HYBRID ENERGY SYSTEM FOR POWER GENERATION USING SOLAR AND WIND

A Thesis is submitted in partial fulfillment of the requirements for the award of Degree of Bachelor of Science in Electrical and Electronic Engineering.

Submitted by:

Md. Muntasir Hasan Shaon
ID: 191-33-5037

Shan Salvin Chowdhury
ID: 191-33-4941

Supervised by:

Mr. Md. Dara Abdus Satter
Associate Professor
and
Associate Head
Department of Electrical and Electronic Engineering

Department of Electrical and Electronic Engineering

Faculty of Engineering

DAFFODIL INTERNATIONAL UNIVERSITY

JANUARY, 2023

DECLARATION

We hereby declare that this thesis "HYBRID ENERGY SYSTEM FOR POWER GENERATION USING SOLAR AND WIND" represents our own work which has been done in the laboratories of the Department of Electrical and Electronic Engineering under the Faculty of Engineering of Daffodil International University in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering, and has not been previously included in a thesis or dissertation submitted to this or any other institution for a degree, diploma or other qualifications. We have attempted to identify all the risks related to this research that may arise in conducting this research, obtained the relevant ethical and safety approval (where applicable), and acknowledged my obligations and the rights of the participants.

Signature of the candidates

Name: MD.MUNTASIR HASAN SHAON

ID: 191-33-5037

Name: SHAN SALVIN CHOWDHURY

ID: 191-33-4941

APPROVAL

The thesis entitled "HYBRID ENERGY SYSTEM FOR POWER GENERATION USING SOLAR AND WIND" submitted by **MD.MUNTASIR HASAN SHAON** (191-33-5037) & **SHAN SALVIN CHOWDHURY** (191-33-4941) has been done under my supervision and accepted as satisfactory in partial fulfillment of the requirements for the degree of Bachelor of Science in Electrical and Electronic Engineering in **JANUARY, 2023**.

Signed

Mr. Md. Dara Abdus Satter

Associate Professor and Associate Head

Department of Electrical and Electronic Engineering

Faculty of Engineering

Daffodil International University

Dedicated

TO

Our Parents

&

Our supervisor

LIST OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENT

First, we want to give thanks to Almighty **Allah**. With the blessing of **Allah,** we are able to complete our work with best effort.

We want to pay our utmost respect to our **Mr. Md. Dara Abdus Satter**, Associate Professor and Associate Head of the Department of EEE, Daffodil International University for who has given us the chance to work on an impactful idea and taken care of every issue of development of this concept. Then we would like to take this opportunity to express gratitude to our supervisor for being dedicated in supporting, motivating and guiding us throughout this thesis. This thesis can't be done without his useful advice and help. Also thank him very much for giving us the opportunity to work with this thesis.

We also want to convey our thankfulness to **Dr.Srimanti Roy Choudhury**, Associate Professor of the Department of EEE, Daffodil International University for her support and encouragement. Apart from that, we would like to thank our entire class fellows for sharing knowledge; information and helping us in making this project a success. To beloved family, we want to give them our deepest love and gratitude for being very supportive and also for their inspiration and encouragement during our studies in this Institution.

ABSTRACT

Wind-solar hybrid systems integrate solar and wind energy to produce a stable, steady energy supply. When integrated, solar and wind power produce stable electricity. Using both of these energy sources for a steady energy flow is desirable. The hybrid renewable energy system includes a PV plant, wind farm, CSP plant, battery, heater absorber, and bidirectional inverter. Multi-objective optimization determines the best power plant-energy storage device combination and capacity. A better system operating model using several energy storage technologies and variable power suppliers is suggested. The CSP-PV plant combination improves power generation reliability economically. When PV plant, battery, and inverter investment prices are low, the battery is preferred to be incorporated into the PV plant to lower the loss of power supply probability (LPSP). Utility-grid-connected systems When RES power is short, they may draw from the grid. The grid may receive extra RES electricity during off-peak demand. Standalone systems are grid-free. In this research, we design, build, and execute a low-cost solar-wind hybrid system. Due to its quantity, availability, and simplicity of use, wind and solar electricity are becoming increasingly popular. A maximum power point tracking (MPPT) module charges rechargeable batteries from wind power through a tiny alternator or solar power via solar cells in the hybrid system. This study creates a basic solar-wind hybrid energy system. Stored energy makes up for shortages. After the prefeasibility analysis, each component must be accurately sized to economically meet the load demand. It improves dependability and reduces dependence on one source. This hybrid solar-wind power generator works for homes and businesses.

Keywords: Solar, wind, hybrid energy system, optimization, design.

CHAPTER 1

INTRODUCTION

1.1 Motivation

Electricity encourages industrialization, urbanization, and financial development. Electricity is produced using conventional and non-conventional energy sources. One of the major energy sources is solar and wind power. Modular and ecologically friendly solar and wind energy systems are becoming more popular. Over the last two decades, standalone utility-scale interactive solar-wind systems have grown in popularity. Solar and wind energy systems may operate independently or be grid-connected. Hybrid renewable energy sources with grid connectivity mitigate this drawback. Hybrid renewable energy systems (HRES) may use two or more renewable energy sources in standalone or grid-connected mode. Solar and wind energy systems create energy simultaneously or sequentially. HRES combines two or more renewable power production technologies to optimize their operational characteristics and increase efficiency. Weather and climate influence wind and solar power.[5] The Hybrid Optimization Model for Electric Penetration of Renewables (HOMER) software is adopted to perform the research. This study reviews hybrid solar–wind–battery-based standalone power supply systems for load requirements. [6] Hybrid power systems use wind and solar generators to charge batteries and meet energy demand. [1] This power generation system was reliable and cost-effective. Power energy storage technology and TES technology, which may be utilized for large-scale energy storage, are not sources of energy. PV and wind farms' excess electricity outputs may be stored in batteries. [8]

1.2 Problem statement and Proposed solution

The importance of hybrid systems continues to increase as it becomes apparent that these systems are the best choice for generating power in a distributed and environmentally friendly manner. The Solar-Wind hybrid power system is a system that harnesses the renewable energies in the sun and wind to generate and supply electricity to a private house, farmhouse, small business, educational institution, or apartment house, depending on the need at the site where it is used. This can be accomplished in several areas. The power that is produced by wind generators has an AC voltage, which is then converted into a DC voltage using an AC-DC converter. In order to step up or step down using MOSFET switching, a unique form of converter known as a "SEPIC" converter is used in wind farms. For the regulation of solar systems, buck converters are often implemented. The microcontroller built into this system frequently refers to the operation of the individual converters and witches, and it is powered by inverters and supplied to either the battery or the load. The output of the inverter is coupled with the load, and then a transformer is used to increase the voltage to the specified level. The gate signal for the MOSFET used in converters is provided by the driver circuit, which is essential in their development. Installing a hybrid electricity generation system is suggested for several reasons, the most significant of which are the presence of unreliable energy supplies and an imbalance of energy resources. The use of a single source will not be a feasible option due to the fact that the wind does not blow continuously throughout the day and the sun does not shine continuously throughout the day. It is possible that a hybrid setup, in which electricity is collected from many sources (such as the wind and the sun) and then stored in a battery, might be an energy source that is more stable and more in accordance with current. Even when there is no wind or sun, the load may still be powered by utilizing the energy that has already been stored in the batteries. It is necessary to have a battery system in order to store the solar and wind energy that is produced during the daytime. The fact that there is wind present at night is an additional benefit, which leads to an improvement in the system's levels of dependability. [1] Hybrid power plants have been shown to be effective in lowering the rate at which fossil fuels are consumed and at supplying electricity to isolated rural locations without having a negative impact on the surrounding environment. Distributed hybrid energy stations have proven to be beneficial for slowing the rate of depletion of fossil fuels and delivering electricity to remote rural areas while minimizing environmental impact. This has been achieved without causing any damage to the natural world. [6] Renewable energy will ultimately fill the role of conventional fossil fuel energy and will take on the major task of fulfilling the ever-increasing demand for energy. Because of the disproportionately high price of battery storage, the renewable energy system will incur much higher costs associated with the production of electrical power. It has been suggested that the integration of TES and thermal-power conversion devices into the PV/wind power system will increase the power generation system's dependability. analyzed the performance of PV-wind hybrid systems with various energy storage technologies from the point of view of multi-objective optimization of installed capacity. The findings indicated that the TES had a significant cost advantage over the PHS, the battery, and the hydrogen storage option. [8] When the battery bank is completely charged and the electricity generated from the wind turbine and solar panels exceeds the demand, controlling this dump load allows for the protection of the battery bank from being overcharged. As a result, the longevity of the battery bank is increased, and the practice of continuously measuring current and voltage is done away with. [2] The contribution that renewable sources of energy will make to the process of generating electricity is one of the most fundamental questions that will affect the energy systems of the globe not too far in the future. The generation of power that is locally generated and releases low levels of carbon dioxide (CO2) may be facilitated using renewable energy sources, which also opens up a number of additional factors that influence [3]

1.3 Aims

We proposed to try a hybrid system where we attached solar panels to the wind turbine stand, propeller and generation box which increased the energy and stored it in batteries. When supply is sufficient to meet demand, stored energy fills the gap.

1.4 Brief Methodology

In many cases, solar and wind power are combined to form a hybrid system, which is then connected to separate power networks. These hybrid systems may then be used to generate electricity. When solar cells and wind turbines are placed at the same site, there is the potential for separate connections to be made and for different supplies to be provided. because the natural world may present itself in a variety of different ways and has the capacity to wreak havoc on the availability of solar and wind energy. We will be capable of producing our own source of energy by combining the power of the sun with the power of the wind if we attach solar panels to the body of the wind system in addition to the propeller. This will allow us to make use of both of these natural assets. In comparison to what it was in the past, which was a lesser amount, the amount of power that is created will rise in the future. In addition to that, in order to protect our information, we are going to make use of batteries. Always make sure the battery has a suitable level of energy stored in its reserve. In the event that the amount of power that is generated is less than the amount of power that is required due to natural concerns, the amount of power that has been stored will be used to provide the necessary amount of power in order to satisfy the demand. This will be done by using the amount of power that has been stored. If we keep on moving in this way, we will be able to create a system for the production of electricity that is not only helpful to the state of the natural world but also lucrative for the operation of the market as a whole. If we continue down this route, we will be able to do this. After taking into consideration all of these specific aspects, we came to the realization that this specific model was the one that best matched our demands.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

The generation of electricity may be accomplished via the utilization of a wide variety of energy sources, both conventional and alternative. One of the most important sources of power is a hybrid system that utilizes solar and wind energy. The combination of solar energy with wind energy in a wind-solar hybrid system results in the production of an independent energy source that is both predictable and constant. This makes the wind-solar hybrid system an effective alternative energy source. Although the amount of energy obtained from solar or wind sources might vary on their own, when combined, these two types of energy offer a stable supply. The optimal approach would be to combine these two different types of energy sources in order to provide an uninterrupted flow of energy. The hybrid power system will serve as the primary focus of this article. In this case, we integrated two different power sources in order to produce an output that is self-sufficient. This

output is a combined output that was achieved by using an inverter or converter in conjunction with certain electrical equipment. Review for Remote and rural village electrification; Residential colonies and apartments for general lighting and Street lighting

2.2 Related Research

Authors of [1] is presenting the Solar-Wind hybrid power system, which is able to create power by using the renewable energies that are found in the sun and the wind. The microcontroller is the primary component in the system's control architecture. It guarantees the most effective usage of resources, which, in turn, leads to an improvement in efficiency when measured against the individual modes of generation those resources utilize. In addition to this, it improves dependability while simultaneously reducing reliance on any one particular source. Both commercial and residential settings are appropriate for the installation of the hybrid solar-wind power generation system being discussed here. Both of these options are clean, plentiful sources of electricity that don't emit any pollutants. An AC-DC converter is used to convert the wind turbine's AC electricity into reliable DC power. With MOSFET switching, a valuable sort of converter referred to as a "SEPIC" converter is utilized to step up or step down for wind turbines. A Cuk converter is used for regulation in the solar system. This module contains a microcontroller that drives the patterned converters, changes the batteries, or feeds power to the load through inverters as needed. It really refers to the well-being of sources on a regular basis. To increase the voltage, a transformer is used after the inverter's output is linked to the load. For converter MOSFETs, the driver circuit that is adapted should provide the gate signal. When executed, the power consumed has been guided by renewables such as solar and wind power. It has resulted in an improvement in the dependability of the system while simultaneously decreasing the impact on any one particular source. As a result, we were capable of increasing the efficiency of the process when matched with the various ways of production that were used.

Authors of [2] is proposed in this paper. In the Simulink model that is being spatially shown, the solar and wind energy sources, which are the most important analysis renewable energy sources, are modeled dynamically before being obtained together to construct a diversified management system. Due to the fact that PI and MPPT control algorithms are then built for each other, the DC converters are set to ensure that they are able to provide stable output values regardless of the outcome. Future efforts will include fuel cell and ultra capacitor applications, which will greatly increase the scope of the proposed system. To round out the Simulink model’s functionality, we’ll include energy storage and damp load. The effectiveness of the suggested method will also be shown in real time by the results of current experimental trials. To define the operation of an energy conversion system, only basic PI control and extended PI control, which consist of a based optimization and observe algorithm in their auxiliary controllers, must be used. The 170 W photovoltaic (PV) panels in the model solar plant are linked together in series, and the generated energy is converted using a maximum power point tracking (MPPT) algorithm that controls a buck converter’s modulator. Using an installment of the perturb and observe (P&O) method that contains a nearly equal (PI) controller, we invent the MPPT algorithm used in the converter’s control phase. To convert alternating current (AC) to direct current (DC), a permanent magnet synchronous generator (PMSG) and an unchecked full-bridge rectifier are used in the wind power plant productivity. An inappropriate full bridge rectifier converts the alternating current (AC) output from the wind turbine to direct current (DC). Such are the DC outputs of the rectifier, where the current and voltage are regulated at the controller in under a tenth of a second. It can be established that the wind turbine’s output current is similar to the rectifier’s output current and that the voltage values generated from the wind turbine are correct. PI-controlled buck converters control the DC output voltage to the set value.

Authors of [3] In this research We present a PV/wind hybrid power generation system that can be connected to an existing grid in this study. An overview of the research is provided, including details on its main components (the WECS, PV, battery, and FC) and a description of the coordinated control approach that will be used to operate the proposed hybrid energy system as a whole. The battery stack serves as a dump site to store any extra electricity generated by the PV and wind generation systems. The Power Factory was used to create a simulation model of the hybrid system. A dual-energy system is included in this system to ensure reliable power is always available. A solar-wind hybrid system includes a wind turbine, a PV array, an inverter, a battery bank, a controller, and some other components. Both the wind turbine and the photovoltaic array are operating in parallel to meet the need. If there are enough available energy sources (sun, wind), the solar energy generated throughout the day will keep the battery topped up until nightfall. In contrast, the battery will release power to help the PV array and wind turbine meet load needs during times of low energy production, up to the point when the storage is stressed. The model of the hybrid solar-wind system is based on the efficiency of its individual units. Each power source must be properly developed and integrated to fulfill the requisite consistency before the overall system’s performance can be predicted.

Authors of [4] This research discusses the implementation of a hybrid renewable energy system for a household application that operates under a microcontroller to utilize solar and wind power. The purpose of the system is to reduce dependence on fossil fuels. The system’s batteries may be charged in one of two ways: either by solar power using an MPPT-Modul or by wind power using a tiny alternator. The microcontroller is the principal element in the system's control scheme .An average house may get a percentage of the energy that it needs from the electricity that is generated by wind and solar power. This helps to decrease the amount of fossil fuels that are used. The kinetic energy of the wind is converted into mechanical energy by the wind turbine, and subsequently the mechanical energy is converted into electrical energy. Tower, alternator, speed converters (also known as gearboxes) and propeller are the elements that make up the wind turbine that is a part of the system. Another semiconductor that has high operating power and low triggering voltage is triggered when a semiconductor with low triggering voltage and low operating power is connected to the input of the system. This semiconductor may either be a triode or a transistor. As a result, the relay is capable of switching on and off far more rapidly than traditional relays. It is employed due to the features that it has, such as spark-free operation and a long life in operation. The electricity produced by wind and solar power has been shown to be capable of meeting some of the requirements for a home's total annual energy consumption. The maximum power point tracking technique that was used in the MPPT brought about the most possible benefit from the sun's rays.

Authors of [5] is presenting a fundamental part of a renewable energy system that combines solar and wind power. The need for power is increasing on a daily basis, and it is impossible for non-renewable energy sources to meet this demand on their own. Renewable forms of energy, such as those derived from the sun and the wind, are abundant and kind to the environment. The renewable energy sources are appearing as different outcomes to satisfy the need for energy, but due to the random nature of their occurrence, we cannot rely on them to meet the demand. A hybrid renewable energy system, often known as an HRES, is one that combines two or more forms of renewable energy, such as a wind turbine with a solar power installation. HRES is offset by the fact that it combines two or more renewable power generation technologies in order to obtain efficiencies higher than those that could be obtained from a single power source, as well as the fact that it makes appropriate use of the operating characteristics of each of these technologies.

Authors of [6] This article asserts that a hybrid wind-solar system is a trustworthy and stable alternative energy source. The solution does this by combining wind and solar power to provide an entirely different and stable supply of energy. Despite the possibility that solar and wind power generation may be variable when used separately, when combined, they provide a reliable supply. Coupling these two forms of power would provide a constant supply of energy. Erratic factors, such as weather and climatic conditions, may have an impact on the constancy of wind and solar sources. The best choice for outlying areas is the auto-solar-wind hybrid system that we've been discussing. These choices, which are designed for this system, are not only inexpensive but also easily available year-round.

Authors of [7] It presents the design, building, and deployment of a solar-wind hybrid system with the purpose of obtaining inexpensive electric energy. Because of their ubiquity, accessibility, and the simplicity with which they may be converted into usable electric power, wind and solar power are quickly becoming the most prominent forms of alternative energy. The hybrid system has rechargeable batteries, some of which are charged by solar power through solar cells and others by wind power via a tiny alternator; in any case, the charging process is facilitated by a maximum power point tracking (MPPT) module. The development and application of a straightforward plan for a solar-wind hybrid energy system is going to be the focus of this body of work. It is anticipated that the completion of this work would enable an effective use of solar and wind power, which will in turn support some portion of the daily home energy demand.

Authors of [8] is proposed that a hybrid renewable energy system (HRES) combining a solar plant, a wind farm, a focused solar power plant, a battery, a heating element, and an inverter is continuously being developed. The multi-objective optimization method is used to determine whether it is efficient to optimize the capabilities already installed in these subsystems. Only the photovoltaic plant and the inverter are required for the system to be able to generate electricity, which results in the system having a low level of durability. The start-up of energy demand is seeing significant transformations at the moment. Renewable energy will someday take the place of standard fossil fuel energy and will take on the primary responsibility of fulfilling the ever-increasing demand for energy.

Authors of [9] A standalone hybrid power generating system made up of solar and wind power sources in addition to an AC load is shown here. In order to get the most out of the simultaneous energy harvesting from the total power production in a variety of climatic circumstances, a supervisory control unit that is built to carry out maximum power point tracking (MPPT) has been implemented. The performance of the WECS is significantly improved thanks to the concept of a wind–solar hybrid system that was suggested. This improvement is measured in terms of an expanded generating capability. In conditions of low wind speed, a solution to problems with power production may be found in the expansion of solar PV systems to an adequate capacity with a minimum storage facility for batteries.

Authors of [10] A grid structure is offered. The utility grid is an example of a connected system. Linked systems are those that are connected to the grid. When the power produced by RES is less than the electricity demanded by the load, they are able to take power from the grid. The extra electricity produced by RES may be sent back into the grid even during periods of lower demand, such as when demand is not at its highest. Standalone systems are not dependent on the electricity provided by the grid. In the process of producing electrical power, one may note that the use of HRES is becoming an increasingly preferred alternative to the utilization of traditional sources. Both the dependability and performance of the system are improved when various kinds of renewable energy sources are combined with storage devices like batteries.

2.3 Compare and Contrast

The consumption of power is rising on a daily basis, and it is impossible for non-renewable energy sources to meet this demand on their own. Renewable forms of energy, such as those derived from the sun and the wind, are ubiquitous and kind to the environment. The renewable energy sources are developing as potential possibilities to satisfy the need for energy, yet, according to the random nature of their occurrence, these sources cannot be relied upon to meet the demand. A hybrid renewable energy system, generally known as an HRES, is one that combines two or more forms of renewable energy, such as a wind turbine with a solar power installation. The availability of electricity is a critical component in the processes of industrialization, urbanization, and economic progress in every nation. The generation of electricity may be achieved through the utilization of a wide variety of energy sources, both conventional and alternative. One of the most important sources of power is a hybrid system that utilizes solar and wind energy. HRES is distinguished by the fact that it combines two or more renewable power generation technologies in order to obtain efficiencies higher than those that could be obtained from a single power source, as well as the fact that it makes appropriate use of the operating characteristics of each of these technologies. We suggested experimenting with a hybrid system in which solar panels would be mounted to the stand and propeller of a wind turbine. This would result in an increase in energy production, which would then be stored in batteries. When there is not enough supply to fulfill the demand, stored energy is used to make up the difference. Following the prefeasibility study comes the process of conducting an accurate assessment of the size of each individual component that is capable of economically satisfying the load requirement.

2.4 Summary

Electricity is generated via solar-wind hybrid power plants. Its microcontroller controls it. The geographically presented Simulink model dynamically reflects solar and wind energy, the two most major renewable energy sources, before being integrated to form a diverse management system. After the PI and MPPT control algorithms are set for each other, DC converters produce stable values regardless of the outcome. PV/wind hybrid generation is related. Solar and wind power in a household microcontroller-controlled hybrid renewable energy system can’t match demand since it’s unpredictable. Solar and wind power generation fluctuates, yet they provide a continuous supply. Due to their affordability, accessibility, and simplicity of conversion into electricity, wind and solar power are the most popular alternative energies. Solar cells and an alternator charge the hybrid system’s rechargeable batteries using an MPPT module. The solar plant and inverter are the only power sources, making the system vulnerable. Energy demand start-up changes are considerable. Grid-linked solar PV systems with battery storage may help low-wind electricity output. RES may take electricity from the grid if their output is less than the load. We suggest combining solar panels with a wind turbine’s platform and propeller. Battery storage boosts energy production. Stored energy needs interaction when demand exceeds supply.

CHAPTER 3

DESIGN PROCEDURE

3.1 Introduction

Energy is not only a fundamental need for countries, but it is also one of the primary locomotives that drives both economic and social progress. Because the vast majority of the processes that are used to create energy are one-way, the energy must go through some type of transformation before it can be utilized. At the same time that we are developing new forms of technology, we are searching for additional types of power source materials since we need more energy than we are currently producing. After looking at the feasibility of wind power as a potential source of electricity, the next renewable energy source that was investigated was solar power. Wind power was the very first kind of renewable energy that was looked at as a feasible choice for the generation of electricity. The task requires the development and execution of a solar-wind hybrid energy system that is designed for installation in a residential setting. It is expected that the accomplishment of these responsibilities would make it feasible to make effective use of the power generated by the sun and the wind, which will in turn supply a portion of the daily requirement for energy in residential settings.

3.2 Methods and Materials

Resources for renewable energy, also known as clean energy, are those that continue to be accessible even as time goes on and continually regenerate themselves. The use of renewable energy resources has become more prevalent in recent years as a result of globalization and rising population levels. Known types of energy sources include solar power, wind power, tidal power, biomass power, geothermal power, and wave power.[3] One of the most common and important sources of power is a hybrid system that utilizes solar and wind energy. Since the commencement of the twentieth century, the area of solar–wind energy has had a phenomenal expansion, shifting from the popular application of standalone solar–wind systems to the use of utility interactive solar–wind systems. Even while solar and wind energy systems function regularly whether they are operating independently or linked to the grid, the efficiency of these sources is lower than that of other sources owing to the stochastic nature of solar and wind resources. This shortcoming of renewable energy sources, which is that they are inherently unpredictable, is circumvented by using hybrid systems that integrate with the grid. A hybrid renewable energy system, also known as an HRES, is a mix of renewable and conventional sources of energy. A hybrid renewable energy system (HRES) may also combine two or more renewable energy sources that are capable of operating in either independent or grid-connected modes. Both simultaneous and sequential modes of operation are available for the HRES, which combines solar and wind energy as its primary resources. In the simultaneous mode of operation, the solar and wind energy system creates energy at the same time, but in the sequential mode of operation, the solar and wind energy system produces power in sequence. [5]

3.2.1 Solar

Fig.3. 1 Photovoltaic array

Solar panels are the means through which solar energy is converted into the electrical energy that may be used. Solar panels have the ability to either convert the energy directly or heat the water using the energy that is induced. Photovoltaic, or PV, cells are constructed using the same kind of semiconducting materials that are used in computer technology. This substance is able to soak up the rays of the sun, which in turn causes the atoms to release electrons. As a result of this release, a current has begun. The process that takes place between the absorption of radiation and the generation of energy is known as “photovoltaic.” A fundamental process known as the photoelectric effect is responsible for the transformation of solar energy into electric power. The solar cell array, also known as the solar panel, is made up of the necessary number of solar cell modules, which may either be linked in series or in parallel, depending on the amount of current and voltage that is needed.[1]

3.2.2 Wind

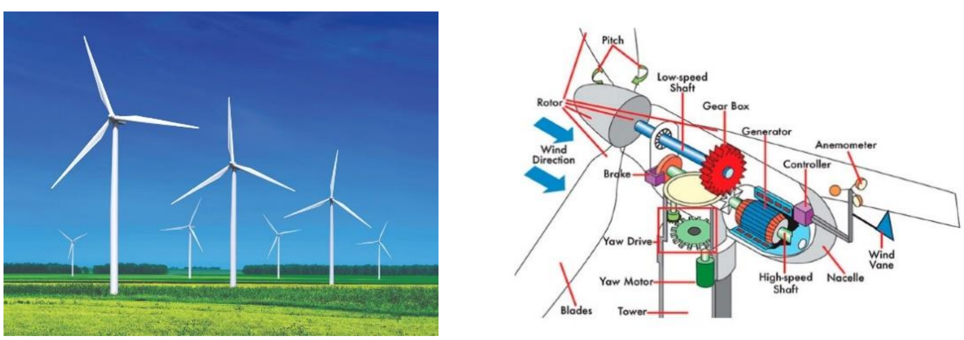


Fig.3. 2 Wind turbine

The energy that arises from the wind is a source of energy that can be supplied. Wind power may be transformed into electrical power through the use of wind turbines. An electric generator installed inside the turbine is capable of transforming the mechanical energy into electric power. There are wind turbine systems available that can generate up to 9 MW. The amount of power generated from the wind-by-wind turbines is dependent on the amount of force that the wind applies to the turbines. Wind energy has the potential to cover not only the supply but also the demand for electricity in more remote locations. It is put to use in the operation of windmills, which in consequence power either wind generators or wind turbines, which in response generate electrical power.[1]

3.2.3 Hybrid Energy System

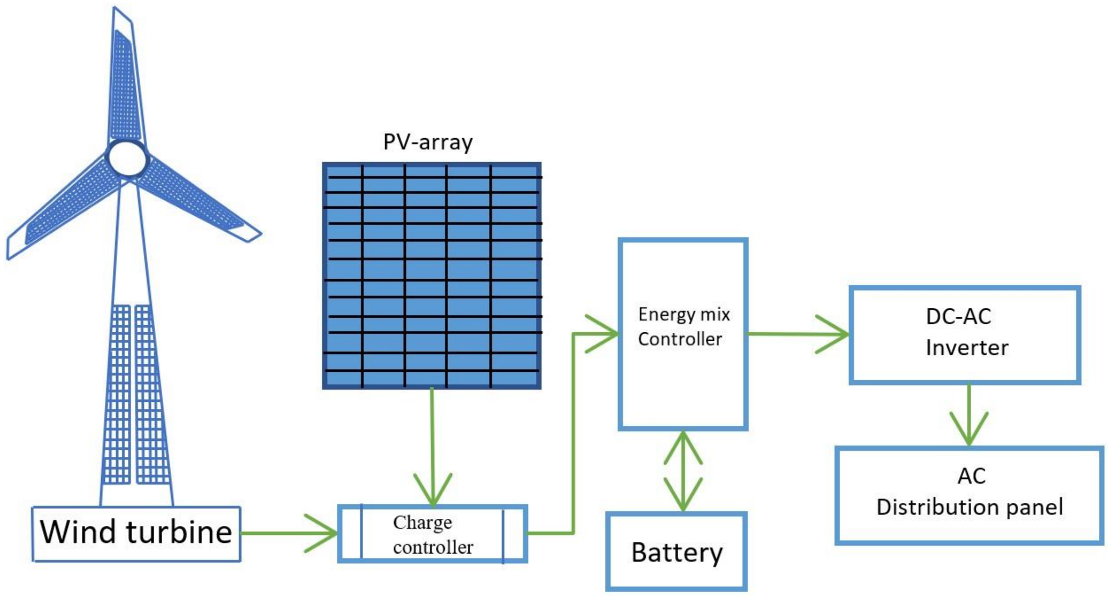


Fig.3. 3Hybrid system

Systems that make use of more than one kind of energy source are known as hybrid systems. In terms of the generation of electrical power, the integration of systems (such as solar and wind) has a greater effect. These kinds of systems are referred to as “hybrid systems.” In the field, where there is a need for continuous energy consumption throughout the year and no room for interruption, hybrid solar and wind applications are put into place. In hybrid energy systems, it is possible to meet the demand for energy using any mix of different types of energy sources, such as oil, solar, and wind power, among others. This project will be quite similar to the one with the wind turbine and solar panels. Climate and weather conditions are important considerations for photovoltaic solar panels and tiny wind turbines. As a result, the electricity generated just by solar or wind sources is insufficient.[4]

3.2.4 Battery

The energy that is produced either by the wind or by solar power may be stored in the system thanks to the batteries that are included in it. By connecting the batteries either in series or in parallel, the desired capacity of the system may be attained. The maintenance-free dry-type battery that makes the most of its potential in wind and solar power systems is one that makes use of unique electrolytes and is of the kind that operates most effectively. These batteries provide exceptional performance even when subjected to prolonged discharges.[1]

3.2.5 Inverter

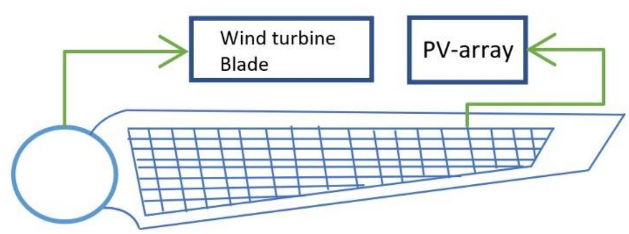
The inverter, which transforms direct current (DC) electricity into alternating current (AC), is used by electrical loads to access the energy that is stored in the battery. The inverter has built-in protections against a short circuit, reverse polarity, low battery voltage, and using more power than it can handle.[1]

3.2.6 Microcontroller

The inputs from both of the power systems are compared by the microcontroller, which then sends the proper signal to the appropriate relay in order to charge the DC battery. The inverter circuits are the ones that are responsible for changing the DC voltage into the AC supply. In this design, the MOSFET is connected to the secondary winding of the center-tapped transformer's secondary winding. The primary winding of the transformer experiences current flow that is also of an alternating character. As a consequence of this, the primary winding of the transformer provides us with an AC supply. The MOSFET is turned on in a manner that is completely arbitrary in order to achieve this result.[1]

3.3Design Specification

The finest hybrid combination of all renewable energy systems is a stand-alone wind system combined with a solar photovoltaic system. This combination is suited for the majority of applications and takes into account the effects of seasonal fluctuations. They also supplement one another during times of scarcity. For instance, the greater energy production by wind during the monsoon months compensates for the lower output that is provided by solar during those same months. In a similar vein, solar photovoltaic power takes over during the winter months when there is little to no wind.



Developed part

Fig.3. 4 Solar attached wind turbine blade.

In order to boost the amount of electricity produced, we linked solar panels directly to the blades of the wind turbine. We have successfully created a connection port at the end of the blade by attaching the solar to it. This port is accessible via the solar cable. Even after attaching the solar to the blade, the weight of the blade has not changed in any significant way. The solar arrays that are used are light in weight, resistant to harm in naturally hostile environments and can follow the movement of the blade without inflicting any damage to itself in the process.

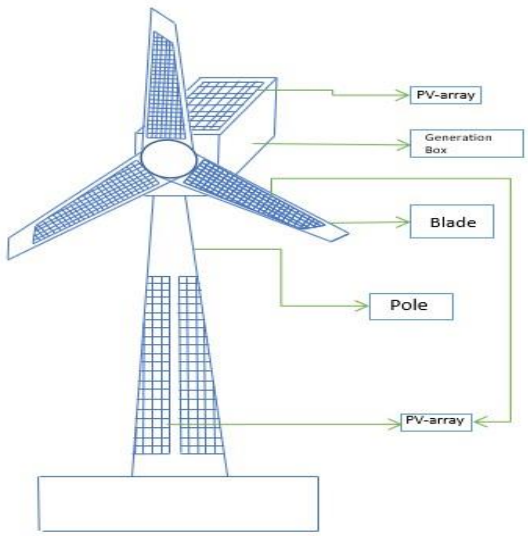


Fig.3. 5 Solar attached wind turbine pole and generation box.

We have provided additional solar panels to the generating box as well as a wind turbine pole, each of which is contributing to an increase in the amount of electricity that is being generated. Through the use of a solar power transfer cable, the solar panels mounted on the generating box and the wind turbine pole are able to provide electricity directly. The solar arrays that is attached to the wind turbine blade, generating box, and pole will be integrated with other solar power sources to generate electricity. Solar energy and that generated by wind turbines are combined to produce the complete power supply, which has evolved into a combined solar and wind power system called a stand-alone hybrid power system.

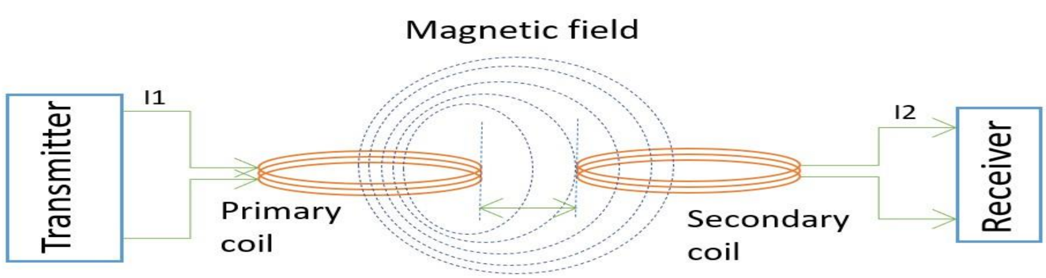


Fig.3. 6 Wireless Power Transmission.

Through the use of wireless power transmission (WPT), the energy that is generated by the solar panels on the wind turbine blades will be transferred. Transformers are a common use of inductive coupling, which occurs when two coils are placed in close proximity to one another. In most cases, they are used inside energy supply devices in order to change the alternating 220 V voltage of the power supply network into lower voltages that are acceptable for consumers. WPT by means of inductive coupling is very similar to inductive coupling by means of transformers; however, it makes use of weakly coupled coils, which create an air gap transformer between a primary (transmitter) circuit and a secondary (receiver) circuit. Fig.7 provides a visual representation of a fundamentally inductively linked system. An alternating magnetic field carries the energy from the main coil to the secondary coil, where it is then used.[16]

3.4 Simulation and Experimental setup

Block diagram environments are used for multidomain simulation and model-based design, and Simulink is one such environment. It simplifies the design, simulation, and automated code generation of embedded systems, as well as continuous testing and verification at the system level. Modeling and simulating dynamic systems is made possible via Simulink's graphical editor, block libraries that may be customized, and solvers. Because it is connected with MATLAB, you will be able to import MATLAB methods into your models and export simulation results to MATLAB so that you may continue your analysis there. In the fields of automated control and digital signal processing, Simulink is extensively used for the purposes of multidomain simulation and model-based design.

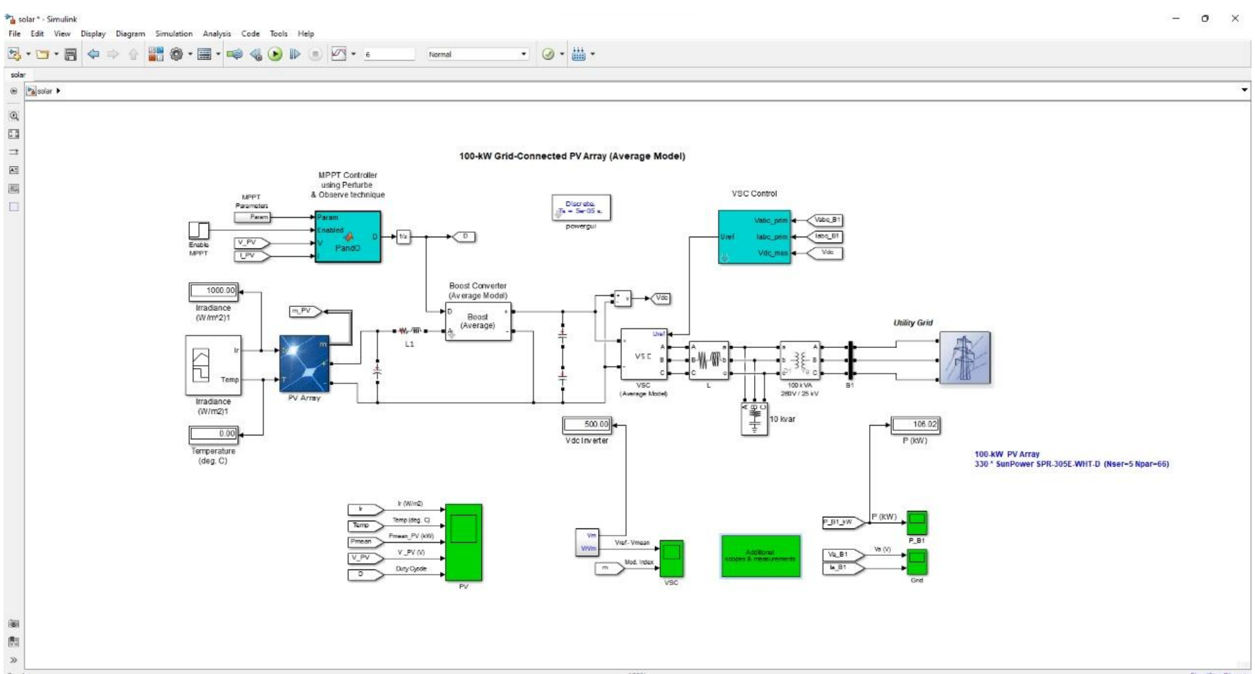


Fig.3. 7 Simulink model of sun energy conversion system with PV array.

Photovoltaic (PV) cells are the structures that are made of semiconductor materials that convert sunlight directly into electrical energy. PV panels are built from PV cells. A current source, a diode, and resistors connected in series and parallel are what create the equivalent electrical circuit of PV cells, as illustrated in Figure 8.[2] Maximum Power Point Tracking is the full name of the electrical system known as MPPT, which stands for Maximum Power Point Tracking. MPPT is a system that modifies the operational conditions of the electrical module so that the solar panel may produce more electrical energy. It is able to store the DC power efficiently that's also generated by the solar panel in the center of the battery. The employment of powerful electrical devices in conjunction with the proper software constitutes maximum power tracking technology. It allows the battery pack to always provide the maximum amount of power. Because there is no maximum power tracking technology, the output power of the battery module will never be able to achieve the ideal (high) value, regardless of the conditions. This will result in a decrease in the solar battery module's usage rate. The dc conversion circuit is often where MPPT solar control is finished, and both the photovoltaic cell array and the load go via the dc circuit.[17]

MPPT controller based on the Perturb & Observe algorithm:[18]

```
function D  = PandO(Param, Enabled, V, I)
% D output = Duty cycle of the boost converter (value between 0 and 1)
% Enabled input = 1 to enable the MPPT controller
% V input = PV array terminal voltage (V)
% I input = PV array current (A)
% Param input:
Dinit = Param(1);  %Initial value for D output
Dmax = Param(2);   %Maximum value for D
Dmin = Param(3);   %Minimum value for D
deltaD = Param(4); %Increment value used to increase/decrease the duty cycle D
% ( increasing D = decreasing Vref )
persistent Vold Pold Dold;
dataType = 'double';
if isempty(Vold)
Vold=0;
Pold=0;
Dold=Dinit;
end
```

```
P= V*I;
dV= V - Vold;
dP= P - Pold;
if dP ~= 0 & Enabled ~=0
if dP < 0
if dV < 0
D = Dold - deltaD;
else
D = Dold + deltaD;
end
else
if dV < 0
D = Dold + deltaD;
else
D = Dold - deltaD;
end
end
else D=Dold;
end
if D >= Dmax | D<= Dmin
D=Dold;
end
Dold=D;
Vold=V;
Pold=P;
```

"Stepping up" an input voltage to a higher level than a load requires may be accomplished with the help of a boost converter. This one-of-a-kind capacity is accomplished by storing energy in an inductor and then releasing that energy to the load at a greater voltage. Integrating HVAC and HVDC systems with devices designed for high-power electronic applications, such as IGBTs, is the job of voltage source converters (VSC), which are self-commutated converters. A selfcommutating VSC may produce AC voltages independently of an external AC power source. The VSC's benefits include AC voltage adjustment, standalone control of active and reactive power and a compact size during installation. The solar panel, together with the help of the MPPT controller, the VSC, the three-phase RL branch, the boost controller, and finally the bus bar, will be responsible for converting the heat and rays of the sun into energy. This electricity will then be sent to the Unity Grid.

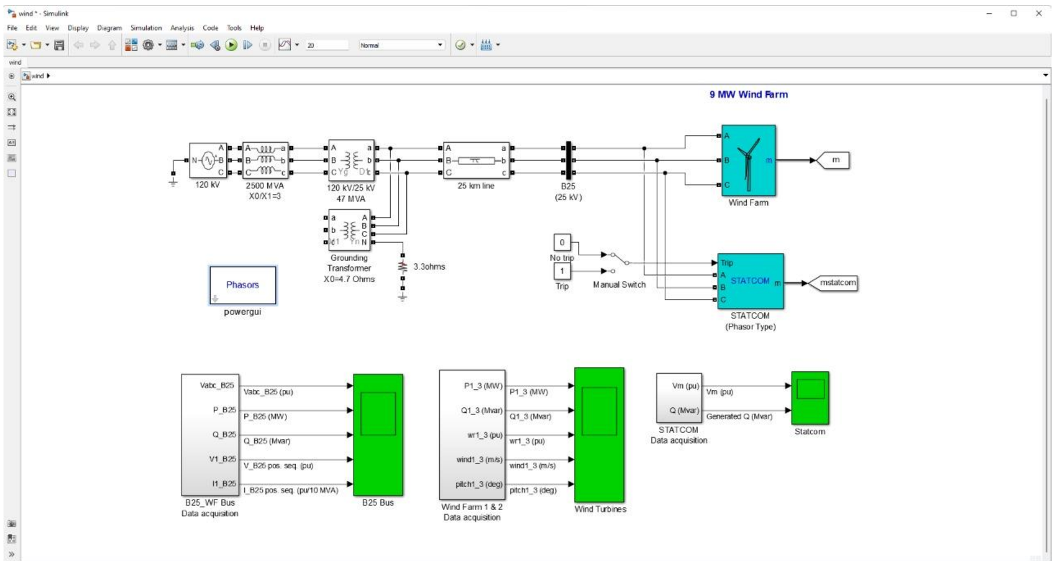


Fig.3. 8 Simulink model of wind energy conversion system.

Wind is a natural process that has to do with the movement of air masses and is mostly caused by the uneven heating of the earth's surface by the sun. Changes in the amount of energy that is absorbed from the sun over the seasons have an effect on both the force of the wind and the direction it blows. The kinetic energy of the wind is harnessed by the wind turbine through the use of a rotor that has two or more blades and is physically attached to an electrical generator. The turbine is held up by a big tower so that it can make as much energy as poss

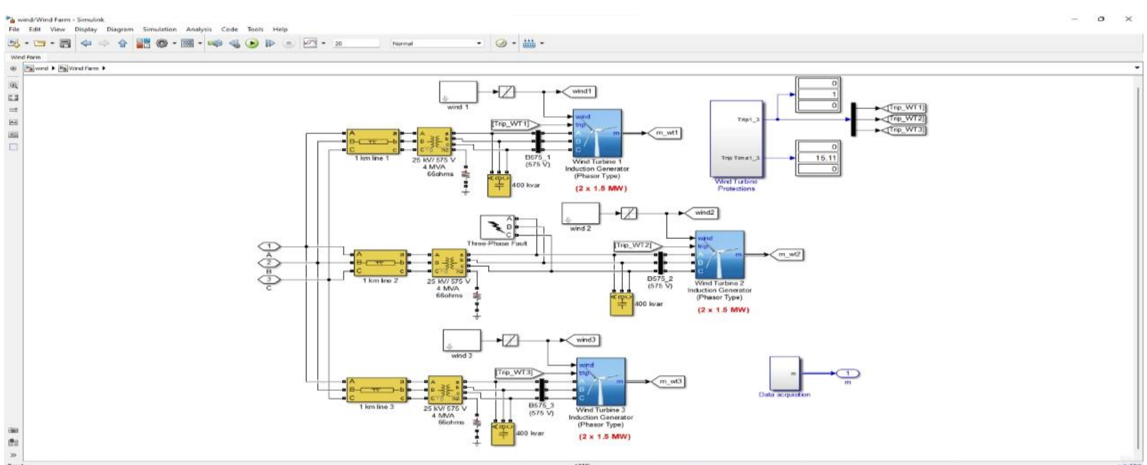


Fig.3. 9 Subsystem of wind farm

We have used three wind turbines, and we have wired each wind turbine such that it is linked to the bus bar, which is wired to the transformer. The three-phase P-I selection line will be linked to the transformer where it will originate. There is a three-phase fault linked in series between the connecting line for the wind turbine and the transformer. The P-I selection line for three phases will be a three-way connection in series. This block represents a single PI portion of a three-phase transmission line that has been modeled. The model is made up of one group of RL series components that are linked between the input terminals and the output terminals, as well as two groups of shunt capacitances that are lumped at both ends of the line. The wind farm is finished as a result. In addition to the ground parameters, the inductive and capacitive couplings between the three phase conductors are taken into account by the line parameters R, L, and C. These parameters are specified as being positive-sequence and zero-sequence parameters, respectively. These parameters are known as the positive-sequence parameters and the zero-sequence parameters, respectively. Using this strategy, the parameters of the line will be defined; however, this method does assume that all three phases are in equilibrium. By managing the amount of reactive power that is either injected into or absorbed from the power supply, the STATCOM is able to maintain a constant voltage at its terminal. The STATCOM will provide reactive power whenever the voltage of the system is low (STATCOM is capacitive). When the voltage of the system is high, it will take in reactive power (STATCOM inductive). A connection to a busbar is made available from the wind farm, and this busbar will eventually be linked to the transformer through a three-phase P-I selection line. The three-phase grounding transformer will be connected in series between the three-phase P-I selection line and the transformer. A three-phase programmable voltage source will also be included, along with the connection from the transformer that will go to the three-phase mutual inductance. The wind power system may now be considered fully operational.

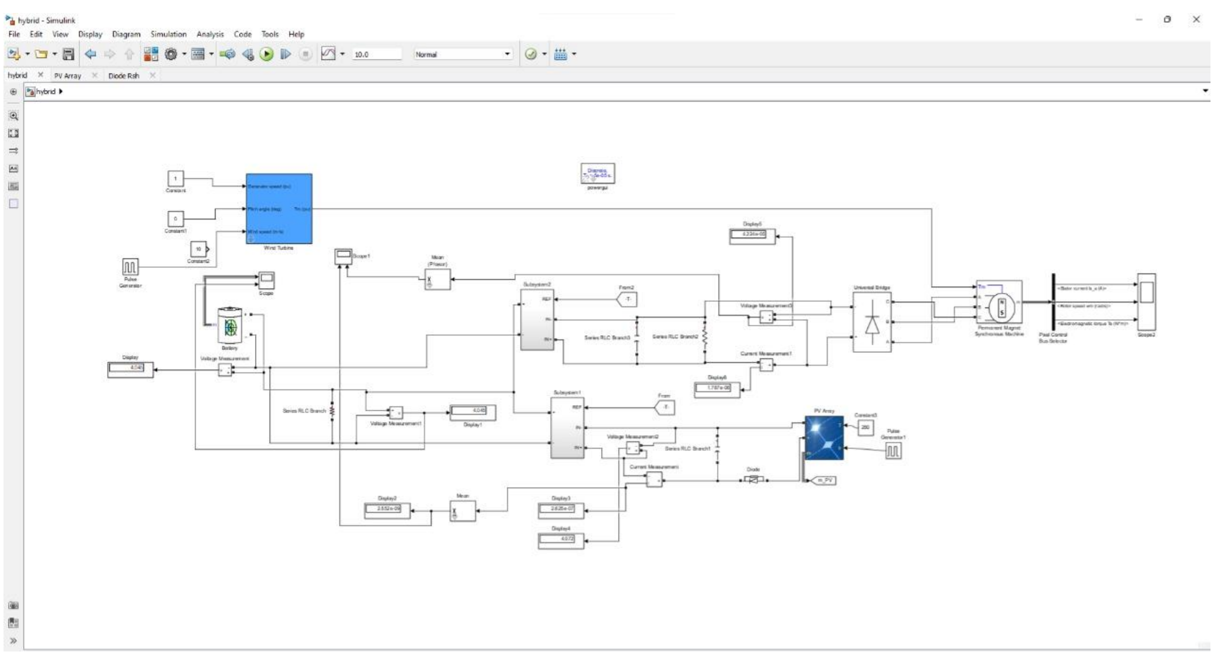


Fig.3. 10 Simulink of hybrid energy conversion system.

Hybrid solar-wind energy systems are based on component performance. For stability, each power source must be planned individually and then combined. Then the system will perform. Each source's power output assessment must be accurate for the combination to be an effective power supply. Using a power electronic interface, a hybrid system may be grid-connected or isolated. Both ways work. Rely on the hybrid system, powered by wind and solar energy and stabilized by batteries. Used batteries are prevalent because system inputs are unpredictable. It meets electricity demand when solar and wind energy are insufficient. Wind, sun radiation, and temperature influence the hybrid system's efficiency. [3] The Universal Bridge block allows you to simulate converters that use either naturally commutated (also known as line-commutated) or forced-commutated (diodes or thyristors, for example) power electronic components (GTO, IGBT, MOSFET). The Universal Bridge block is the most important part for building two-level voltage-source converters (VSC). A rotating magnetic field is produced in the space between the stator winding and the air gaps. whenever the stator winding is powered by the three-phase supply. This results in the production of torque whenever the rotor field poles maintain the rotating magnetic field at synchronous speed while the rotor itself is in a state of continuous rotation.

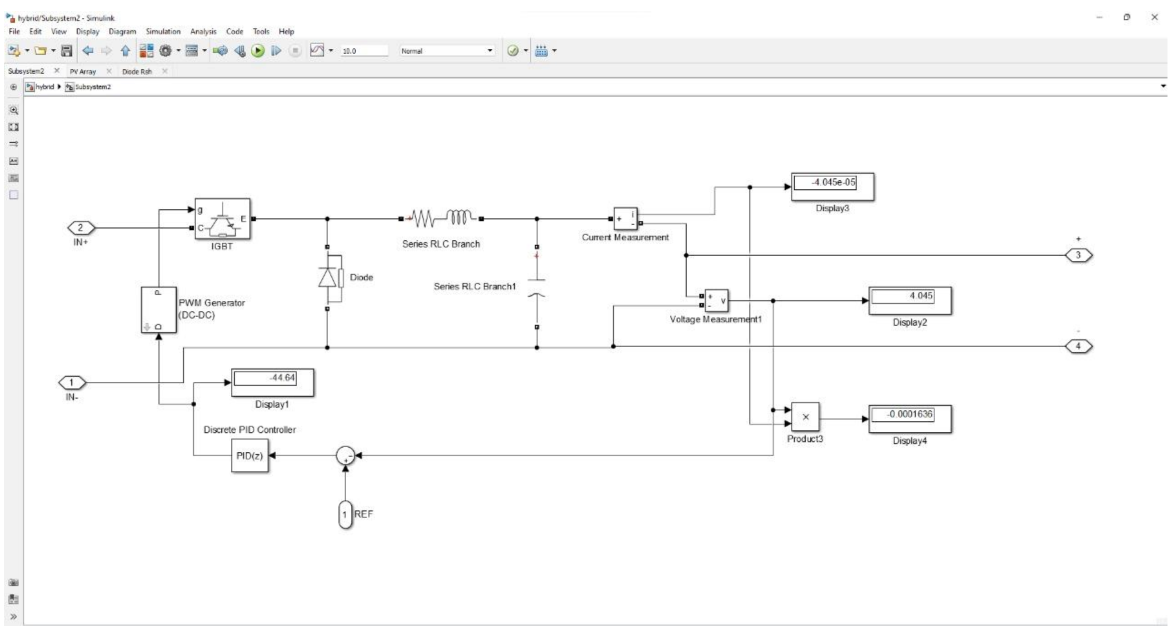


Fig.3. 11 Subsystem of inverter.

From the IGBT to the PWM generator, from the discrete PID controller to the sum, and ultimately the voltage measurement A line connection is provided from the E terminal of an IGBT to the series RL branch, which is used for measuring the current. The opposite end of the current measurement is compared to the opposite end of the voltage measurement. The line that is connected for voltage measurement, which is connected between E and the series RL branch of the IGBT, has a diode connected in parallel to that. Thus, the inverter subsystem is created. Connect the line from the inverter subsystem's IN negative to the solar array's negative terminal. The inverter's positive terminal is linked to the meter's positive voltage terminal and the meter's negative current terminal. The voltage meter's negative end has been attached. Antenna linking the inverter's negative terminal to the PV in this way. There will be a diode in series between the positive end of the current measurement and the positive end of the PV. Parallel to the line connecting the current meter diode, the negative terminal of the PV is connected to one end of the series C branch. There is a direct connection between the inverter's negative terminal and the battery's negative terminal through the connecting line. The battery's connecting line also serves to link the inverter's positive terminal to the terminal's positive terminal. related to the good point. When starting from the reverse terminal of the inverter system Line connections are made from the positive point of the inverter subsystem to the positive point of the universal bridge and from the negative point of the bridge to the series C branch and the series R branch, respectively. The permanent magnet synchronous machine details the link between the universal bridge and the wind turbine. This is how hybrid is completed and supply power.

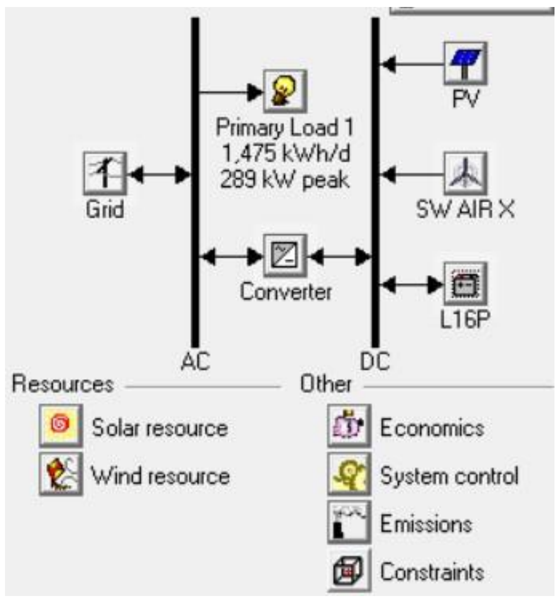


Fig.3. 12 Hybrid system criteria in HOMER software.

For the purposes of this research, the HOMER simulation software has been used. HOMER, the renewable energy optimization program, may assess a system's design and development in terms of whether or not it can fulfill the loads (electrical and thermal). Fig. 13 illustrates the Homer software's architecture, which is separated into two parts—input and output—to illustrate how, when given the right information, the program may provide the best possible outcomes. We have created a hybrid system using solar panels and wind turbines using the HOMER software. This system generates direct current (DC) electricity and uses batteries to store excess power. Solar and wind power production are both susceptible to suspension in the event that the environment is struck by a natural catastrophe. The power supply that was initially stored in the battery will then be used to make up for the shortfall in generation. The electricity that is generated by wind turbines and solar panels The battery is able to restore its previous amount of power if it is in normal condition. A converter is used to change the DC supply into AC, and then AC power is given to the main load as well as the grid.

3.5 Summary

The task requires the development and execution of a solar-wind hybrid energy system that is designed for installation in a residential setting. It is expected that the accomplishment of these responsibilities would make it feasible to make effective use of the power generated by the sun and the wind. A hybrid renewable energy system (HRES) is a mix of renewable and conventional sources of energy. HRESs can operate in either independent or grid-connected modes. Solar panels are the means through which solar energy is converted into electrical energy. Wind power may be transformed into electrical power through the use of wind turbines. In hybrid energy systems, it is possible to meet the demand for energy using any mix of different types of energy sources, such as oil, solar, and wind power. Energy that is produced either by the wind or by solar power may be stored in the system thanks to the batteries. The MOSFET is turned on in a manner that is completely arbitrary in order to achieve an alternating current supply. The solar arrays are light in weight, resistant to harm in naturally hostile environments, and can follow the movement of the blade without inflicting any damage to themselves. Transformers are a common use of inductive coupling, which occurs when two coils are placed in close proximity to one another. WPT makes use of weakly coupled coils, which create an air gap transformer between a primary (transmitter) circuit and a secondary (receiver) circuit. MPPT solar control is frequently used when the photovoltaic cell array and load are connected via a dc circuit. The solar panel, together with the help of the MPPT controller, the VSC, the boost controller, and finally the bus bar, will be responsible for converting the sun's heat into electricity. The model is made up of one group of RL series components that are linked between the input terminals and the output terminals. The wind farm has made a connection to a busbar available. The busbar will eventually be linked to the transformer through a three-phase P-I selection line. The Universal Bridge block is the most important part for building two-level voltage-source converters (VSC). A rotating magnetic field is produced in the space between the stator winding and the air gaps. Connect the line from the inverter subsystem's IN negative to the solar array's negative terminal. We have created a hybrid system using solar panels and wind turbines using the HOMER software. system generates direct current (DC) electricity and uses batteries to store excess power. Solar and wind power production are susceptible to suspension in the event of a natural disaster.

Keywords: Simulink, MPPT, STATCOM, MOSFET, IGBT, HRES, DC conversion circuit and Energy source.

CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Results

Renewable energy sources, often known as "clean energy," replenish themselves over time. Globalization and population growth have increased demand for renewable energy. Solar, wind, tidal, biomass, geothermal, wave, and [3] Hybrid solar-wind power systems are prevalent and vital. HRESs combine renewable and traditional energy sources. A hybrid renewable energy system (HRES) may also use renewable energy sources that can operate independently or be connected to the grid. Solar panels convert solar energy into electricity. Solar panels may heat water directly or indirectly. Wind energy is available. Wind turbines convert wind energy into electricity. Hybrid systems are multi-energy systems. Integrated solar and wind systems generate more electricity. These are hybrid systems. This investigation employed HOMER simulation software. HOMER, the renewable energy optimization software, may evaluate a system's design and development for load capacity.

4.1.1 Simulation Results

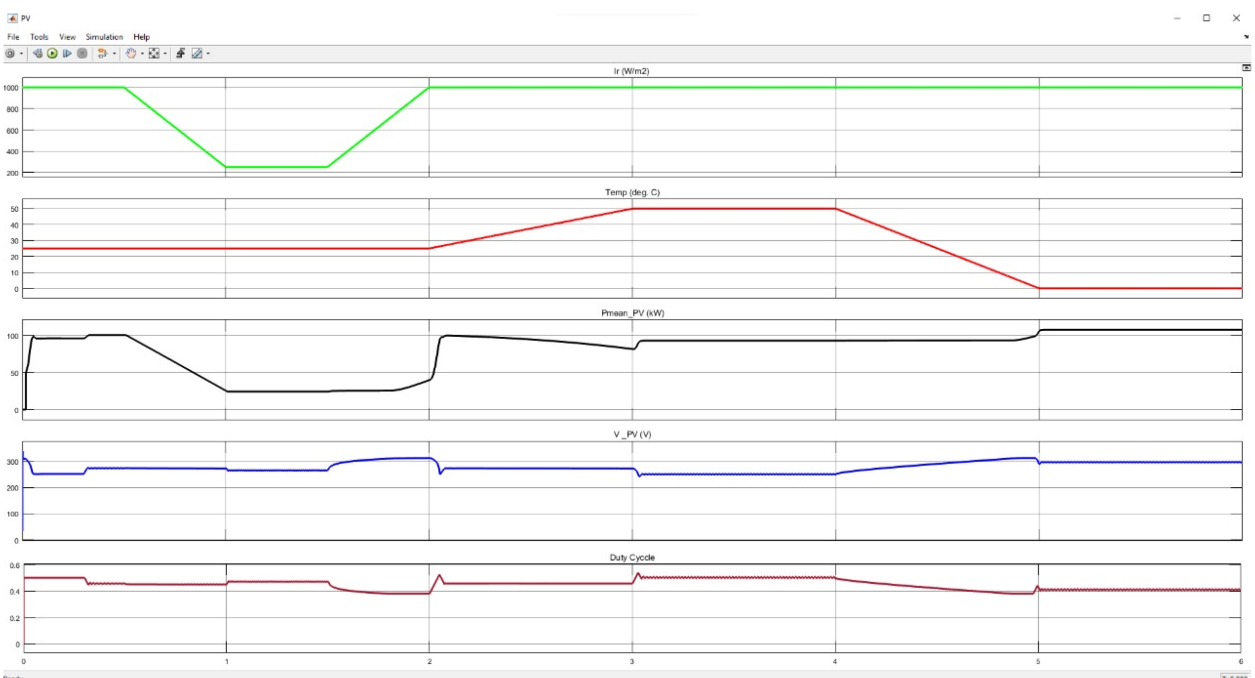


Fig.4. 1: PV array data acquisition.

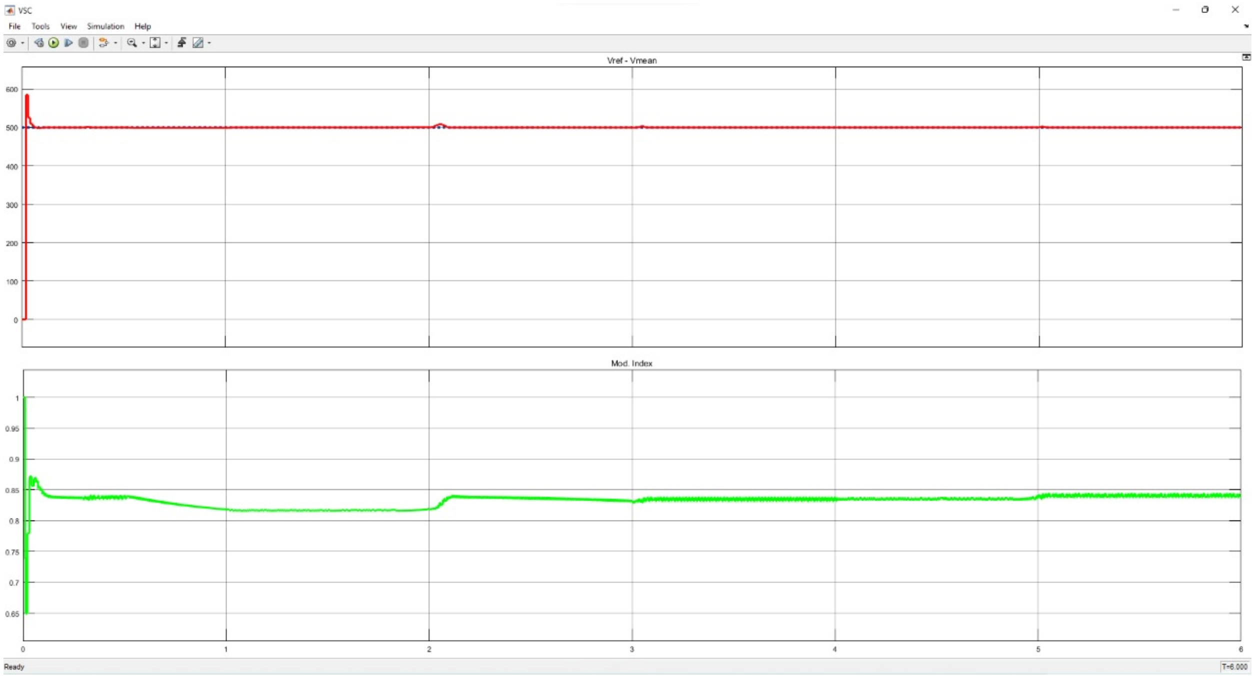


Fig.4. 2: Solar system's VSC data acquisition.

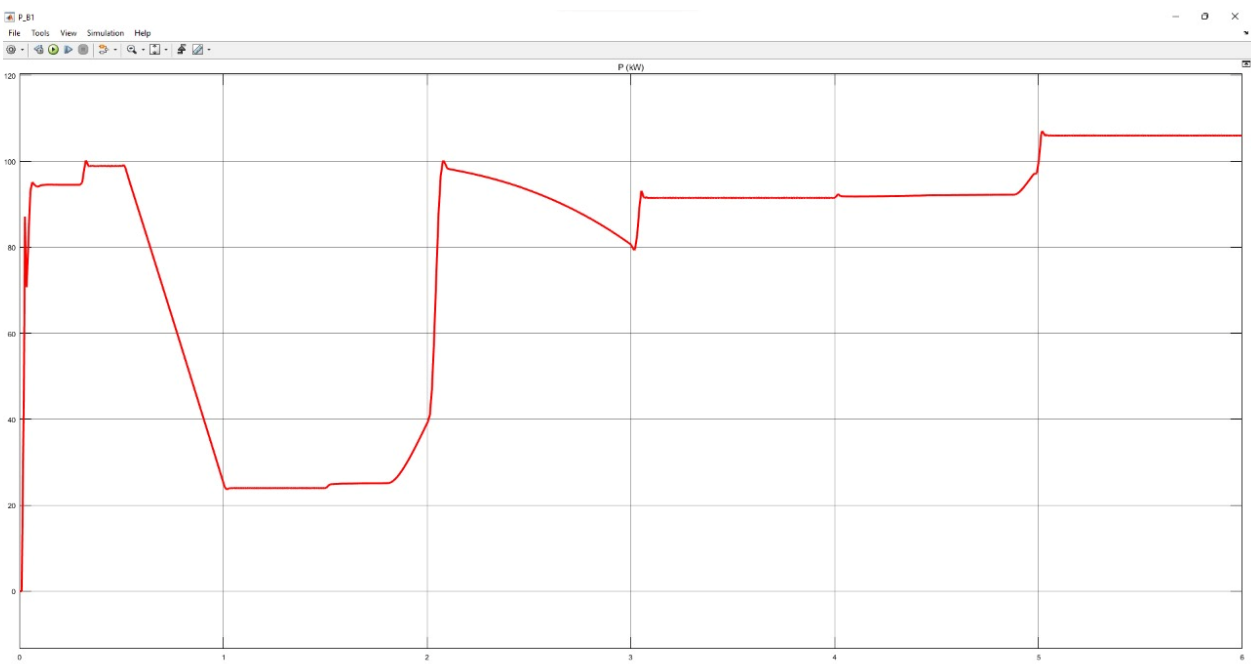


Fig.4. 3: Solar system's P-B1 bus bar data acquisition.

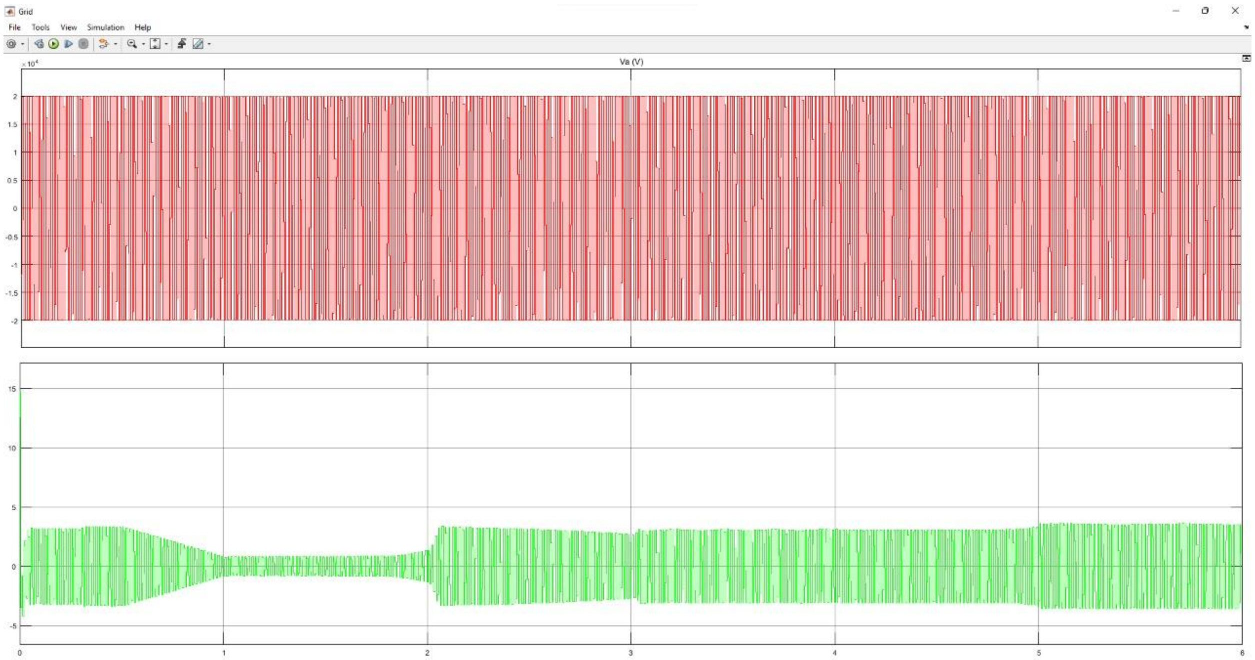


Fig.4. 4: Solar system's Unity grid data acquisition.

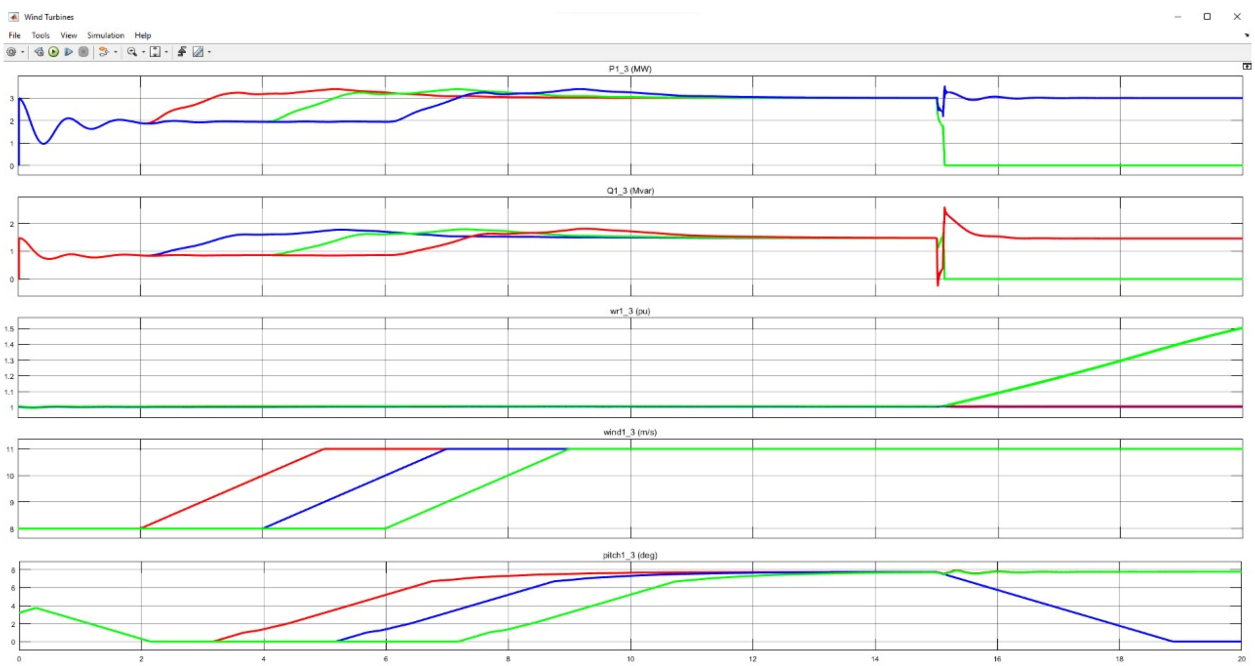


Fig.4. 5: Wind farm data acquisition.

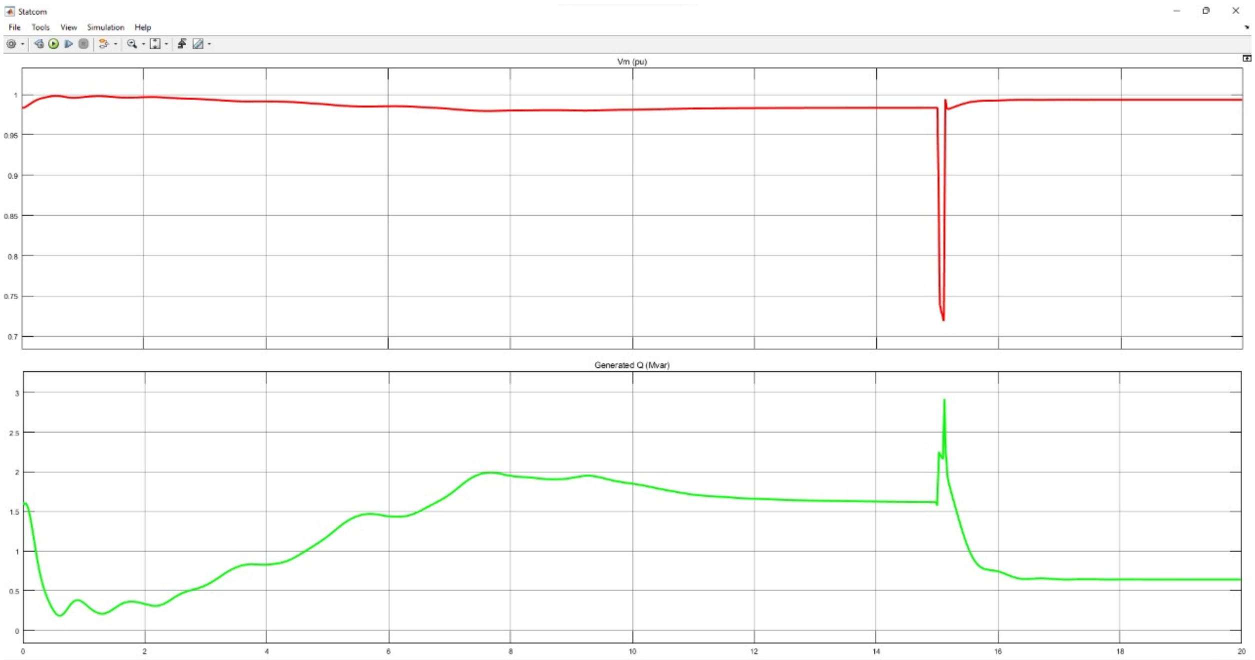


Fig.4. 6: Wind farm's STATCOM data acquisition.

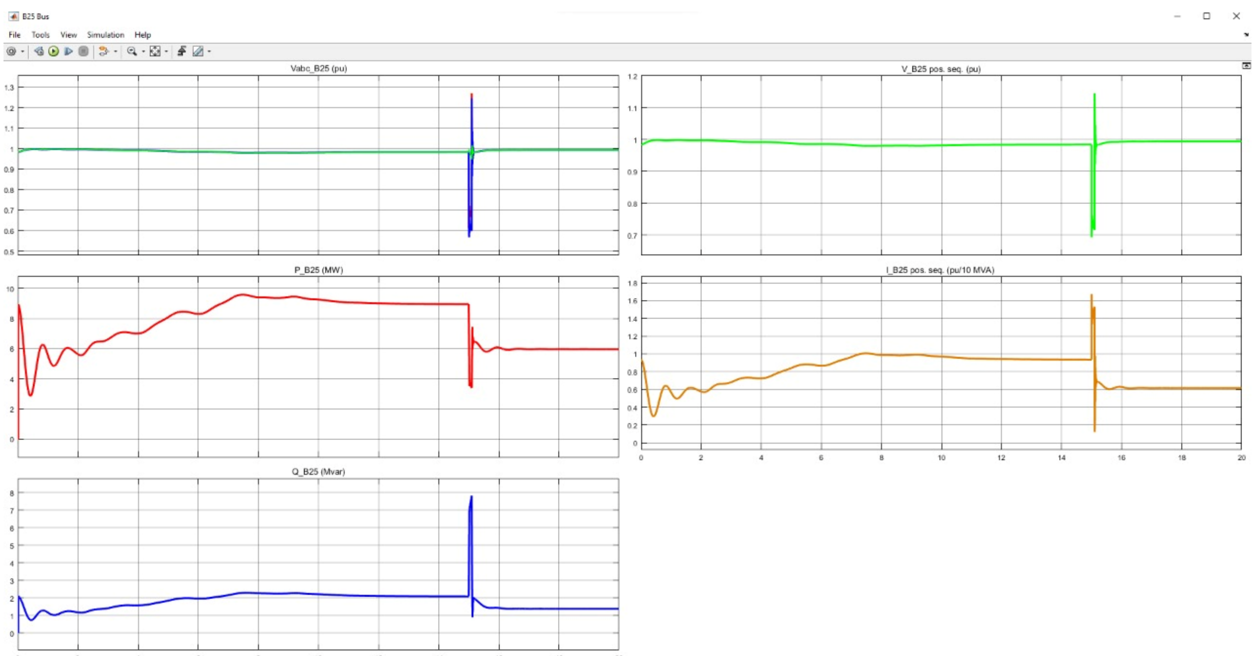


Fig.4. 7: Wind farm's B25-WF data acquisition.

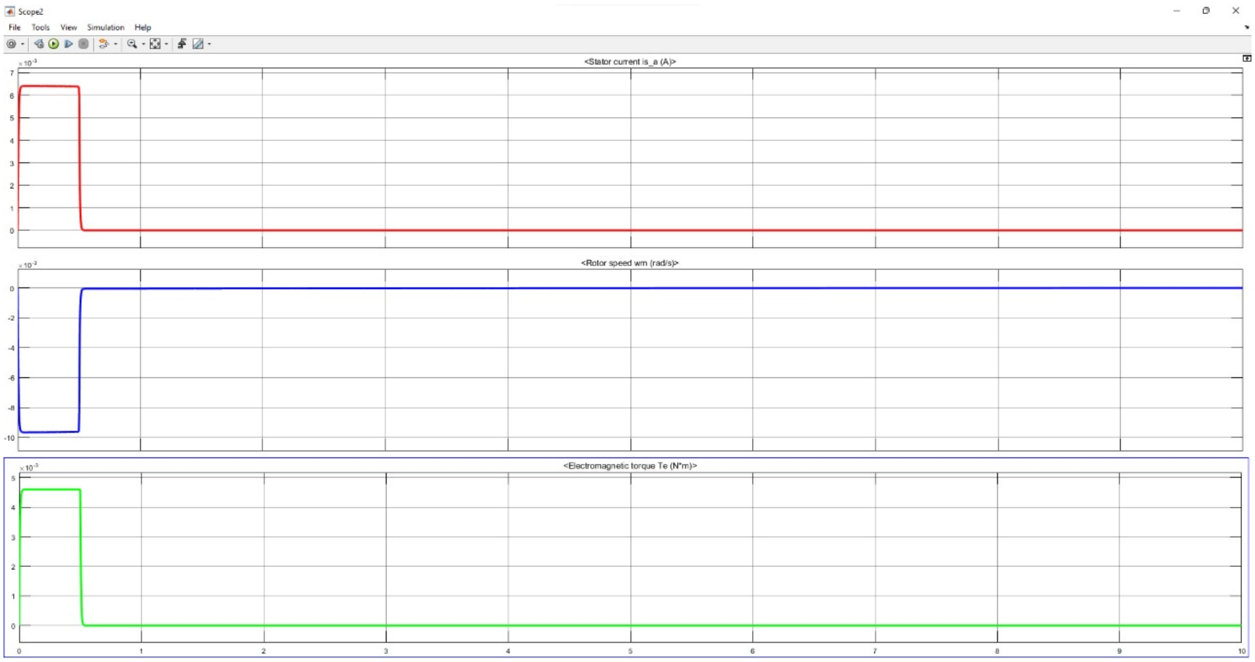


Fig.4. 8: Hybrid system's stator current, rotor speed and electromagnetic torque data acquisition.

4.1.2 Homer Results

Table. 1-One year weather data collection:[20]

Month	Monthly Average Temperature in (F)	Monthly Average cloud cover categories in %		Monthly Average rainfall	Monthly Average daylight hours	Monthly Average wind speed	Monthly Average incident shortwaves solar energy
		Cloudier	Clearer				
January	65	15	85	0.2”	10.9h	5.3mph	4.5kwh
February	71	13	87	0.5”	11.4h	5.5mph	5.4kwh
March	80	15	85	1.3”	12.0h	6.5mph	6.2kwh
April	84	21	79	3.4”	12.7h	8.3mph	6.4kwh
May	85	46	54	7.0”	13.3h	8.6mph	5.8kwh
June	85	79	21	9.2”	13.6h	9.6mph	4.9kwh
July	84	89	11	9.7”	13.4h	9.8mph	4.8kwh
August	84	89	11	8.1”	12.9h	8.5mph	4.7kwh
September	84	80	20	7.1”	12.3h	6.5mph	4.3kwh
October	81	44	56	3.9”	11.6h	4.8mph	4.7kwh
November	75	20	80	1.0”	11.0h	4.6mph	4.7kwh
December	68	17	83	0.3”	11.7h	4.8mph	4.3kwh
Average yearly temperature	79	44	56	4.3”	12.15h	6.9mph	5.05kwh

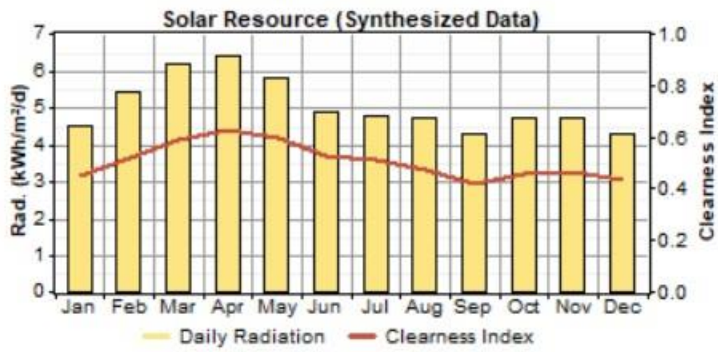


Fig.4. 9: Solar Synthesized data.

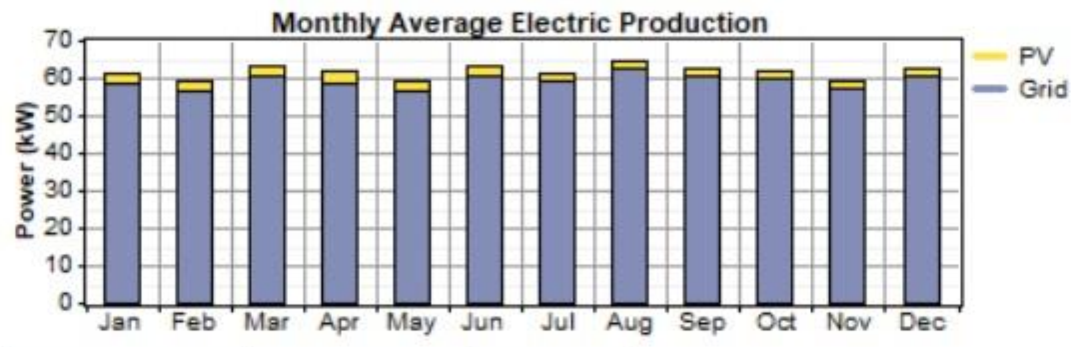


Fig.4. 10: PV system's Monthly average electric production.

Table. 2-PV system:

Quantity	Value	Unit
Rated capacity	14.0	KW
Mean output	2.36	KW
Mean output	56.7	KWh/d
Capacity factor	16.9	%
Total production	20,678	KWh/yr
Maximum output	13.3	KW
PV penetration	3.84	%
Hours of operation	4,380	hr/yr

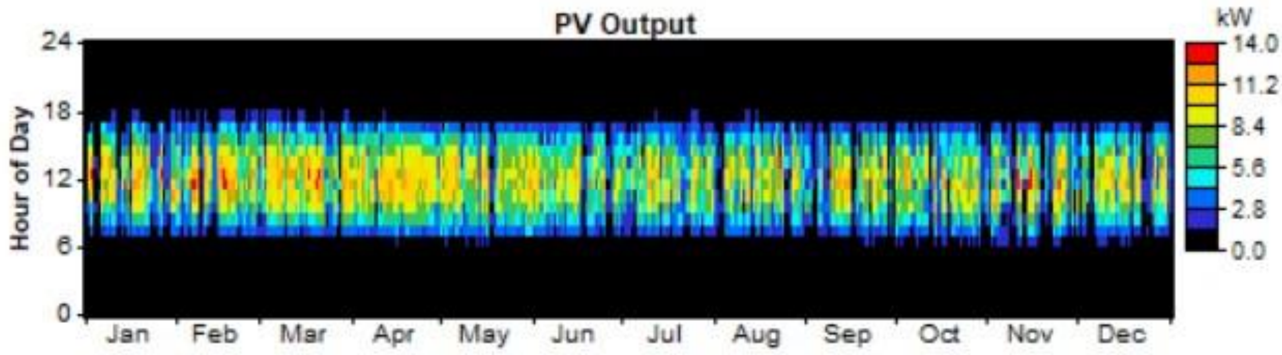


Fig.4. 11: PV output.

Table. 3-Inverter data:

Quantity	Inverter	Units
Capacity	15.0	KW
Mean output	2.1	KW
Maximum output	12.0	KW
Capacity factor	14.2	%
Hours of operation	4,380	Hrs/yr
Energy in	20,678	KWh/yr
Energy out	18,610	KWh/yr
Losses	2,068	KWh/yr

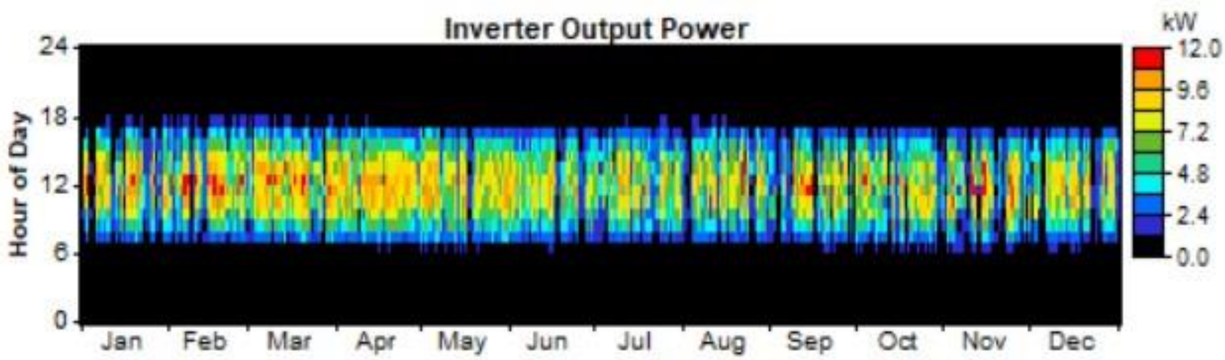


Fig.4. 12: PV system's Inverter output.

Fig.4. 13: Wind synthesized data.

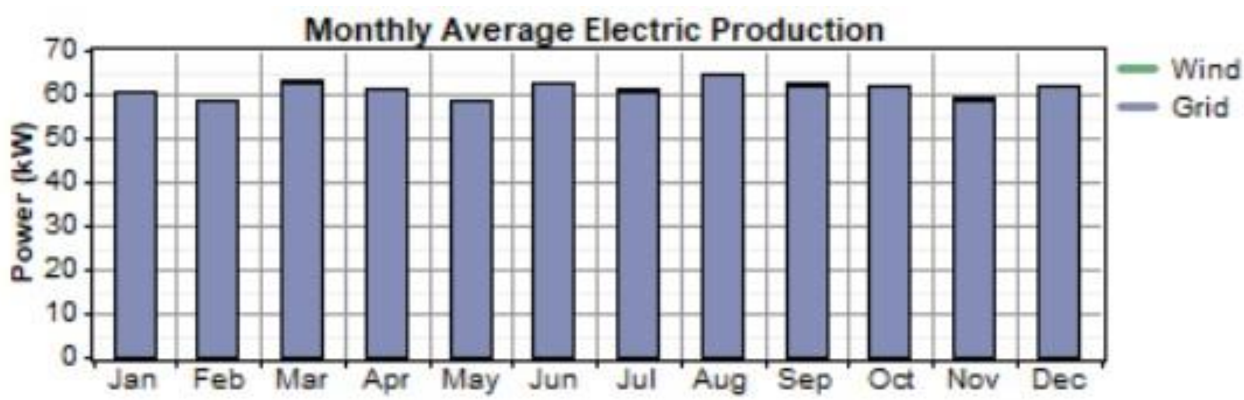


Fig.4. 14: Wind farm's Monthly average electric production.

Table. 4-DC wind turbine (SW AIR X):

Variable	Value	Units
Total rated capacity	2.00	KW
Mean output	0.261	KW
Capacity factor	13.1	%
Total production	2,289	KWh/yr
Maximum output	0.745	KW
Wind penetration	0.425	%
Hours of operation	7,365	hr/yr

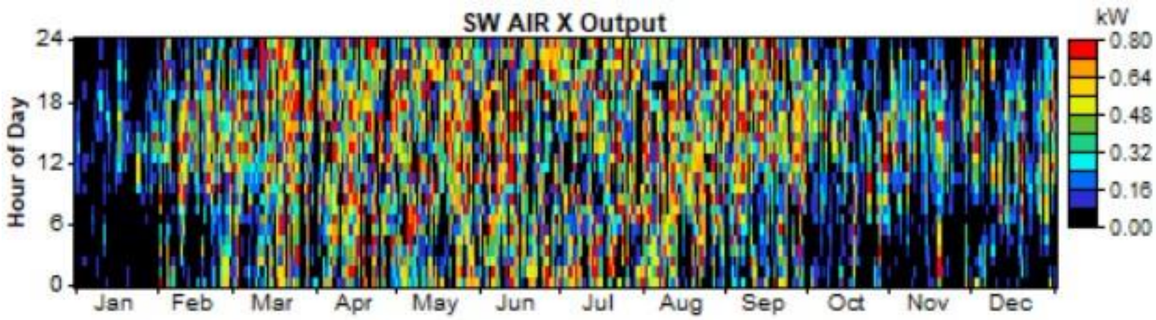


Fig.4. 15: Wind output

Table. 5-Inverter data:

Quantity	Inverter	Units
Capacity	15.0	KW
Mean output	0.2	KW
Maximum output	0.7	KW
Capacity factor	1.6	%
Hours of operation	7,365	hrs/yr
Energy in	2,289	KWh/yr
Energy out	2,060	KWh/yr
Losses	229	KWh/yr

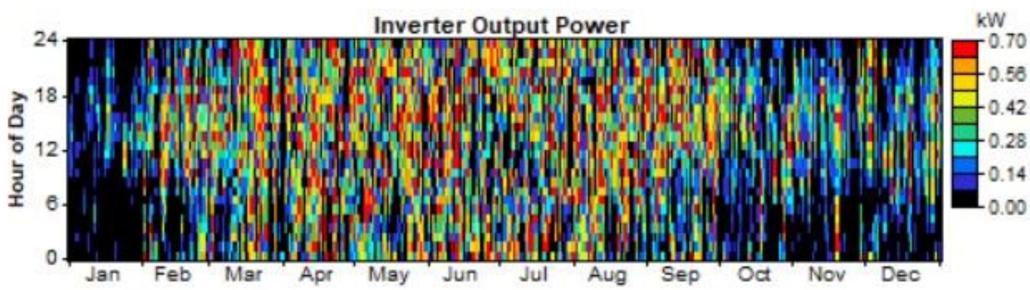


Fig.4. 16: Wind farm's Inverter output.

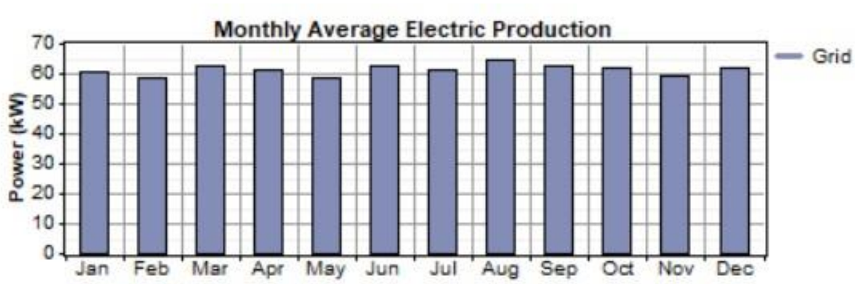


Fig.4. 17 Grid Load demand

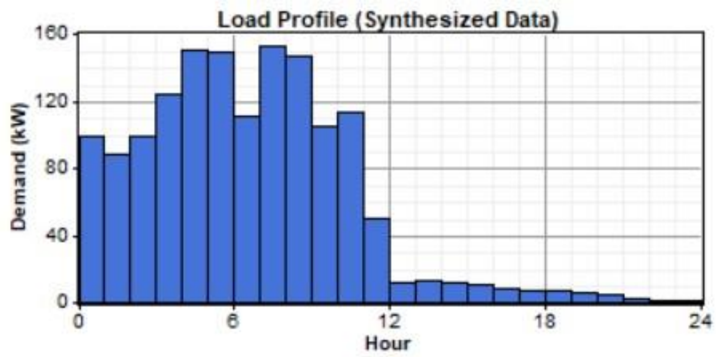


Fig.4. 18 Load synthesized data.

4.2 Result comparison

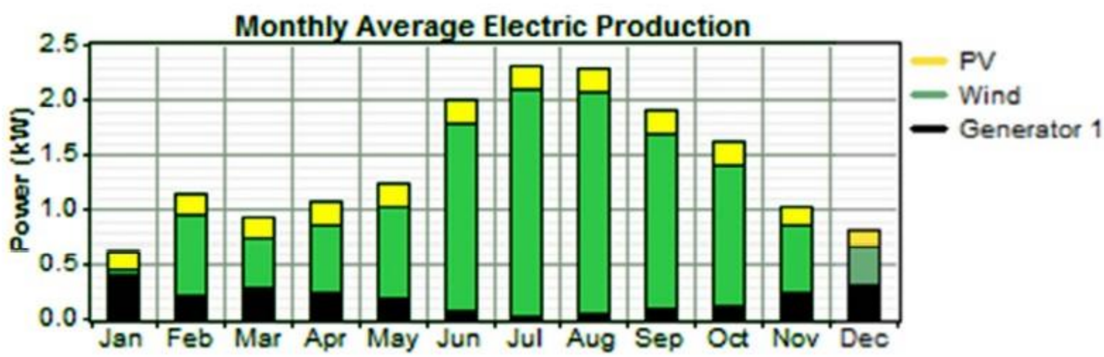


Fig.4. 19: Monthly average electric production of PV-generator hybrid for Zabol.[21]

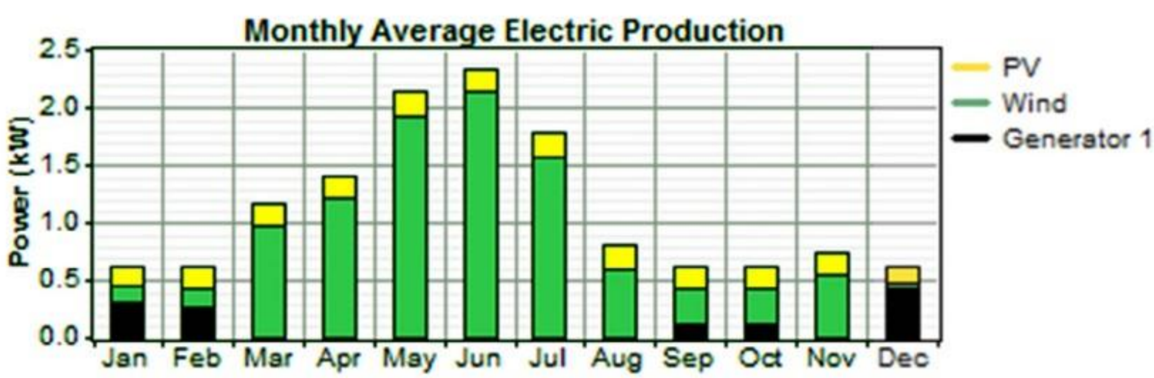


Fig.4. 20: Monthly average electric production of PV-generator hybrid for Zahak.[21]

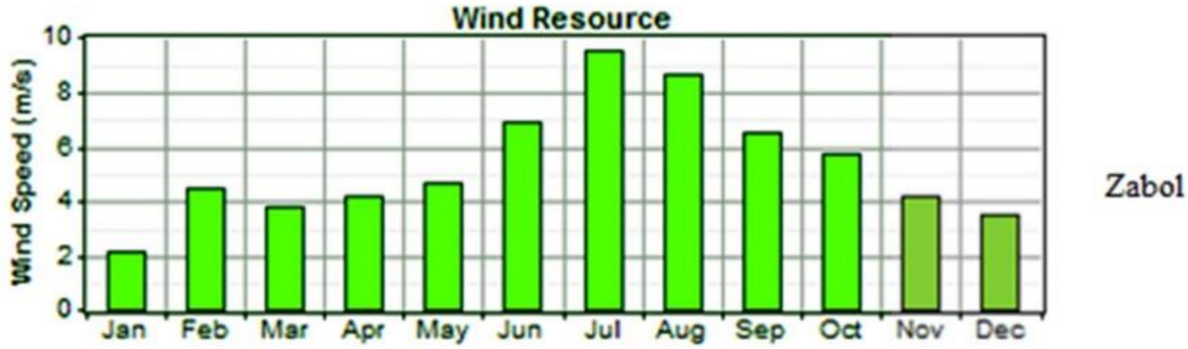


Fig.4. 21: Wind synthesized data for Zabol.[21]

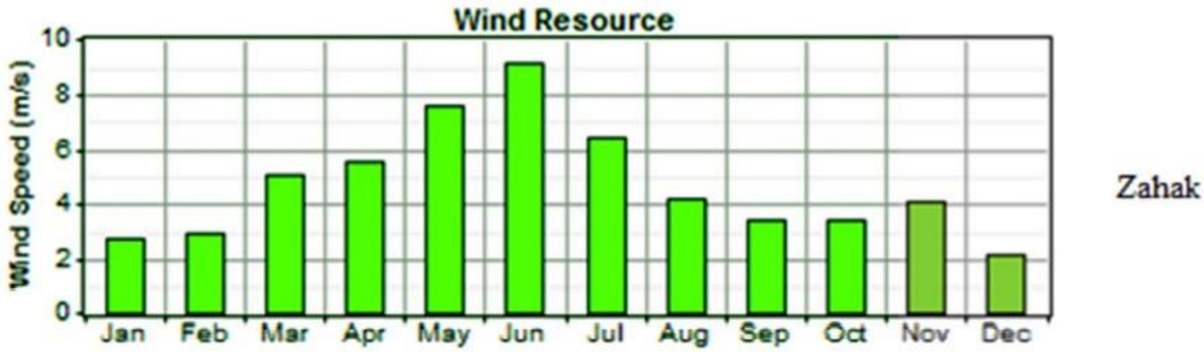


Fig.4. 22: Wind synthesized data for Zahak.[21]

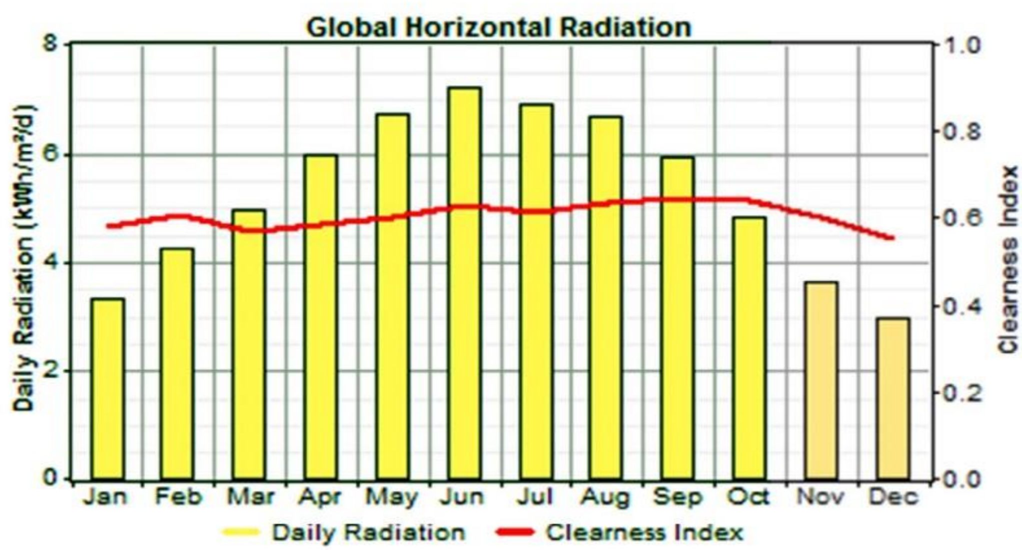


Fig.4. 23: Global horizontal radiation for Zabol.[21]

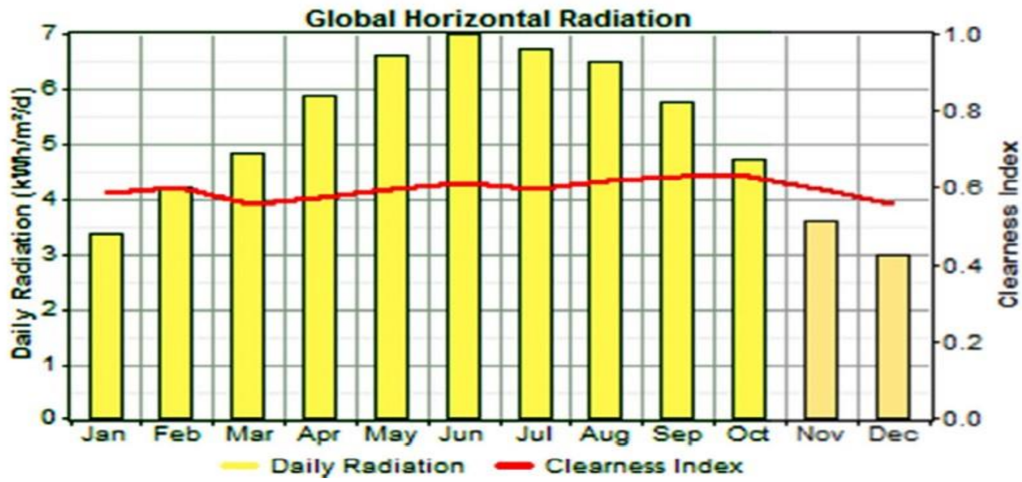


Fig.4. 24: Global horizontal radiation for Zahak.[21]

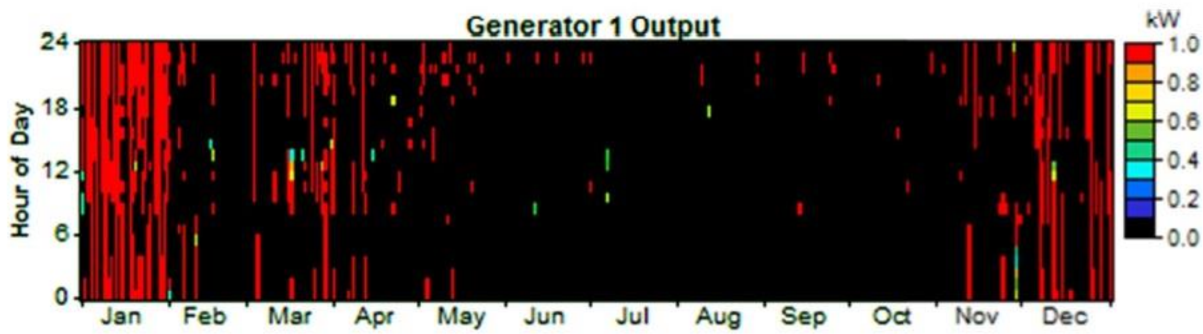


Fig.4. 25: Generator output Zabol.[21]

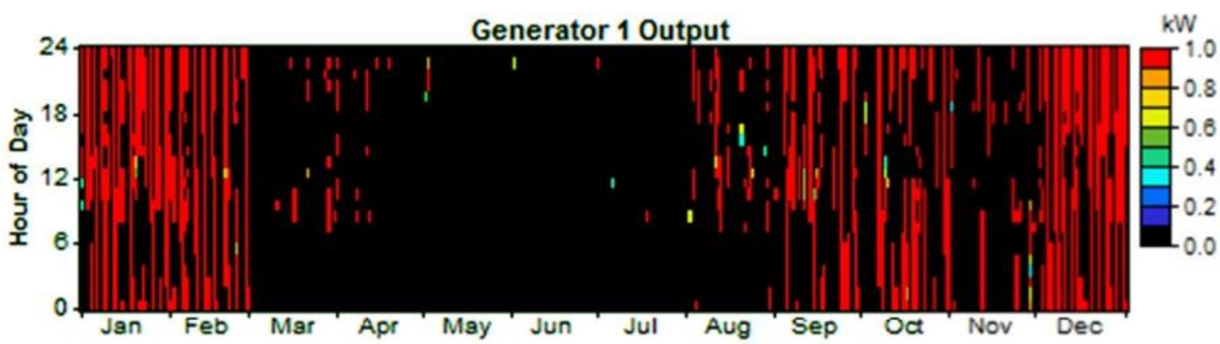


Fig.4. 26: Generator output Zahak.[21]

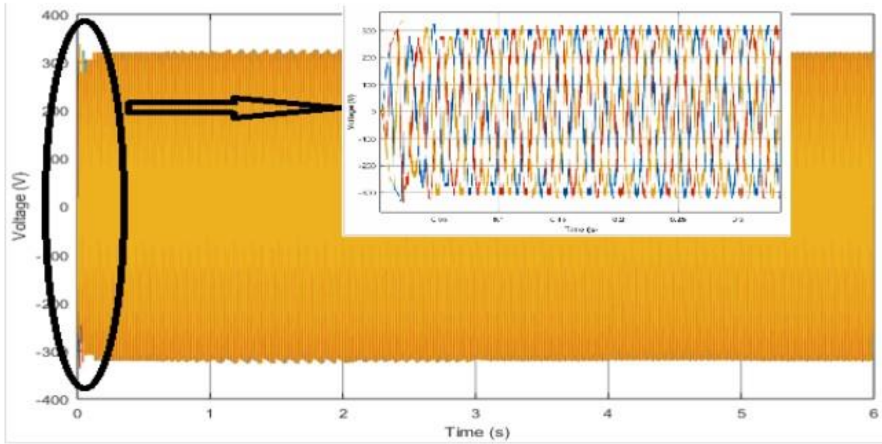


Fig.4. 27: Output voltage of Inverter.[9]

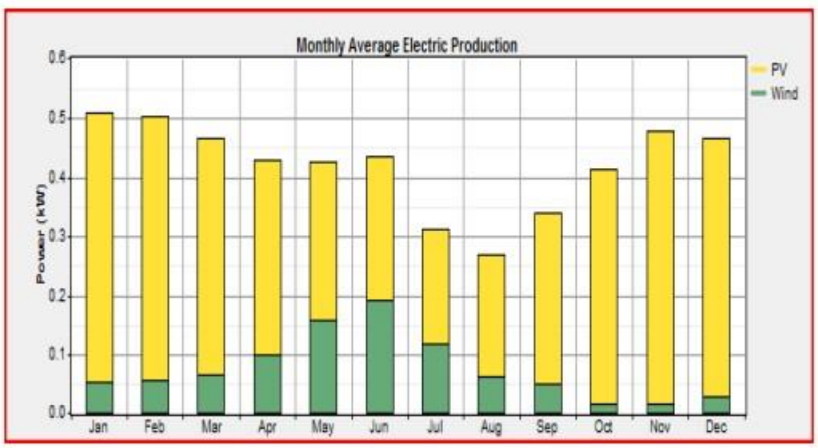


Fig.4. 28: Graphical representation of result for hybrid solar-wind

4.3 Discussions

The load-demand power has been determined successfully by us. We have been successful in determining the amount of electricity that we are able to provide to the grid on a monthly basis. We have been able to determine the amount of electricity that is generated by the wind farm on a monthly basis. We have been successful in determining the solar system's average monthly output of electricity. MATLAB was used to get the data and graph charts for the hybrid system's stator current, rotor speed, electromagnetic torque, and other variables. We gathered a year's worth of weather observations and analyzed the data using Homer.

CHAPTER 5

IMPACT ASSESSMENT

5.1 Economical, Societal and Global impact

We believe that this development of a stand-alone hybrid system will be able to provide an electricity supply to underdeveloped areas where electricity has not yet reached and where there are many issues with load shedding; furthermore, we believe that this development will be able to eliminate the issue of load shedding. It contributes to the advancement of our economic goals. This fusion of many types of growth would be beneficial to our society. Employment possibilities will be available as a result of this hybrid power plant. It makes up for the shortfall in the gross domestic product's need for power.

5.2 Environmental and Ethical issues

As a result of this development, the demand for energy will be satisfied, which will either cause an increase in the amount of carbon dioxide (CO2) emissions in the natural environment or a decrease in the total amount of carbon dioxide (CO2) emissions in the natural environment. Because solar and wind are forms of renewable energy that do not produce carbon dioxide emissions, our project plan will not lead to the release of any of those gases into the atmosphere.

CHAPTER 6

CONCLUSIONS

6.1 Conclusions

In this paper, a plan for a study describes in detail a hybrid system for turning renewable energy into usable energy. In rural or remote areas, a solar-wind hybrid stand-alone system is the best way to get power from renewable sources. These proposed system ideas are inexpensive and can be used all year. Solar and wind energy are the most common renewable energy sources. In the Simulink model, these two energy sources are modeled separately and then put together to make a distributed generation system. Due to how PI and MPPT control algorithms were made to work with each other, DC converters are made to make sure that the output values are stable in different situations. The DC busbar connection keeps different power levels from coming into contact with each other. This lets the energy conversion system work in a stable way.

6.2 New Skills and Experiences Learned

We were new to MATLAB and Homer, and we learned how to use them both as well as how to create subsystems in MATLAB. Our experience was extremely positive, which contributed to the development of our skills, and we gained knowledge of how to generate output and an HTML report with input from Homer.

6.3 Future Recommendations

The use of renewable energy systems that combine solar and wind power is growing at a steady rate and has shown extraordinary expansion over the last several decades for the generation of electricity in every region of the globe. The development of new technologies in the area of hybrid solar-wind renewable energy systems has resulted in the emergence of a new challenge, the solution to which has the potential to become much more interesting. These issues are going to be addressed in some upcoming study on the relevant subject, and they will be resolved.

The lists below show some possible directions for future research in this field:

- In order to determine the exact location and climatic conditions, site-by-site data is required, which is tough for distant locations. To figure out how much solar radiation and how fast the wind can be, you need a real optimization method and geographic software.

- By making the photovoltaic array able to take in more solar energy, the amount of electricity produced goes up.

- It is possible to make the wind turbine generator produce more energy.

- The development of a wireless system for the transfer of electricity is possible.

REFARANCE:

[1] Godson, J., Karthick, M., Muthukrishnan, T. and Sivagamasundari, M.S., 2013. Solar PV-Wind hybrid power generation System. International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, 2(11), pp.5350-5354.

[2] Kabalci, E., 2013. Design and analysis of a hybrid renewable energy plant with solar and wind power. Energy Conversion and Management, 72, pp.51-59.

[3] Abdali, A.L.M., Yakimovich, B.A. and Kuvshinov, V.V., 2018. Hybrid power generation by using solar and wind energy. energy, 2(3), pp.26-31.

[4] Fesli, U., Bayir, R. and Özer, M., 2009, November. Design and implementation of a domestic solar-wind hybrid energy system. In 2009 International Conference on Electrical and Electronics Engineering-ELECO 2009 (pp. I-29). IEEE.

[5] Khare, V., Nema, S. and Baredar, P., 2016. Solar–wind hybrid renewable energy system: A review.Renewable and Sustainable Energy Reviews, 58, pp.23-33.

[6] Dalwadi, P., Shrinet, V., Mehta, C.R. and Shah, P., 2011, December. Optimization of solar-wind hybrid system for distributed generation.In 2011 Nirma University International Conference on Engineering (pp. 1-4). IEEE.

[7] Castillo, J.P., Mafiolis, C.D., Escobar, E.C., Barrientos, A.G. and Segura, R.V., 2015. Design,construction and implementation of a low cost solar-wind hybrid energy system.IEEE Latin America Transactions, 13(10), pp.3304-3309.

[8] Yang, J., Yang, Z. and Duan, Y., 2021. Optimal capacity and operation strategy of a solar-wind hybrid renewable energy system.Energy Conversion and Management, 244, p.114519.

[9] Saidi, A. and Chellali, B., 2017, May. Simulation and control of Solar Wind hybrid renewable power system.In 2017 6th International Conference on Systems and Control (ICSC) (pp. 51-56). IEEE.

[10] Ganguly, P., Kalam, A. and Zayegh, A., 2018. Solar–wind hybrid renewable energy system: current status of research on configurations, control,and sizing methodologies. Hybrid-renewable energy systems in microgrids, pp.219-248.

[11] Available online: https://www.linquip.com/blog/a-complete-guide-to-solar-panel-output/

[12] Available online: https://www.mdpi.com/2411-5134/6/1/3

[13] Available online: https://www.mdpi.com/2411-5134/6/1/3

[14]Availableonline:https://www.tuvie.com/solar-powered-wind-turbine-with-a-new-set-of-spinning-solar-blades/

[15]Availableonline:https://www.google.com/search?q=wind%20propeller%20with%20adjust%20solar%20panel&tbm=isch&tbs=rimg:CSyVznSlFolfYZoNnp-en0yz8AEAsgIMCgIIABAAOgQIABAB&hl=en&sa=X&ved=0CB0QuIIBahcKEwjQ_9j2nNn7AhUAAAAAHQAAAAAQGA&biw=1519&bih=688#imgrc=3RGDIPgYg4wkpM

[16] Mayordomo, I., Dräger, T., Spies, P., Bernhard, J. and Pflaum, A., 2013. An overview of technical challenges and advances of inductive wireless power transmission. Proceedings of the IEEE, 101(6), pp.1302-1311.

[17] https://www.inverter.com/mppt-solar-controller-working-principle

[18] https://www.mathworks.com/

[19] https://www.mathworks.com/help/sps/powersys/ref/threephasepisectionline.html

[20]https://weatherspark.com/y/111858/Average-Weather-in-Dhaka-Bangladesh-Year-Round#Sections-Humidity

[21] Razmjoo, A., Shirmohammadi, R., Davarpanah, A., Pourfayaz, F. and Aslani, A., 2019. Stand-alone hybrid energy systems for remote area power generation. Energy reports, 5, pp.231-241.