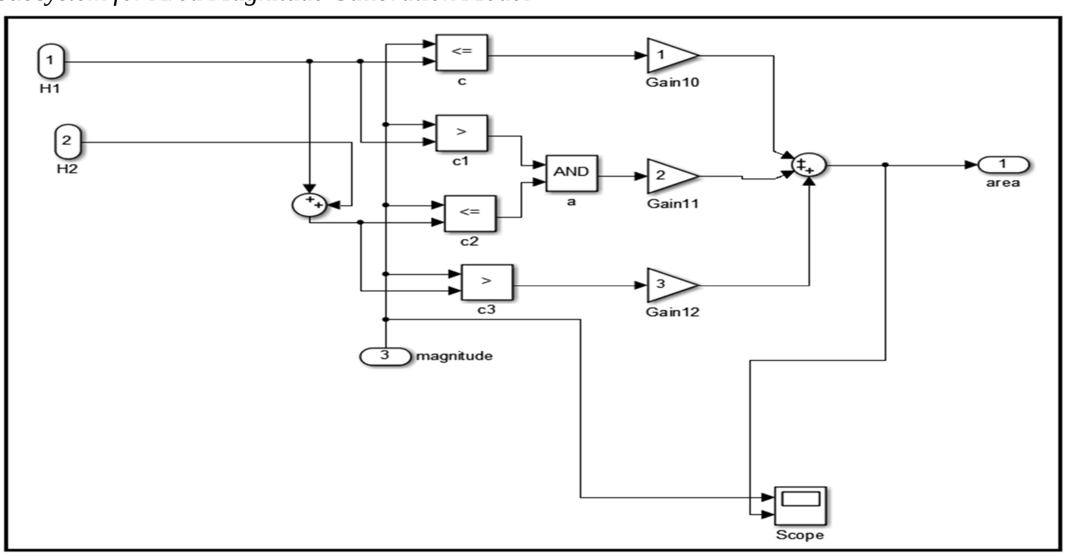


Fig.11. Controller subsystem for area magnitude calibration model in MATLAB simulink

E. Result from Scope of Magnitude Calibration Model

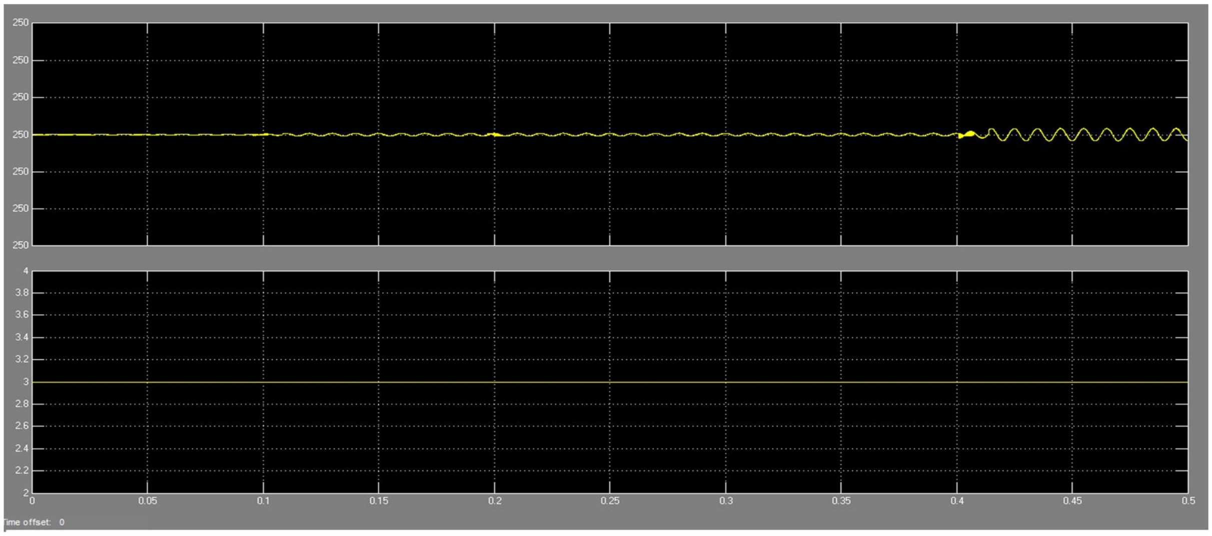


Fig.12. MATLAB Simulink result for magnitude calibration result

F. Wind Turbine System

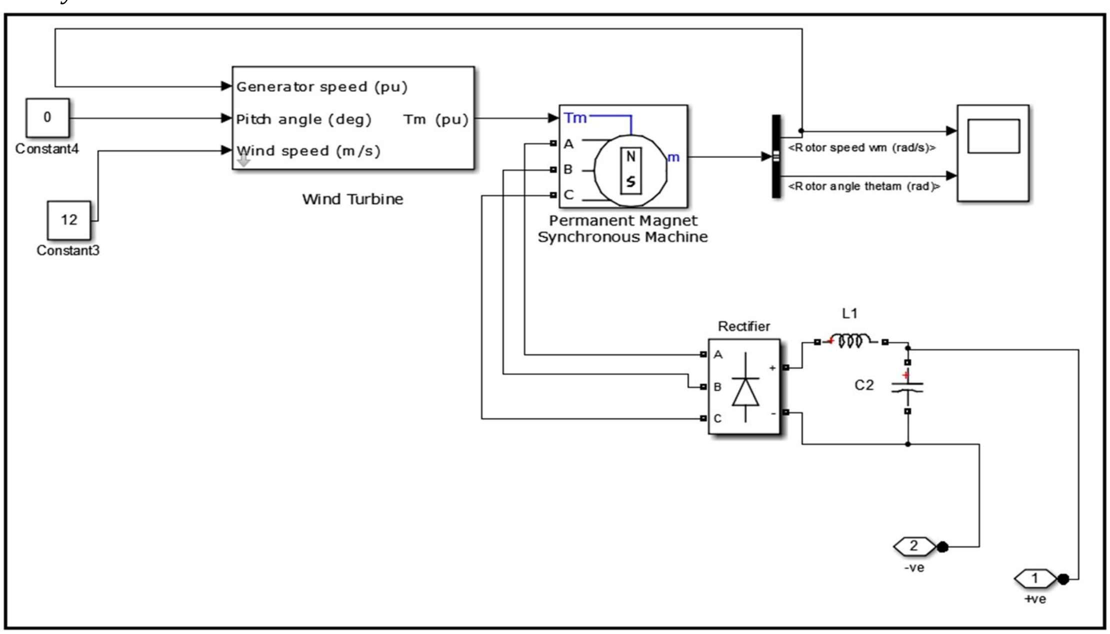


Fig.13.Wind turbine system design in MATLAB simulation

Wind turbine parameter specification are:
Voltage = 400V;
Generator speed = 2 rad/sec;
Base wind speed = 12 m/s;
Stator resistance Rs = 2.875 Ohm;
Ld = 8.5 mH;
Lq = 8.5 mH;
Mechanical output = 1.5 M/w;
MVA Rating = 1.5/0.9 MVA.
M. Wind turbine system MATLAB simulation result

©IJRASET: All Rights are Reserved

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue VIII Aug 2021- Available at www.ijraset.com

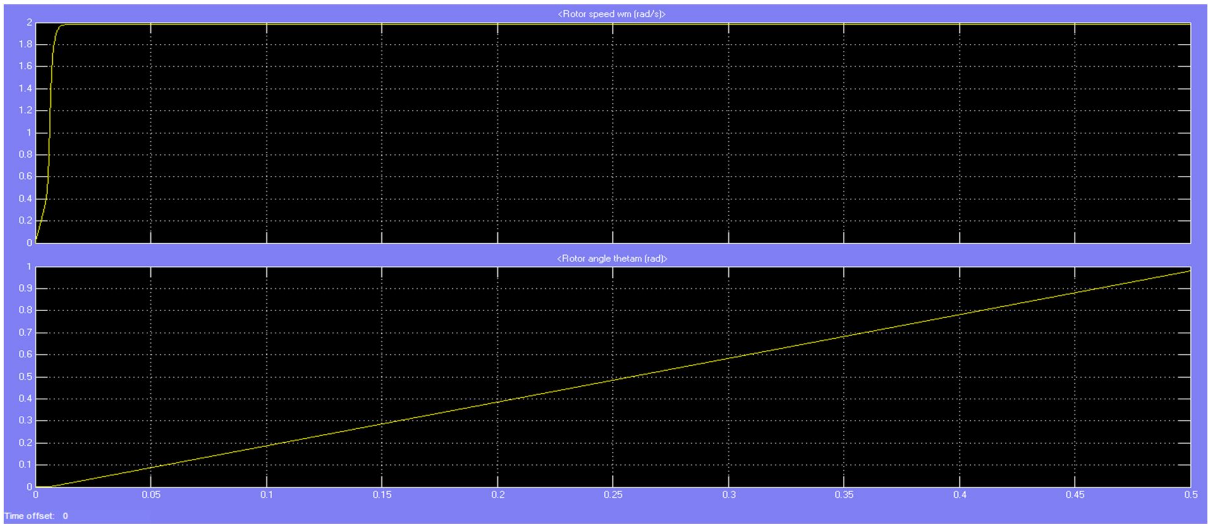


Fig.14. Wind turbine system MATLAB simulation result for rotor angle and rotor speed

V. CONCLUSION

This project demonstrates a photovoltaic (PV) and wind hybrid power system equipped with a Diode Clamped Multi-Level Inverter and LC filter. These renewable sources of energy are ideal for hybrid systems due to their environmental friendliness and vast availability throughout India. Due to fluctuations in the output voltage, devices that require a consistent supply will be damaged by hybrid power systems that are solely powered by intermittent renewable energy sources. MATLAB Simulink is used to model the hybrid system with a multi-level inverter and LC filter. Before merging a DC voltage hybrid system with the main grid of the power system, blocks such as the wind model, solar model, Diode Clamped Multi-Level Inverter, and LC filter are constructed independently. The project simulation uses different irradiance values and wind speeds as input inputs. Present are the wind and photovoltaic model characteristics, as well as simulation results for a hybrid system with and without a Diode Clamped Multi-Level Inverter and LC Filter. Comparing hybrid and stand-alone systems, the results demonstrate that hybrid systems are more reliable when it comes to output voltage. LC filter and multi-level inverter fitted in the hybrid system can also reduce output voltage fluctuations.

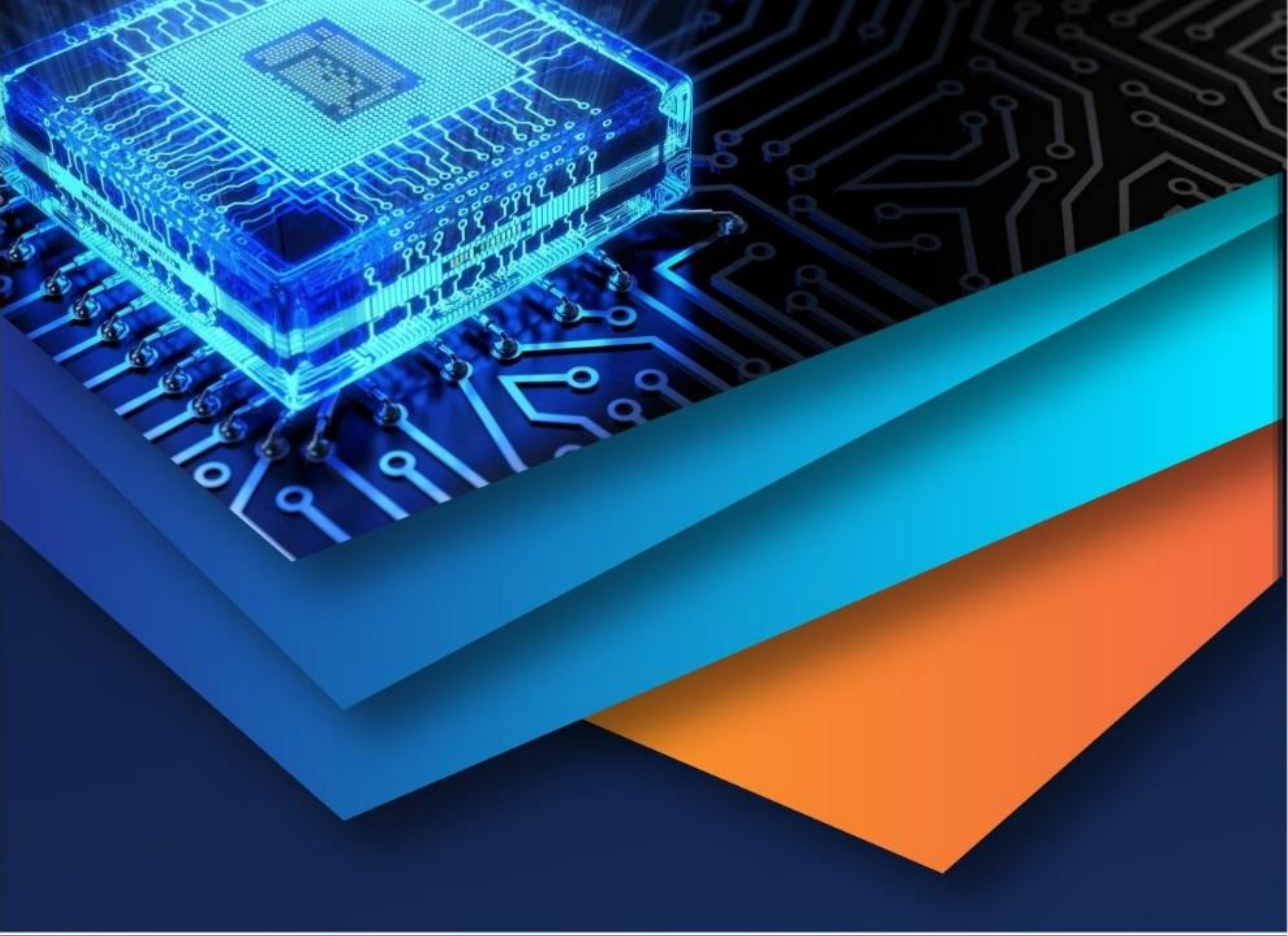
REFRENCES

[1] Mekkaoui, A., Laouer, M., &Mimoun, Y. (2017). Modeling and simulation for smart grid integration of solar/wind energy. Leonardo Journal of Sciences, 30, 31-46.
[2] Israr, Majhrul, and Ashok Kumar Pandey. "Modeling and control of utility grid connected solar photovoltaic array integrated system using MATLAB." Computation of Power, Energy Information and Commuincation (ICCPEIC), 2017 International Conference on. IEEE, 2017.
[3] Sechilariu, Manuela, Baochao Wang, and Fabrice Locment. "Building integrated photovoltaic system with energy storage and smart grid communication." IEEE Transactions on Industrial Electronics 60.4 (2013): 1607-1618.
[4] Bala BK, Siddique SA. Optimal design of a PV–diesel hybrid system for electrification of an isolated island – Sandwip in Bangladesh using genetic algorithm. Energy for Sustainable Development 2009;13(3):137–42.
[5] Daud Abdel-Karim, Ismail M., Kukhun Walid and Mahmoud Marwan M., Simulation of a Hybrid Power System Consisting of Wind Turbine, PV, Storage Battery and Diesel Generator: Design, Optimization and Economical Evaluation, International Journal of Energy Engineering.
[6] Jose L. Bernal-Agustin, Rodolfo Dufo-Lopez, Simulation and optimization of standalone hybrid renewable energy systems, Renewable and Sustainable Energy Reviews 2009; 13(8):2111-2118.
[7] B. Wichert, PV-diesel hybrid energy systems for remote area power generation – A review of current practice and future developments, Renewable and Sustainable Energy Reviews 1997;1(3):209-228.
[8] Pragya Nema, R. K. Nema and Saroj Rangnekar, A current and future state of art development of hybrid energy system using wind and PV-solar: A review, Renewable and Sustainable Energy Reviews 2009;13(8):2096-2103.
[9] Hakimi SM, Tafreshi SMM. Optimal sizing of a stand-alone hybrid power system via particle swarm optimization for Kahnouj area in south-east of Iran. Renewable Energy 2009;34(7):1855–62.
[10] T.T. Yetayew and T.R. Jyothsna. Improved single-diode modeling approach for photovoltaic modules using data sheet. In India Conference (INDICON), 2013 Annual IEEE, pages 1{6, Dec 2013.
[11] N.M. Abd Alrahim Shannan, N.Z. Yahaya, and B. Singh. Single-diode model and two-diode model of pv modules: A comparison. In Control System, Computing and Engineering (ICCSCE), 2013 IEEE International Conference on, pages 210{214, Nov 2013.
[12] M.G. Villalva, J.R. Gazoli, and E.R. Filho. Comprehensive approach to modeling and simulation of photovoltaic arrays. Power Electronics, IEEE Transactions on, 24(5):1198{1208, May 2009.

©IJRASET: All Rights are Reserved

[13] Tarak Salmi, Mounir Bouzguenda, Adel Gastli, and Ahmed Masmoudi. Mat- lab/simulink based modeling of photovoltaic cell. International Journal of Renewable Energy Research (IJRER), 2(2):213{218, 2012.
[14] N Pandiarajan and Ranganath Muthu. Mathematical modeling of photovoltaic module with simulink. In IEEE Ist International Conference on Electrical energy Systems, pages 257{263, 2011.
[15] Dehghan, S., Kiani, B., Kazemi, A. and Parizad, A. (2009), "Optimal sizing of a hybrid wind/PV plant considering reliability indices", Proceedings of World Academy of Science, Engineering and Technology, vol. 56, pp. 527-535.
[16] El-Shatter, T. F., Eskander, M. N. and El-Hagry, M. T. (2006), "Energy flow and management of a hybrid wind/PV/fuel cell generation system", Energy Conversion and Management, vol. 47, no. 9-10, pp. 1264-1280.
[17] Dehghan, S., Kiani, B., Kazemi, A. and Parizad, A. (2009), "Optimal sizing of a hybrid wind/PV plant considering reliability indices", Proceedings of World Academy of Science, Engineering and Technology, vol. 56, pp. 527-535.

©IJRASET: All Rights are Reserved



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL
IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Call : 08813907089 (24*7 Support on Whatsapp)