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DESIGNING AN OPTIMAL MODEL TO MAXIMIZE THE PRODUCTION FROM SOLAR AND WIND POWER: A STUDY OF PAKISTAN

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Abstract

To control the energy shortfall and this interrupted power, we will use a hybrid solar, wind, and utility system to overcome this issue. Solar and wind energy is nowadays very commonly renewable source, and it does not pollute the atmosphere and can very quickly be optimized and integrated; therefore, the coordination of these renewable sources is very efficient and will also control line losses and will also take the issue of interrupted power usually if a continuous force is supplied. This paper examines the challenges and solutions of hybrid wind, solar and utility integration systems. The switch integrates solar, current, and utility, and this research has several cases in which the switching process occurs automatically to meet consumer demands and minimize the unit rate. It is cost-effective because the system tries to fulfill the needs of solar and wind, but if both fail, it will automatically be switched, and the utility will meet the demands. It has no power unbalance because the load is equally distributed in all the phases, which shows that there is no bother. In the future, we can implement it efficiently and work on it to further improve its efficiency and reliability. Also, we can improve the voltage stability of the system.

***Keywords*—** PV Panel, Wind Turbine, National Grid, Power Unbalance and Uninterrupted Power Supply.

Introduction

A high carbon dioxide concentration causes global warming [5]. At the end of this century, w will anticipate the global temperature to climb by 3–6 °C [4]. In 2010, e estimated that almost 1.3 billion people had no electricity access [6]. Many academics worldwide have redirected their attention to hybrid renewable energy systems (HRESs) to provide grid and off-grid regions with inexpensive, dependable, and CO2-free power. Numerous case studies have been conducted to optimize HRES up to this point. Asia is endowed with tremendous potential for renewable energy sources. Malaysia, for instance, has a high potential for renewable energy, but these resources have only been harnessed locally as individual power generation sources. M. Fadaeenejad suggested in 2013 that photovoltaics and wind batteries might be the most cost-effective combination for rural electricity in Malaysia's small communities [12]. Hongyang Zou looked at China's large-scale PV power generation from a technical and economic point of view in 2017 [13].

In the Middle East, the use of renewable resources for energy generation is on the rise. Arab nations such as Saudi Arabia rely significantly on conventional power facilities to supply their daily electrical needs. d did a techno-economic analysis of a solar system connected to the grid at several sites in Saudi Arabia to see if it could help reduce fuel use [14]. Despite the abundance of renewable resources such as wind and solar energy in Africa, one-third of the population lacks access to power. Researchers in Ghana are looking into HRES with PV, FC, and battery power, as well as a diesel generator as a base case, to provide electricity to remote mining industries since grid expansion is impossible [15].

Electrical energy is used in everyday life, from tiny homes to vast manufacturing and profit-making lands, and it is desirable everywhere. For a country's financial level and growth, the continuous operation of industries is essential. For the nonstop operation of these mills, a persistently attainable electric power quality is an exceptionally fundamental need. Pakistan's energy crises range between 5000 and 55000 MW, with a requirement to stay above 21,620 MW and a production limit of 16,550 MW in June 2016.

Pakistan is in a severe crash of electrical energy and is experiencing a sad beneficial, dynamic development. Around 41 % of firms also have mechanical divisions presently shut down, and just about 10 % of workers are jobless due to this significant issue. To restrict these issues, Pakistan started the available electrical power profit in case they are maintainable or non-endless in abundance. Nature has given us a couple of wellsprings of energy that c can use to assemble electrical power. It comprises hydro, wind, sunlight-based, atomic, and biomass energy. The accessible sources can be described as inexhaustible and non-sustainable power sources. Hydro, current, and sun-oriented can comprehensively be considered sustainable power source resources, while the remaining are non-sustainable power source resources [7].

Nuclear-powered energy is not reachable and accessible because, for many reasons, it is not available in the world market. The availability of renewable energy is reachable for use of humanity around the globe. This vitality is general to vide extent, but at the same time is the most significant measure of number in nature. Sustainable power source zone is giving 13.4% of the world vitality request. Sustainable power source zone is increasing their popularity daily in all remaining energies because of their easy availability, cleanness, reachability, and accessibility of

energy in the world. Different situations suggest a fastly growing share of renewable energy technology (created from wind, solar, biomass, and the primary source is hydro). Under these circumstances, renewable energy could attain 50% of the total energy target by the 21st century with proper strategies and new available technological new developments.[8]

Electricity – Total limit introduced 22,000 MW Power – Sources (2014) Relic fuel 14,635 MW 64.2 % of aggregate oil 35.2% and gas 29%.water [hydro] 6,611 MW 29% Nuclear 1,322 MW and 5.8% of its entirety average request 17,000 MW Loss is among five thousand MW and six thousand MW [9]

The primary renewable energy resources are hydro, wind, and solar. In Pakistan, Hydropower plants generate almost 6811 MW of electrical energy with an excellent efficacy of approximately 90%. Wind plays a vital role in the production of electrical power. It cooperates with an inexpensive amiable, environment source production of electrical power along with the faculty to visualize and maximize from 250 to 1,530 MW with the capability of 60% in 2020. The energy produced or generated by the sun is the primary and essential source of all energy resources in the world. [10-11]

The transforming or converting of sun rays immediately into electrical energy through solar cells is called Photovoltaic. Solar cells are infrequent, whereas they can instantly change the incident rays of solar energy into electrical power along with null noise and pollution and form them very safe and sound, solid and lifelong. Upgrading of photovoltaics gained its substantial primary enhancement from space trades in the 1960s. It is essential to have a distinct electrical power supply aside from grid power for the utilization and application of satellites. Through that phase, the solar cells of that era were very costly compared to the solar cells of this modern era, even though they could not produce electrical energy that co could produce through these new PV cells. Their boundless perseverance and favorable circumstance to the remote power source assortment was immediately perceived and accepted to increment in the change of earth photovoltaic creations. [8].

The inferior Figure 1 exhibits that whenever the sun rays drop on the solar panel's surface, it makes an electron-hole pair. The electron-hole couple drifts in an antipode direction for the reconsolidation and produces electricity.

Solar Energy- Photovoltaics (solar cells)

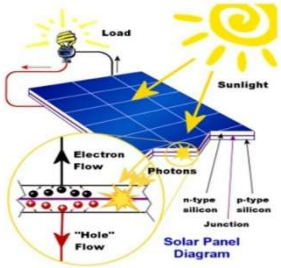


Figure 1 Solar Energy Photovoltaic

In the 1980s, tremendous increase and investigation in silicon solar cells asphalt was a fresh trail for growing their competencies. For delivering electrical power and a much more reliable life routine to those individuals who are the nonappearance on-matrix get, they additionally have an excellent hotspot for remarkably diminishing natural damage that came about by conventional power generation in created nations. The demand for PV cells is growing daily, and many houses are now powered by PV cells. PV cells are used everywhere, from minor objects to major ones, such as small watches or calculators to many electrical power-generating sources of several megawatts [9].

In massive quantities, the generating power grade and its accuracy or stability may be influenced by the generating sources, such as wind power and solar PV cells. The irregularity on the grid voltage been modeled earlier by the influence of photovoltaic Now, the impact of photovoltaic at a huge discrimination degree in a conventional electrical generating system has been inspected by utilizing by each time, i.e., hourly average separation as a substitute of photovoltaic power outcome and the actual load info with the specific and every hourly time declaration [10]. Based on every month or a monthly basis, photovoltaic-generating power plants are bringing out the average natural power outcome on a vast scale [11].

Now exhibit interpretation of the accurate power outcome info with 10 seconds and one-minute resolution from an individual 4-megawatt site and with ten minutes resolution from 3 to 100 kW sites. The big-scale photovoltaic can arrange the insight into the quality of cyclic and cyclic oscillations linked with the range of outcomes by the power spectral density (PSD). The Power spectral analysis may indicate the kind of firm power or need feedback suitable to praise photovoltaic, containing the compulsory ramp rank [16].

The correspondence of any outcome from different or various distributed locations gives us data, and knowledge relative to geographic smoothing, earlier inspected for distributed wind-generated power [17]. Geographic smoothing may estimate the distributed locations or sites in the time domain by the statistical correlation and the technique consumed earlier to appraise the influence of the site diversity on wind generating power [18].

The profit and costs of alternative generating sources of energy may be argued by different Academician, practitioners, and policymakers. Based on environmental surroundings, Wind power is deliberately endurable and sustainable; at which sustainable is defined as the generation that wants production without any damage or detriment; the age of wind power is immaculate and cheap as well as it is renewable, and it gives the final ultimate in power liberation. Wind energy is endurable and sustainable; because of this, Wind energy has occurred as a prominent outlook. On the other hand, others have noticed that ecological and financial regard must further conciliate. On the other point of view at which, choices that combine society's concern for the environment and shareholder craving for an investor's value increase are most likely maintainable [17].

In Pakistan, a considerable section of locals has no approach to commercial electrical energy because Pakistan is a poor profitable country approximately half of the country's residents have no

path to electrical power. Per capita, electrical energy depletion is only 1/10th of the world average; many have no access to electrical energy because approximately 68 percent of the people live in rural areas. [16-17]. In 2005 conventional power production contained 51 percent and 61 percent of natural gas and oil production—the commitment of various vitality sources in the aggregate traditional power age in the nation. The native capital of oil and gas is insufficient with the current worth of generation. The corrigible capital or gas and oil fund will be depleted separately in 13 and 21 years afterward. However, there is a vast capacity of coal, i.e., approximately (185 billion tons) in the country, though it does not been used to its significant power because of several causes. In Pakistan, the expectation of nuclear energy is attractive and luminous, but it has high cost or money, technology impediments, and worldwide restraints are huge complications in this track [17-18]. The country's provision and demands for electrical energy from conventional energy resources are crudely insufficient. Approximately Pakistan clash about 32 percent of its yearly fundamental commercial energy desires from abroad oil with expenses of around US$5 billion. The oil import bill weakens the balance of payment criteria, and it severely strains countryside restraint. Pakistan is improving progressively, relying on rare sources of the stockpile. The electrical energy assurance generally sets on the flimsy hazard of abroad oil, which is focused on source agitation and cost instability. With its accompanying dangers to the electrical energy assurance, it must minimize the confidence in oil to attain a steady energy demand. There is a significant influence on the environment due to the mining, processing, transportation, and transformation of electrical energy generated from fossil fuels. In Pakistan, there is a harmful effect on the surrounding environment because of the careless liberation of harmful content of fossil fuels. The nation expends vast quantities on the debasement of the surroundings that would have a harmful bluff in each area of the nationwide economy. We can conclude that Pakistan must make another congenital friendly environment or surroundings energy assets to gain the future energy demands. We need such energy which has no harmful effect on the environment if we look at this. Hence, wind energy is one of the most important, cheap, and clean sources through which we can attain the growing or increasing energy demands of the nation [19-20].

Internationally renewable dynamism resources are reachable to manhood. Renewable energy resources are not just nearby in a wide variety; they may overflow in nature. In worldwide electrical energy needs, it is approximately 13.5 percent in nature. The utilization of generation of electrical energy from renewable energy sources is increasing rapidly day by day in the market, in comparison to all energy production. Certain long-lasting conditions guess a quickly growing portion of renewable resources (ready up of solar power, geothermal power, wind power, fresh biomass, and the more old-fashioned generated source, i.e., hydro). Because of this rapid utilization of developed renewable energy would meet up to 50 percent of the total generated energy demands by 21 century with basic policies and more technological outgrowth [20-21-22].

Research Methodology

It describes the model and technique for planning a power framework display known as the switch at which sunlight-based and wind control coordinate over the transmission framework through the regular hydroelectric framework. This product is utilized in Matlab, and distinctive segments used

as a part of the tests have been clarified. The procedure tolerably activity entangled in the entire investigation of this venture, here took sun-powered vitality, wind vitality, and the other national grid which is renewable or non-renewable of imperativeness. Sun arranged, wind essentialness is composed of the switch and may also record clients' demand. The DC voltage comes from the solar panel board, and s; as sensors measure voltage and current wind turbine generates alternating current voltage, which passes from a device called a rectifier and converts the alternating current voltage to direct current voltage; these two DC sources are united to provide one source supply than both of the supplies are given to the inverter, so the pulse generator related to the inverter and the ability to fixed the replication of turning yield. This 3-phase yield from the inverter is given to the LC channel to clear the tumult. In this paper, Hydropower is the primary source that is a national grid, and then it is synchronized to endless source, which is solar and wind. Lastly, supply is given to the customers through transmission lines.

The primary condition in a focal controller for exchanging is the event that it fulfills the situation, so just a sustainable source will give the vitality, yet if it does not meets the demands and the whole source should provide power, and the exchanging is finished by the switch.

PV Panel

The photovoltaic cell is made to convert sunlight. It is a source of energy for producing electrical power and gives us heat. It is a 6x10m2 solar cell combined or connected to make a photovoltaic. Photovoltaic can be utilized commercially and can also be used as a residentiary. The PV panel consists of an array of solar cells that combine to make the PV panel. Every solar panel component is rated under a specific strategy, and a DC output power rate usually compasses from 100-365 watts. The efficacy of every element resolves the area of a component granted the identical estimated outcome and 8 % competent 230w element having double the size of a 16 % capable 230-watt component.

Some solar panels have an efficiency of 22 %, and some exceeding 24 % are available in the market commercially. The photovoltaics are prepared to furnish the electrical power. The photovoltaic is composed of the proper strategy of many components containing different solar panels which absorb the sun's rays and convert them directly into electricity. Direct current is converted to alternating current through a solar inverter, increasing wiring, and additional

electrical equipment to establish a properly working system.

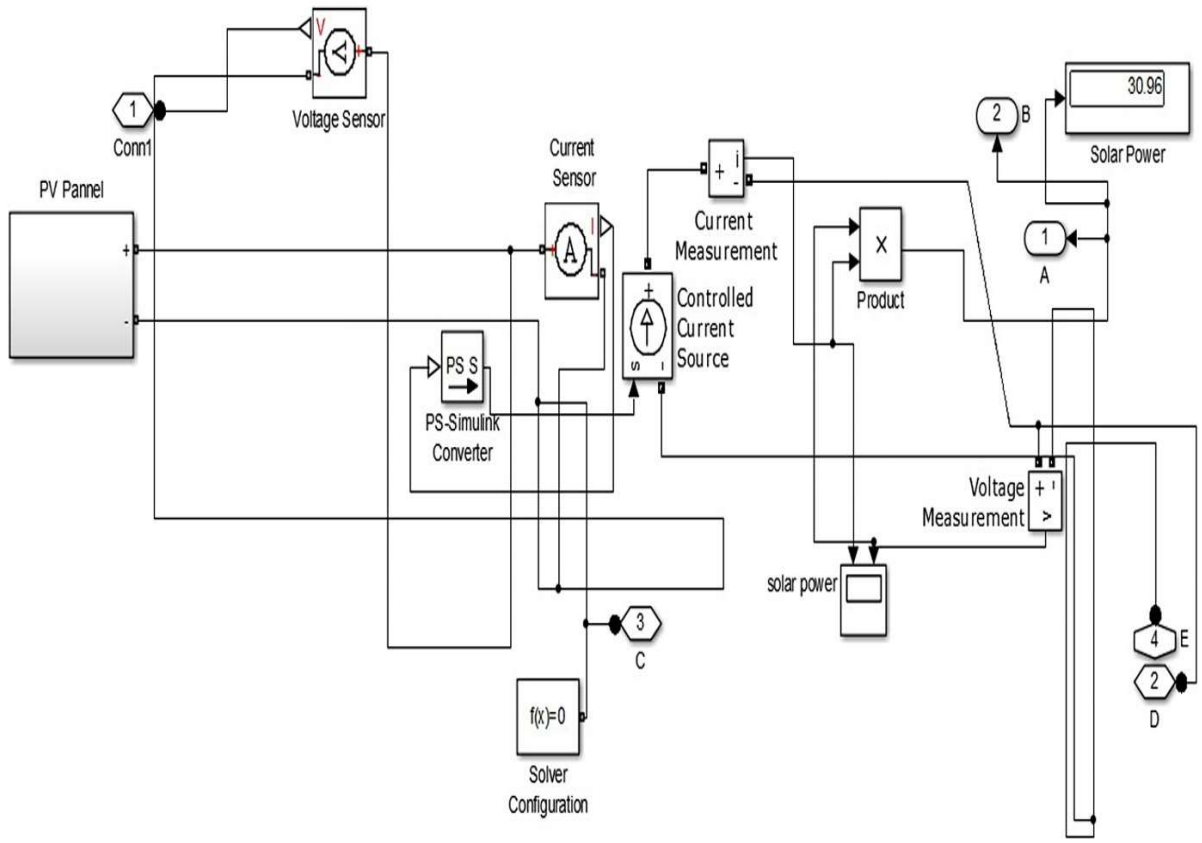


Figure 2 Block Model of solar Panel

It can enhance the overall performance through a solar tracking system, and it also contains a combined battery solution. The rate of reservoir types of equipment is predictable to slump. Severely talking a solar panel entirely involves the aggregate of solar panels, the detectible portion of the photovoltaic system that does not contain the whole hardware regularly brief as a balance system. A Photovoltaic is a device that directly transforms or changes the sunlight into electricity. It does not become disordered from other technical knowledge, such as concentrated solar power or thermal energy consumed for cooling and heating purposes. Photovoltaic is used from a few kilowatts to colossal power stations of hundreds and thousands of megawatts by using a small rooftop-mounted or building-integrated system. Currently, mainly photovoltaic systems may be grid linked through standalone systems used for the small need of demand.

Software

A calculation is done using MATLAB Simulink. It is a square guide stage to multitask reproduction and a Model-based plan. It helps reenactment and customize and can bolster the age code and customary trial and legitimization of settled programs. While Matlab is used to calculate initially for an arithmetical calculating and elective toolbox, utilized in the mu PAD symbolic

engine that permits the admittance to representational calculating skills and extra packages, the Model-based design for dynamic and embedded system adds the graphical multi-domain simulation.

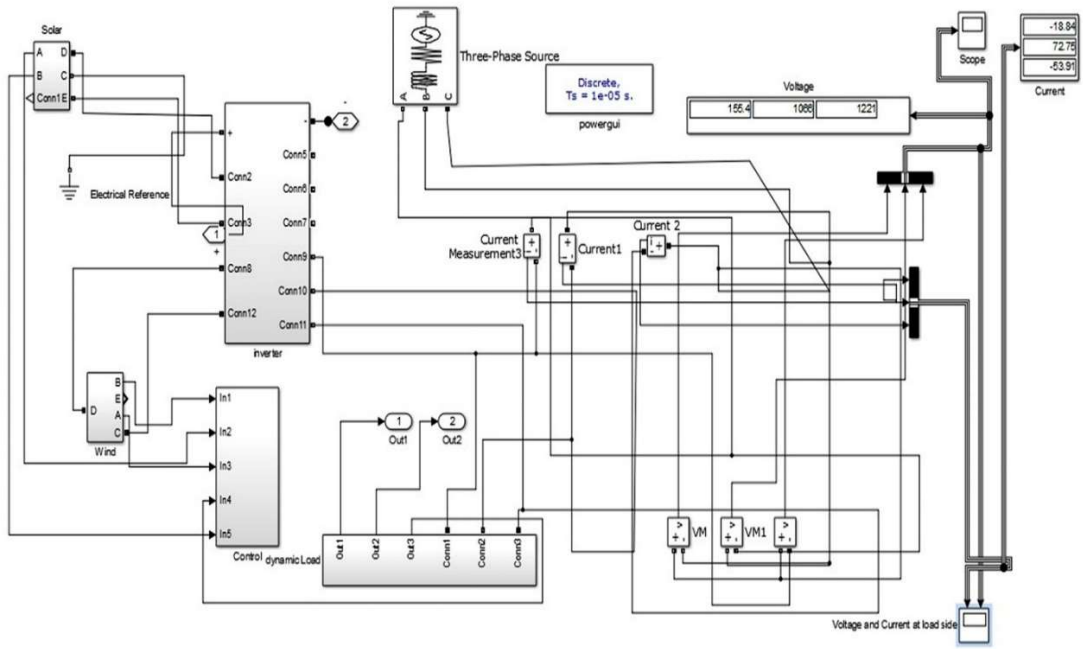


Figure 3 Simulink model of integration of wind & solar power

Wind Turbine

Wind turbine attribute here depend on the Steady State Power (SSP). The hardness of the drive train is unlimited and the friction factor and its inertia of the wind turbine have to consolidate with the coupled generator to wind turbine. The outcomes from the wind turbine can be find by the following equations which are shown below.

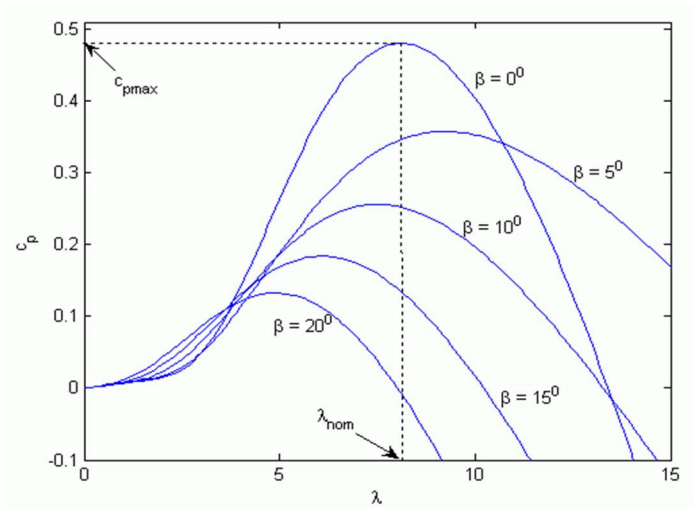
$$P_m = c_p(\lambda,\beta)\frac{\rho A}{2}v_{\text{wind}}^3,$$

Where

Pm	The output comes from the Wind Turbine on Mechanical side i.e. W
Cp	Operation coefficient of Wind Turbine.
P	It shows the density of air and i.e. (kg/m power 3)
A	It shows the swept area of Wind Turbine i.e (m power 2)
v_{wind}	It shows the speed of the Wind i.e (m/s)

Λ	It shows the ratio between the rotor blade and speed of wind.
B	It shows the angle of blade pitch i.e (deg)

There are three inputs of the wind turbine i.e. one is the speed of the generator (ωr-pu) in pu to the generator of nominal speed, pitch angle of the turbine measured in degrees and the last one input is the wind speed measured in m/s. The speed ratio of the tip will be get by the division of rational speed of the rotational base speed and the speed of wind. The outcome will be get by applying the torque to the shaft of generator,



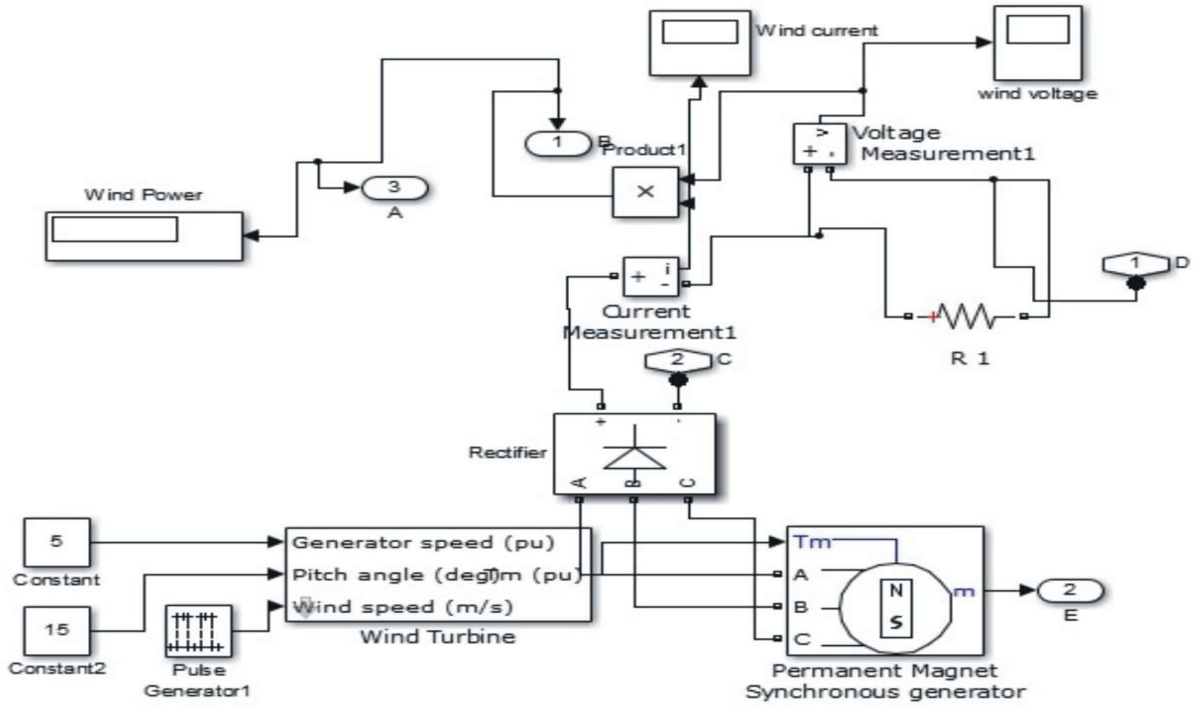


Figure 4 Simulink model of Wind Turbine

Will take the outcome in watts, i.e., W. it shows the mechanical output power. The wind turbine is coupled with the power of the electrical generator. It is utilized to calculate the output torque in pu of the generator nominal torque.

The base wind speed is taken in m/s, utilized in each system. The wind speed here is the mean value of the forth seen speed of the wind. The wind speed generates mechanical power that is commonly diminished than the nominal power.

This is essentially the pick-up control, i.e., KP, which is characterized as of now. It demonstrates the most extreme energy of the breeze speed in pu of ostensible power of mechanical.

Results and Discussion

This section finishes up the outcomes acquired in the MATLAB tests. The result of the research paper indicates a design to SWITCH and to show that it is a free acronym for "Sun controlled and Wind power is optimized with Transmission and utility sources." It gives a sensible augmentation among the minor cost of CO2 discharges and the structure of the electrical system. Sketching out of the switch demonstrates having the ability to provide improved yield and expecting almost no exertion.

Diagrams for various climate inconsistencies. It describes 4 cases, sun-powered and twisted most significant and most minor point.
Case Study 1:wind and solar are producing maximum
CaseStudy2: wind max and sun generating min.
Case Study3: Wind minimum and solar maximum
Case Study4: Both are Producing minimum

If the wind speed is the most extreme, sun-based force produces the least possible qualities in the area. The power chart for this situation is demonstrated as follows. I will take an accompanying chart for the most extreme and negligible winds.

- Least speed of wind=7 m/s
- The worldwide normal for wind speed is ten m/s
- Greatest speed of wind =15 m/s

The accompanying diagram is to be taken accompanying sunlight-based emission gathered. Intensity is written as under.
Max= 500
Min = 50

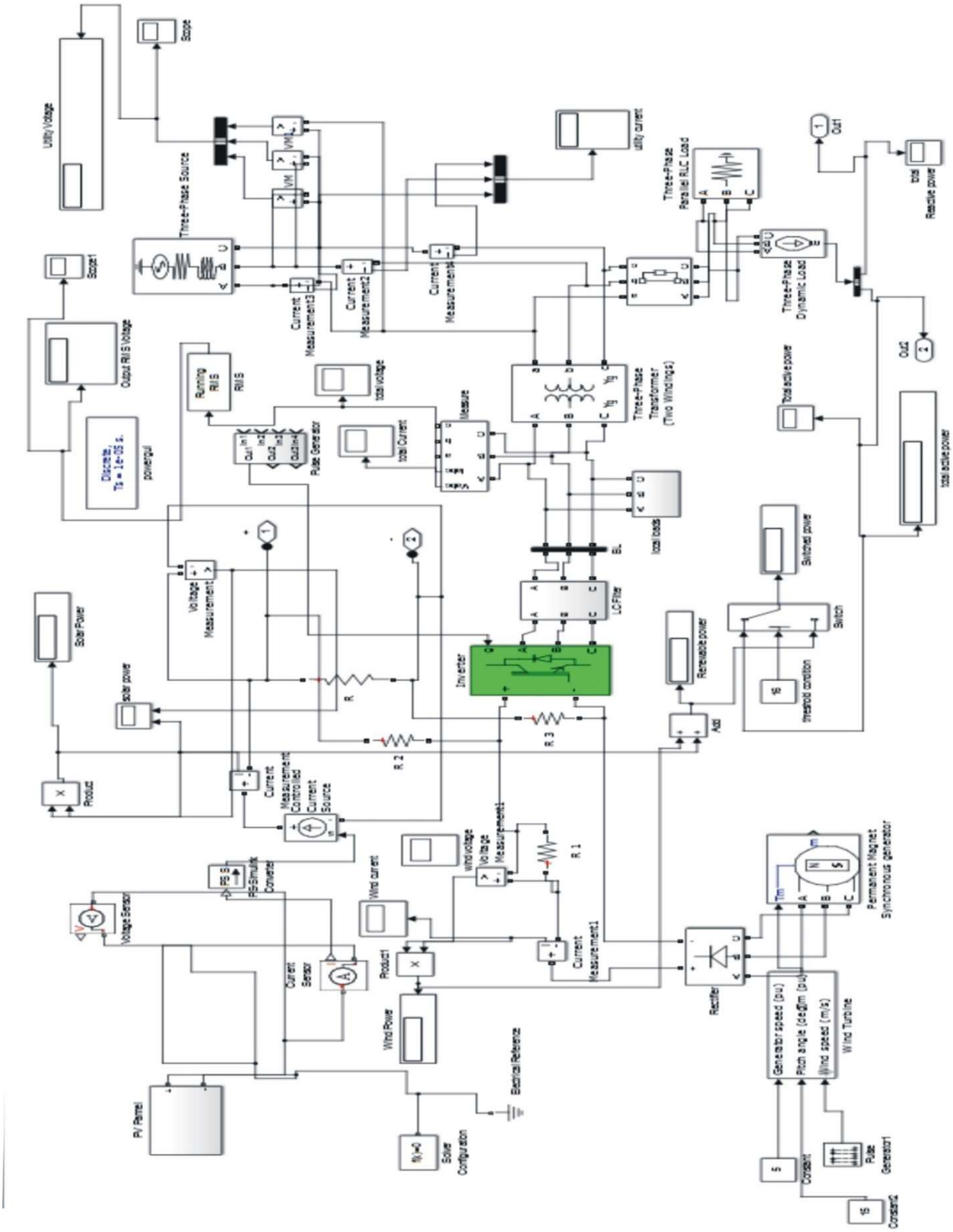


Figure 5 Complete Simulink Model

Case Study 1: Wind and solar maximum

Here the below graphs discuss different parameter when wind and solar generating maximum output. The weather is clear and the sun is on peak, it will generate the maximum power between the 12 pm to 4 pm approximately because at this time the radiation from the sun is high. So it is crystal clear from the graph that the power is gradually increased than after some time it is stable.

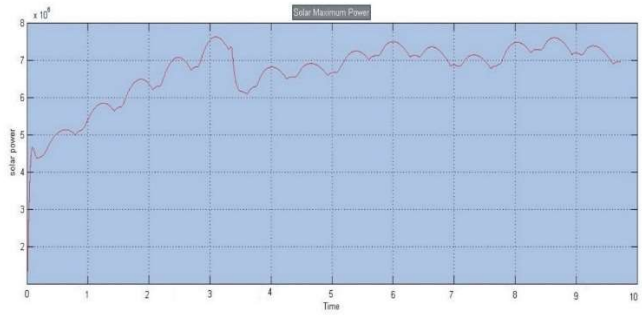


Figure 6 Graph of solar maximum

In figure 6, x- axis shows time and y axis shows solar power, it's gradually increase and then become stable till the sun arisen. From 0 to 3 it is gradually increasing similarly and from 4 to 10 it's stable.

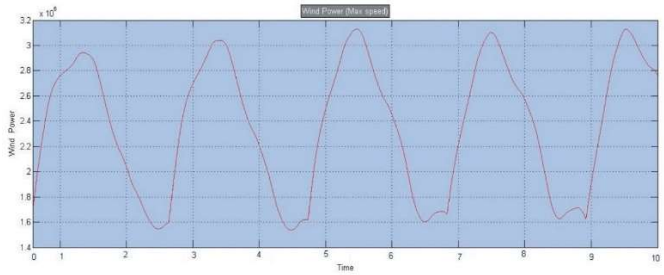


Figure 7 Graph of Wind speed maximum

On a sunny day, when the solar energy is at peak while wind speed is at its high, the power generated from these two renewable sources is shown in the above graph. From the analysis of graphs, we can say that the power from Solar System is adding to the substation is averaged at 7MW (megawatt) and there is low fluctuation the energy obtaining from this is stable, while the power from the Wind Turbine adding to the substation is fluctuating between 3.2 and 1.6 MW or we can say an average of 2.2 MW.

Figure8, Demonstrates that when wind and sun oriented vitality is at most extreme point so the power will increment. We required significant investment on level pivot and power on vertical hub

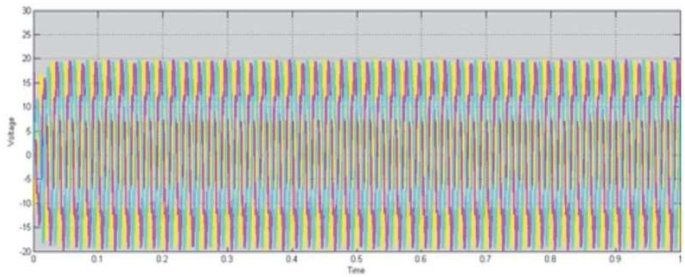


Figure 8 Graph of frequency when Wind and solar speed maximum

Figure 8 represents that on vertical axis we took the voltage and the time on horizontal axis. I shrinked the cycles completed in one cycle from which we can be able to find the frequency because frequency can be defining as the number of cycle per second is called frequency. So here the frequency is 50 HZ and the voltage is between 20 KV to 20 KV. It is our peak to peak voltage. Vrms= Vp/square root of 2 20/square root of 2= 14.142 Vrms= 14.142 V

Case Study 2: Wind maximum and solar minimum

It is case of forecast type weather in which clouds are shattered in the sky and speed of wind is at its peak. The sun is covered by the clouds; it's at minimum position to generate electric power. We got the below results of power generated from wind is max and solar at mini radiations.

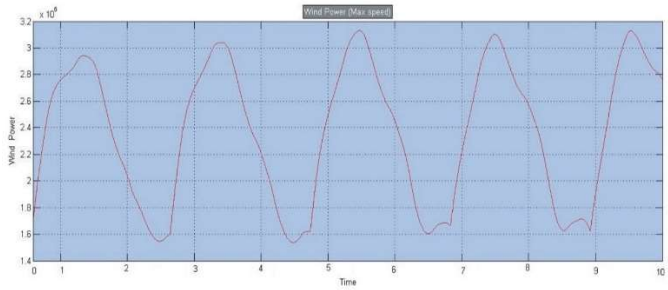


Figure 9 Graph of Wind speed maximum

The above figure 9 shows the graph of wind when it is maximum means flow of air is maximum, x axis shows the time and y axis shows the wind power.

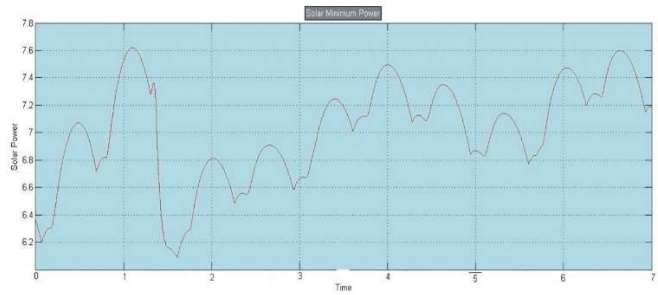


Figure 10 Graph of Solar Minimum

In figure 10 represents that when the solar energy is generating minimum while wind speed is at its high, the power generated from these two renewable sources is shown in the above graph. From the analysis of graphs, we can say that the power from Solar System is adding to the substation is fluctuating first 6.2 to 7.6 than decreased it means when solar energy is minimum so it having fluctuation while the power from the Wind Turbine adding to the substation is fluctuating between 3.2 and 1.6 MW or we can say an average of 2.2 MW.

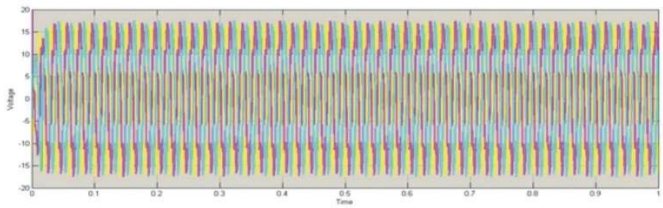


Figure 11 Graph of frequency when Solar Minimum and wind max

The figure 11 represents the graph of frequency, vertical axis shows the voltage and the time on horizontal axis.
The cycles completed in one cycle from which can be easily find the frequency because frequency can be define as the number of cycle per second is called frequency. So here the frequency is 50 HZ and the voltage is between 17 KV to 17 KV as this is our peak to peak voltage as shown in the above graph. Vrms = Vp/Square root of 2 17/Square root of 2=12.02 Vrms = 12.02 V

Case Study 3: Wind minimum and solar is maximum
In this case we will study that when power generating from the wind is minimum and the power generating from the solar is maximum it shows that the day is clear but there is no wind and the radiation from the sun is at peak. The time we can get from this is approximately 12 pm to 4 pm noon because at this time the sun is at peak level.

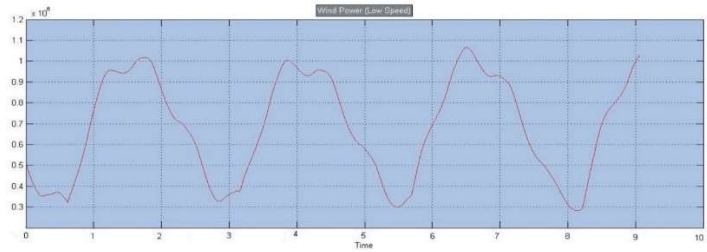


Figure 12 Graph when wind is minimum

In figure 12 shows the that when wind generates minimum power , here x axis shows time and y axis shows speed of wind power and It is further clear from the graph that power is increased at day time than gradually decrease at some level than it become stable from some time. It can meet the demand from the solar when the sun radiation is high so it can switch automatically towards the solar so the power can be generated through the solar.

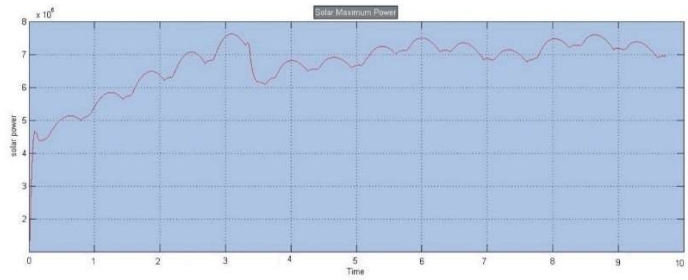


Figure 13 Solar is maximum

Figure 13 indicates when solar generates maximum power so on a clear day, when the solar energy is at peak while wind speed is at its lowest, the power generated from these two renewable sources is shown in the above graph. From the analysis of graphs, we can say that the power from Solar System is adding to the substation is averaged at 7MW (megawatt) while the power from the Wind Turbine adding to the substation is fluctuating between 0.3 and 1 MW or we can say an average of 0.7 MW.

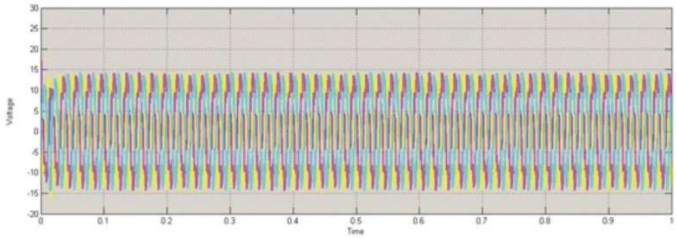


Figure 14 Graph of frequency when Solar Max and wind minimum.

The above figure 14 shows the frequency time graph, Vertical axis shows the voltage and the time on horizontal axis. I shrinked the cycles completed in one cycle from which we can be able to find the frequency because frequency can be define as the number of cycle per second is called frequency. So here the frequency is 50 Hz and the voltage is between 15 KV to 15 KV as shown in the above graph. This is our peak to peak voltage.
Vrms = Vp square root of 2 15 square root of 2= 10.60 Vrms = 10.60 v

Case Study 4: Wind and Solar Minimum
On a sunny day, when the solar energy is at low and also wind speed is at its lowest, the power generated from these two renewable sources is shown in the graph. From the analysis of graphs, we can say that the power from Solar System is adding to the substation is fluctuating between 6.2 to 7.6 MW and averaged at 7.2 MW (megawatt) while the power from the Wind Turbine adding to the substation is fluctuating between 0.3 and 1 MW or we can say an average of 0.7 MW.

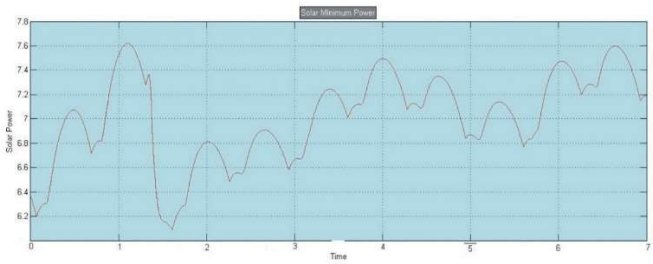


Figure 15 Graph of Solar minimum

In figure 15 horizontal axis shows time and solar power on vertical axis. Which illustrates the solar power is least means its generating low from solar.

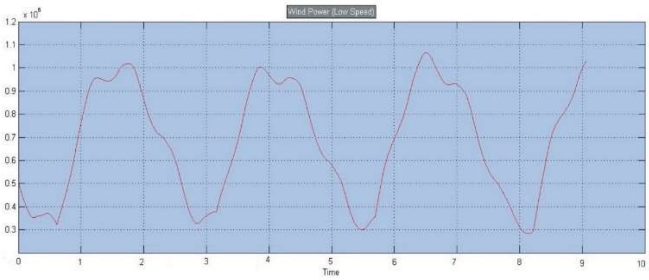


Figure 16 Graph when wind speed is minimum

In this case when solar and wind is generating minimum power and the demand is not full filled so here automatic switching occurs and the supply starts from the utility (national grid), an uninterrupted power supplies to the users. The scope of this model that whenever the demand is not meet by any kind of source in any case so it will done switching to provide uninterrupted supply

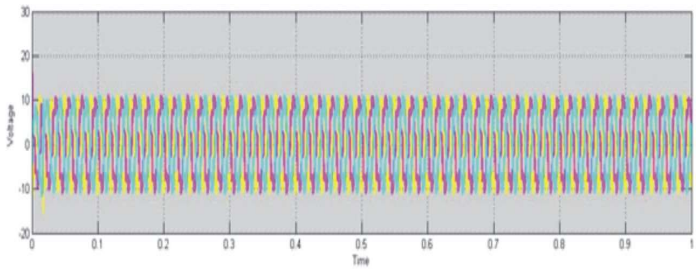


Figure 17 wind and solar speed is minimum

Figure 17 represents the graph which shows the voltage on vertical axis or y axis and time on the horizontal x-axis. Here peak to peak voltage is between 10 KV to 10 KV. The cycles are shrinked and completed in one second so take the time is one second than count the no of cycles in one second so it is our frequency and that is 50 HZ.

Vrms = Vp square root of 2

10 square root of 2= 7.07

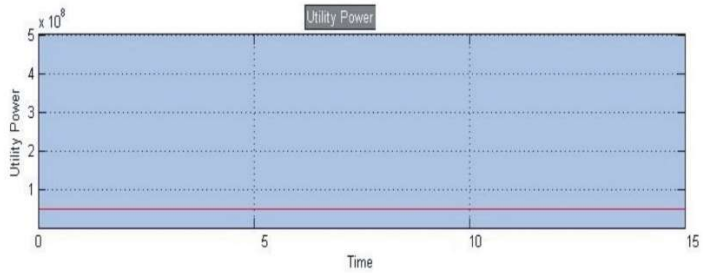


Figure 18 Power from utility

Figure 18 indicates the graph of utility in which the power from hydal source is constant at 50 MW as there is defined number of hydal turbines with defined amount of output power. This power is constant in each case while the solar and wind sources are changing according to different cases.

Power Unbalance

The power unbalance problem occurs in 3 phase electrical systems when the load is not equally distributed on all phases of the neutral line is cut off. This results in unbalanced voltages and currents. It leads to a reduction in the life span of our electrical appliances and causes heat-up issues in motor loads. Voltage can be found with a voltmeter by measuring between phases on the compressor's motor terminals, at the disconnect, or the contactor or starter terminals. The Wye and Delta configurations are some of the more common formats in three-phase motor windings. By measuring voltages from Line 1 to Line 2, Line 2 to Line 3, and Line 3 to Line 1 and performing simple calculations, we can determine if there is a voltage unbalance problem. Voltage unbalance exceeding more than 2 percent in three-phase systems can cause current to bother among the windings. These, in turn, can cause an increase in winding temperature and an overheating problem that can harm the MOTOR.

Measurement Method

Step 1. Measure line voltages between phases

Step 2. Find the average of the three-line voltage readings

Step 3. Find the unbalance for each phase by figuring the difference between each phase voltage (step 1) and the average voltage (step 2). Make sure the subtraction comes out to be a positive number:

Step 4. Take the largest unbalance in step 3 (in this case, 5.33 V) and divide it by the average volts found in Step 2. Multiply by 100 to put it into a percentage form:

In our case, when the system is simulated in Simulink and rms voltages are observed, there occurred no difference in line voltages because the load is equally distributed on all the phases.

The rms values at different times are shown below. And the power unbalance problem does not exist. Although there occurs a little bit variations in voltage which are shown in output rms voltage graph. So there is no power unbalance in every case.

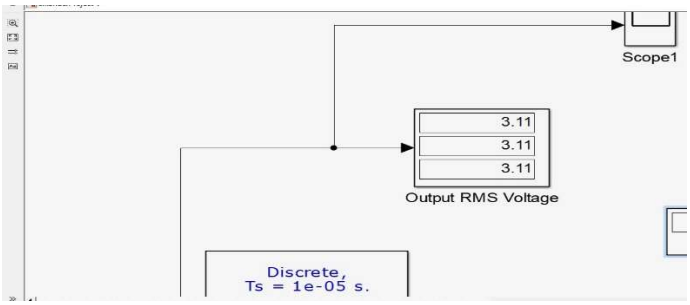


Figure 19 Graph of output RMS voltage in different case

Here different experiments are done by this model we get the output rms voltages i.e 3.31 and 3.3 which is showed hence it is crystal clear from the graph that there is no power unbalance and the system is fully stable.

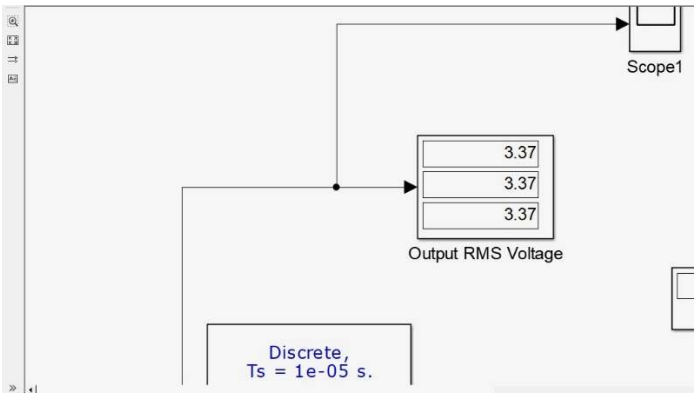


Figure 20 Graph of output RMS voltage in different case

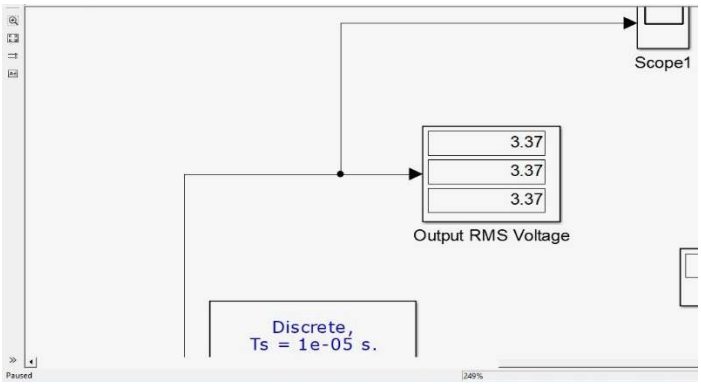


Figure 21 Graph of output RMS voltage in different case

Conclusion

It consists of the conclusion of the overall research work. . Achieved all the objectives successfully. All the research work went through a specific design and implementation methodology. I obtained the results.

Through this research work, a hybrid model which includes Wind, Solar, and Utility has been achieved. It can be concluded that if the wind is high and the radiation from the sun is high so it will meet the demand for renewable energies without utilizing the utility, and when Solar generates more power, and the wind is low, then it causes the point from renewable energy and vice versa, but if the wind is not available and the radiation from the sun is also weak, for it this model having the SWITCH which is working automatically and the demand is not meet it can be switched automatically towards the utility. The utility may be any generating power station that may be Hydro, Nuclear, Diesel, etc. this model has different case studies when the wind is high and solar is also high, wind high solar minimum, solar is maximum, and the wind is minimum when wind and solar are minimal. This model contains different parameters such as Power, Voltage, and frequency. The frequency is approximately the same in all the cases that are 50 HZ, and the voltage fluctuations occur. Still, this voltage passes through an autotransformer, where the output automatically adjusts to 25 KV. So the generation voltage is 25 kV, and the voltage fluctuations are between 15 v to 22 KV.

This model contains three sources of energy solar generating DC, and passes from the inverter to convert it into ac it is to match the frequency and phase of the grid and wind turbine generating ac, and third is utility. These resources automatically meet demand, and switching is done according to the cases. With the optimization and integration of these energies, the model can increase reliability, and the cost of the unit will be minimized, which is the fundamental objective of this model.

For frequency, the total cycles are compressed in a single figure for 1 second and then count the number of cycles for each case; from this, we can calculate the frequency easily because the frequency is defined as the number of cycles per second is called frequency and in this model, frequency is calculated for all the cases which are 50 HZ overall, so the model is perfect.

So this model can maximize the production from wind and solar it can fulfill the demand, so the energy generated from this model will be low cost. We also made a model of the average of 80 years of load data, and the essentialness asks for as the imperativeness will increase with the extension of essentialness demands.

Future Recommendation

In the future, this simulated system can be practically applied for the desired results. Also, some improvements in terms of reliability can be made by improving the efficiencies of the renewable energy sources, power quality, and voltage stability of the system, Due to which Will consume low power from the national grid. Also, there is an improvement place of storing the extra energy in different forms like water keeping at height or charging batteries for more efficiency and reliability in a Hybrid system which will be expensive and so on.

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