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"Improvement in Power Quality of Grid Connected PV & Wind Power Generation System"

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Abstract: ***Power structure is really extraordinary and future one system. In this structure, there is wind system with neighboring planetary gathering and diesel generator system, which is limit in one spot that is reserves (Batteries) and yield, gives age sources, little turbines system used in hybrid, infers relationship with battery, diesel-generator and photovoltaic system. The breeze is a wellspring of free-energy, which has been used since bygone era. It is used of wind stream through wind turbine to provide the mechanical ability to change into electrical power this structure for used by a wide margin off and off-network system in like manner, that marvel called hybrid power system. Now and again, this blend power system in any case called Green Energy. Mix of something like two economical power sources is more convincing than single. This is called as blend system. 'Hybrid' connotes unite harmless to the ecosystem power sources headways.***

This advancements yield gives electric deftly gets at home, on-network and so forth Numerous combination system sources, which worked off-grid structure, not related with an appropriated structure from this system, we set aside the energy power stream in batteries. A mix of somewhere around two supportable power sources is more effective than a singular is brought with respect to cost, capability and reliability. Energy is the main element for both present day and agribusiness progression of any country.

Keywords: Charging station, DC grid, Electric vehicle, MATLAB Simulink

I. INTRODUCTION

A few sustainable sources have experienced a decent improvement in the most recent many years. Along these lines, their mix would clearly give a decent uninterruptible force framework. Distinctive sustainable generators would supplement one another. Notwithstanding, a ton of prerequisites must be viewed as first. It is critical to see all the elements that impact its conduct, all together to bamboozle it. The most significant variables are area, time and client needs (power). Area partners data about atmosphere, fuel sources accessibility and climate conditions. This data is critical to choose what sort of sustainable generators can be picked [1]. Again, the quickly expanding expenses of electrical cable expansions and petroleum derivative, joined with the craving to decrease carbon dioxide discharges pushed the advancement of half and half force framework appropriate for far off areas. Crossover power frameworks are intended for the age and utilization of electrical force. They are autonomous of a huge, brought together power network and join more than one sort of intensity source. They may go in size from generally huge island lattices to singular family unit power supplies. As a rule, a cross breed framework may contain substituting current (AC) diesel generators, an AC appropriation framework, a DC conveyance framework, loads, sustainable force sources, energy stockpiling, power converters, rotational converters, coupled diesel framework, dump loads, load the executive's choices or an administrative control framework

The non-conventional energy such as solar photovoltaic system and wind turbine are natural resources and provides sustainable green energy. Its advancement is quite exciting but the technical challenges on integrating wind and PV system is noticeable. In order to meet the energy, demand the wind and PV system is combined. The wind turbine converts wind energy into electrical energy by generating AC output voltage whereas the PV array converts light energy into electrical energy by generating DC output voltage. Solar and wind energy system are commonly used Renewable energy sources (RES) to supply power. The wind and PV system are integrated to meet the energy demand. The output power of wind and PV output power is controlled using power conditioners. It is stored in batteries. The excess power is utilized by the grid. When the load demand goes high, the power is drawn from the battery and even from the grid to run the wind turbine. The Power electronic equipment's are interlinked with PV and wind energy system either to convert or control or transfer the power.

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In the entire stream of power system, the power quality is the key factor. Power quality should be maintained in generating, transmitting and distribution sector, to increase the efficiency, performance and life of the system Thus it is required majorly in renewable energy system such as wind and PV system too. Power quality refers to maintain the rated magnitude and frequency near the rated current and voltage of a power system In the present scenario, energy resources are being used at alarmingly high rate. High penetration of renewable energy resources in the existing micro grid is the dire need to fulfill increasing load demand while considering the alarming situation of global warming and higher emissions. The project introduces the hybrid power generation by the use of PV and wind energy system. The hybrid power generation is basically for improving the power quality. The power generated is stored in batteries which can be converted into A.C. by means of inverter and is fed to AC load. The surplus power is fed to the grid. For improving power quality, multilevel inverter is used as controller

The customary fuel sources are restricted and have contamination to the climate. Consequently, more consideration has been paid to the usage of sustainable power sources, for example, wind energy, power device and sun-based energy and so on Wind energy is the quickest developing and most encouraging sustainable power source. During most recent twenty years, the high infiltration of wind turbines in the force framework has been firmly identified with the progression of the breeze turbine innovation and the method of how to control. Doubly-took care of acceptance machines are getting expanding consideration for wind energy transformation framework during such circumstance Wind turbine is arranged into two general sorts: 1. Horizontal pivot and 2. Vertical hub. The restrictions on the extraction of energy from the breeze incorporate the reasonable size of wind machines, their thickness, erosion misfortunes in the pivoting hardware and efficiencies of transformation from rotational energy to electrical energy. A windmill chips away at the rule of changing dynamic energy of the breeze over to rotational mechanical energy. In further developed model the rotational energy is changed over into power [7]. Wind turbines convert the motor energy present in the breeze into mechanical energy by methods for delivering force. Since the energy contained by the breeze is as active energy, its extent relies upon the air thickness and the breeze speed.

II. HYBRID ENERGY SYSTEM

Hybrid power generation systems are the best possible solution to meet the increasing demands of the future. Hybrid energy systems means combination of two or more energy sources to generate electricity. Renewable energy sources depend on the weather conditions. When the sun's radiation is higher normally the temperature will be high which is enough for generating solar energy but during this time the wind energy will be feeble. Similarly, during the times of wind the atmospheric condition will be cloudy with chances of rain and the visibility will be dark with very less sunlight. Therefore, depending on a single source of energy is not worth for a continuous power generation. The energy from sun is available during the day time while wind is available during day and night. However, the intensity of wind is higher during the night time in effect one or the other power supply will be available throughout. As per seasonal variations the energy from sun is more useful during summer seasons and energy from wind is beneficial during the times of winter since the weather will be windier. Therefore, the integration of renewable energy sources provides better performance and reliable output than standalone systems during any cycle of the power generation system.

The hybrid energy systems aim to combine solar and wind energy connected to grid with controlling techniques for maximum power generation. The benefit of power generation unit coupled to grid is that, at times of any shutdown occur in the production from the solar or wind energy the grid can act like a source or a backup system. The excess energy generation from the renewable resources is stored in the grid and is supplied to meet the load demand. The hybrid power generation is a best solution in coming future because the seasonal variations for the sun and wind can be solved on combining the energy and output performance is improved.

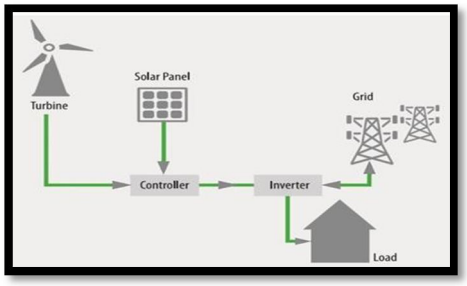


Fig. 1: Hybrid Energy System.

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The above figure represents the diagram for a hybrid power generation using solar and the wind energy. The two energy resources are combined through controlling techniques before powering the grid or the load. The solar energy from the sun with the help of MPPT technique is fed to converter to produce a regulated DC output and this output is fed to inverter to form AC output. The mechanical energy produced by the wind turbine is converted to electrical energy using generator and is fed to inverter. Both the output is combined and supplied to the AC grid. Due to seasonal variations of sun and wind, and for continuous power generation, a hybrid system plays a significant role by combining solar and wind energy.

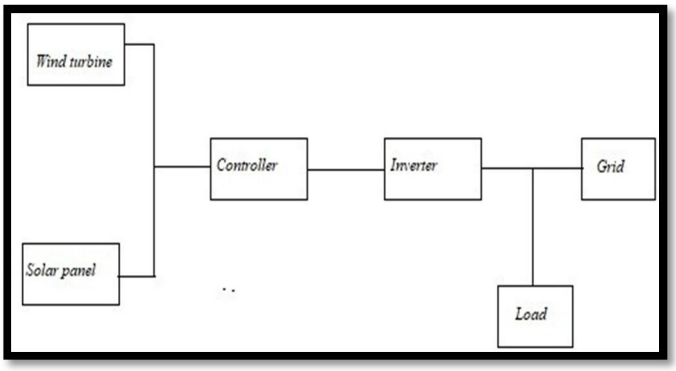


Fig. 2: Block Diagram of Hybrid Energy System.

The above figure is the block diagram for a hybrid energy generation system using the solar and wind power. The figure gives an overall idea of the hybrid system. The energy from sun is captured and transformed for generating power for that tracking technique is used to utilize the maximum available power from energy resource. The tracking Method used is Perturb and Observe (P & O). The utilized power is sent through a boost converter to step up the solar DC output power to supply to the inverter. Inverter converts the DC power to AC power. A three-phase inverter is used to transform the input to AC to supply to the grid to meet the energy needs. Likewise, the energy from wind is transformed to useful form with a wind turbine capturing the rotating wind speed and converting to mechanical energy. The energy from wind is transformed to electrical energy with generator. The generator used is permanent magnet synchronous generator. The generated power is sent to the grid to meet the needs.

III. METHODOLOGY

The research project was done using the Matlab/Simulink software. Using the Matlab/Simulink blocks in the Simulink library the hybrid PV-wind model was designed. Mathematical equations are used and analyzed for the design of the hybrid power generation system. Matlab stands for Matrix Laboratory and was developed by MathWorks and it is a high-level programming language which can interact with the environmental numerical calculations, visuals and the programming. It also helps to create models using the physical blocks in the inbuilt Matlab/Simulink library, does matrix calculations and the programs written in other computer languages can be interfaced in Matlab to analyze the data. Matlab programming is widely used in the field of science and engineering. It also has a wide library of mathematical functions for linear algebra, statics, Fourier analysis, integration and differentiation of numerical equations.

The methodology adopted for the design of a hybrid power generation system using solar and wind power is connected to a grid system for the transfer of power to meet the demands. The hybrid system is combined use of solar energy and wind energy from available resources with efficient and maximum utilization along with power-control. Based on the climatic conditions and availability of solar and wind power this system allows to supply power to load and the grid. The energy from solar is available and is tracked with MPPT technique such as Perturb and Observe method. According to the available voltage of the solar cells and the temperature the output solar energy is produced. The energy from solar is boosted with the help of DC-DC boost converters to supply to a DC-AC inverter circuit to supply to the load. For a wind energy system, the speed of rotor of the wind turbines are captured by permanent magnet synchronous machines and the output wind energy is coupled with the turbines to convert to electrical energy. The output is fed to inverters for conversion of DC to AC to supply to load.

The system works at normal standard temperature and radiation from sun and the normal wind speed availability. Combining these techniques such as converters, inverters, transformers, controlling techniques like PI, PWM for internal operations it can develop a hybrid system. This hybrid system is developed and modelled in Matlab/Simulink software with the help of Matlab block sets.

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IV. MODELLING AND ANALYSIS

The PV and Wind energy systems are modeled in Matlab/Simulink software using the Simulink blocks. To start with a Simulink model first the Matlab/Simulink software is started. Open a new Simulink file and the file is saved. Using the block sets from library, these blocks are added to the file, then blocks are connected, initiate the blocks by adding values and thereby model is created. Further updates in the model is done, initiated the model. Then the model is simulated. The simulation output is viewed.

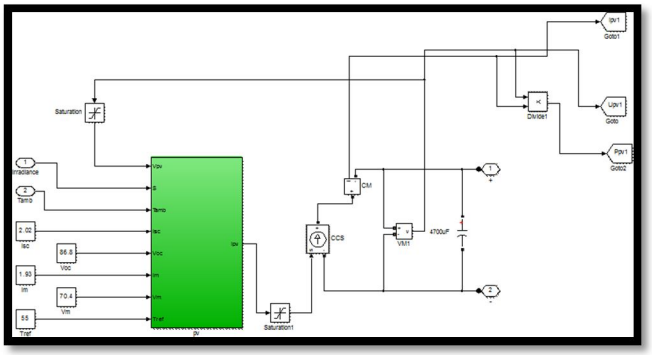


Fig. 3: PV Matlab / Simulink Model.

The above figure is the PV Matlab model. The model is created based on the basic equivalent circuit diagram for a solar cell. In this model an extra diode is added to the equivalent circuit to improve the accuracy of the I-V characteristics. The diode is attached in parallel with the first diode in the circuit. As discussed earlier the model is designed using the theoretical equivalent circuit equations. Comparing with the single diode model the accuracy with two diode models is better. Using a two-diode model makes the circuit more complex in work therefore a single diode model is preferred due to its simple performance. Therefore, the basic equation for a two-diode circuit is given by

$$I = I_{pv} - I_{D1} - I_{D2}$$

$$I_{D1} = I_{01} * \left\{ exp\left(\frac{V}{A_1 * V_T}\right) - 1 \right\}$$

$$I_{D2} = I_{02} * \left\{ exp\left(\frac{V}{A_2 * V_T}\right) - 1 \right\}$$

Hence,

$$I = I_{pv} - I_{01} * \left\{ exp\left(\frac{V}{A_1 * V_T}\right) - 1 \right\} - I_{02} * \left\{ exp\left(\frac{V}{A_2 * V_T}\right) - 1 \right\} - \frac{V + R_s * I}{Rsh}$$

In equation I01 is the reverse saturation current by diffusion and I02 is the reverse saturation current due to recombination. A1 is the diode reality factor of diode 1 and A2 is the diode reality factor diode 2.

The light incident on the PV as photon current which is influenced by the temperature and solar irradiance is given by

$$I_{pv} = \left(I_{pv,n} + K_1 * \Delta T\right) * \frac{G}{G_n}$$

$I_{pv,n}$ is the light incident on solar panel under standard test conditions (STC).

The diode reverse saturation current equation is given by

$$I_0 = I_{0,n} * \left\{\frac{T_n}{T}\right\}^3 exp\left[\frac{qE_g}{AK}\left(\frac{1}{T_n} - \frac{1}{T}\right)\right]$$

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The diode reverse saturation current equation is given by

$$I_{0,n} = \frac{I_{sc,n} + K_i * \Delta T}{exp\left\{\frac{V_{oc,n} + K_v * \Delta T}{A * V_{T,n}}\right\} - 1}$$

Ki and Kv represents the short circuit temperature coefficient and Isc,n is the short circuit current, Voc, n is the open circuit voltage, Gn is the irradiance, Tn all these parameters under standard test conditions. Based on the above equations the PV design is modelled in the Matlab software.

The input to the PV model is the solar irradiance and the temperature based on these two factors output current voltage and power is generated. The solar irradiance and temperature have much influence over the output and varies upon these input changes. The produced output current and voltage is supplied to the converter circuit. The output from the solar panels are in the form of DC power which is supplied to a converter to produce a regulated DC output.

The figure is the Hybrid PV-Wind energy system modelled in Matlab/Simulink. The combination of two renewable inputs solar energy and wind energy forms the hybrid model. The Hybrid PV-Wind energy system is a grid connected model. The grid is a source whereby acting as a backup system for the renewable energy in case of any power shutdown. The grid also acts as a storage system at times of excess energy generation by the renewable energy systems. In case, if there is shortage of power from solar or wind or these sources are not able to meet the load demands the grid will automatically cover the entire demand.

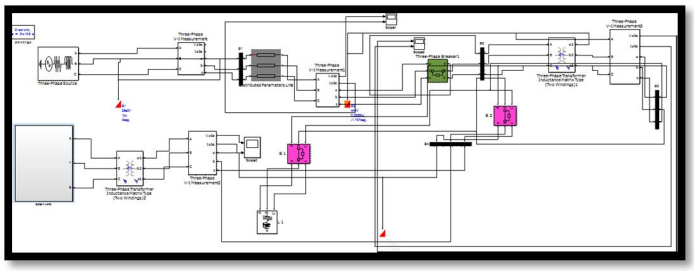


Fig. 4: Hybrid PV and Wind Energy System Matlab / Simulink Model.

V. RESULTS

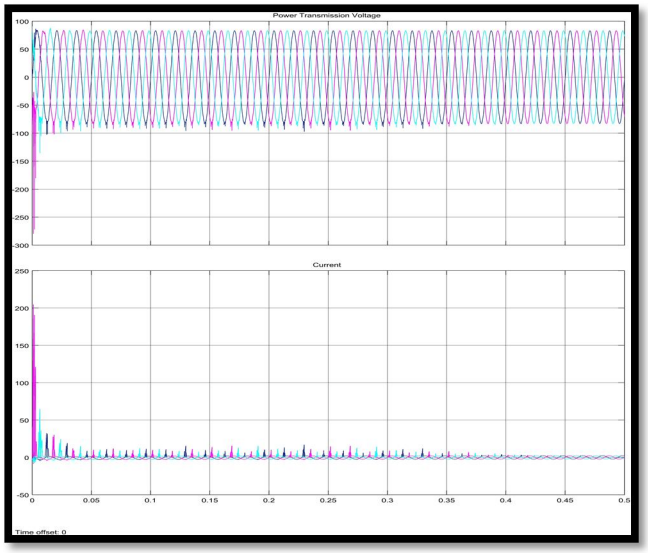


Fig. 5: Simulation Result of output of Hybrid Energy System.

The graph represents the sinusoidal voltage and current output from the hybrid energy system. From the hybrid system supply is fed to the load also and power remaining is supplied to the grid.

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On combining the hybrid system using the solar and the wind energy to power the grid. The generated power from wind is connected parallel and shared with PV system. There is a difference in generation from wind and solar because sources depend on varying climatic conditions therefore, there is likely to be inequality in the measurement of power even though the two systems are connected in parallel to the grid.

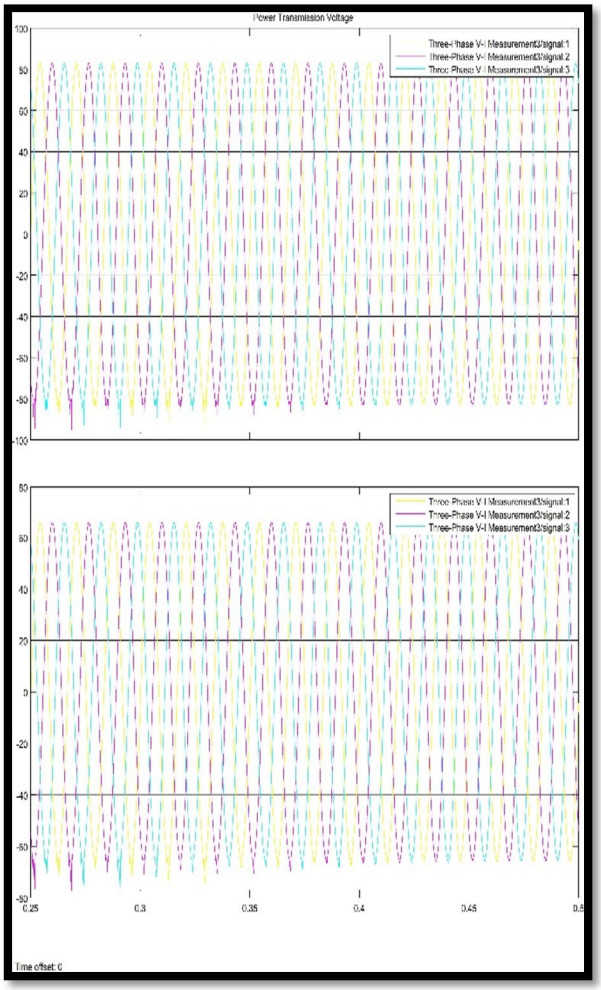


Fig. 6: Simulation Result of Voltage and Current of Load.

The graph represents the sinusoidal voltage and current output of load.

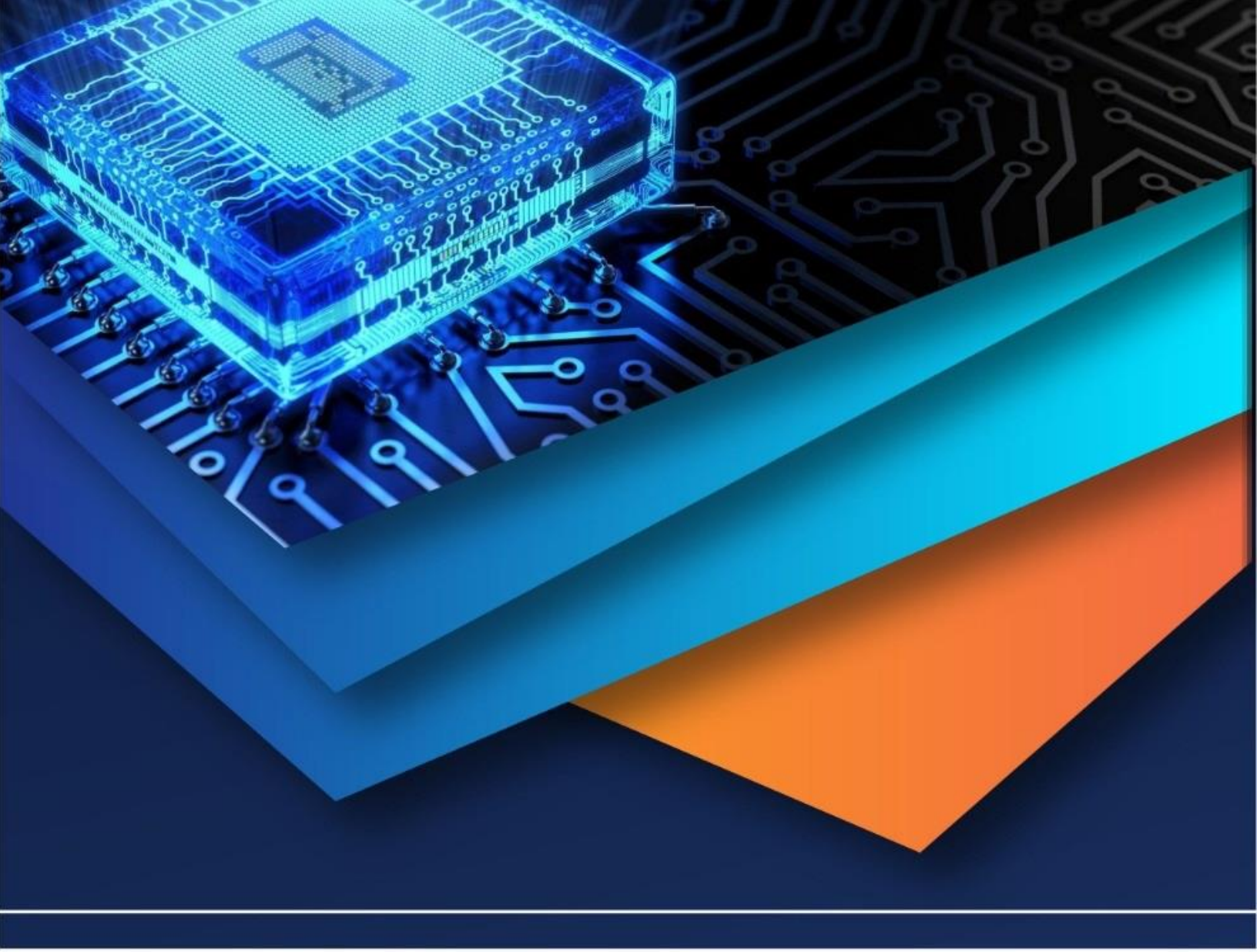
VI. CONCLUSIONS

The postulation plans to zero in on the investigation of a mixture PV-Wind power age framework for a network associated application utilizing the Matlab/Simulink programming. Age of force from single wellspring of environmentally friendly power can't satisfy the heap needs in this way, crossover PV-Wind model is proposed to remunerate the impacts of ecological variables and climatic varieties of the assets influencing the nonstop activity of force age. Wind energy framework with long-lasting magnet simultaneous generator produces sinusoidal AC power. the two energy sources are joined to drive the matrix to fulfill the needs.

The half and half model was displayed in Matlab/Simulink programming and result is checked. The outcomes show that sunlight based radiation and temperature impacts the result of the framework. As the sun based irradiance builds the worth of current increments at the same time the result power increments while expansion in temperature diminishes the worth of voltage which influences the decrement in power. the breeze speed and bearing of wind are fundamental variables influencing the result and results show that sinusoidal AC power is acquired with slight varieties because of the vacillations in wind speed. Joining these two inexhaustible hotspots for age of power to fulfill the needs gives a spotless energy yield.

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