Ministry of Higher Education and Scientific Research

Al-Mustaqbal University

Air Conditioning and Refrigeration Engineering Department

Design and Implementation of a Hybrid Solar-Wind Power Generation System for Sustainable Electricity Supply

Graduation Project Submitted to the department of Air Conditioning and Refrigeration Engineering Technology/Al-Mustaqbal University in fulfillment of the Requirements for obtaining a Bachelors' Degree

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2026 A.D **1448 A.H**

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﴿يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ وَاللَّهُ بِمَا تَعْمَلُونَ خَبِيرٌ﴾

صدق الله العظيم

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I certify that this project, entitled **" Design and Implementation of a Hybrid Solar-Wind Power Generation System for Sustainable Electricity Supply"** was prepared by the students under our supervision of Assist. Lect. Abrar Abdulkareem Saeed at Al-Mustaqbal University, College of Technical Engineering, in partial fulfillment of the requirements for the degree of Bachelor of Science in Refrigeration and Air Conditioning Engineering.

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Abstract

The increasing demand for clean and sustainable energy has encouraged the development of hybrid renewable energy systems that combine multiple energy sources to improve reliability and efficiency. This project presents the design and implementation of a hybrid solar-wind energy system for sustainable power generation. The system integrates photovoltaic (PV) solar panels and a small-scale wind turbine to harness energy from both solar radiation and wind resources.

The practical implementation of the project includes the selection and installation of the main system components, such as solar panels, a wind turbine, charge controllers, a battery storage unit, and a power management circuit. The generated electrical energy from both sources is combined and regulated to provide a stable power output while ensuring efficient battery charging and energy utilization.

Experimental tests were conducted under different environmental conditions to evaluate the performance of the hybrid system. The results demonstrated that the integration of solar and wind energy sources enhances the overall energy production and improves system reliability compared to using a single renewable source. The hybrid configuration was able to maintain power generation during periods of low solar irradiance or weak wind conditions, thereby increasing the availability of sustainable energy.

The proposed hybrid solar-wind system offers an environmentally friendly and cost-effective solution for renewable energy generation, particularly in areas with variable weather conditions. The project highlights the potential of hybrid renewable energy technologies in supporting sustainable development and reducing dependence on conventional fossil-fuel-based energy sources.

Chapter One

Introduction

1.1 Background

In recent decades, the global demand for energy has increased dramatically due to rapid population growth, industrial expansion, and technological advancement. Traditional energy sources such as fossil fuels (oil, coal, and natural gas) have long been the primary contributors to electricity generation. However, these sources are finite, environmentally harmful, and contribute significantly to greenhouse gas emissions, which are a leading cause of climate change and global warming. As a result, there is an urgent need to transition toward clean, renewable, and sustainable energy solutions.

Renewable energy sources, including solar and wind energy, have emerged as promising alternatives due to their abundance, environmental friendliness, and long-term sustainability. Solar energy harnesses the power of sunlight using photovoltaic (PV) panels, while wind energy converts kinetic energy from wind into electrical energy using wind turbines. Both sources are clean and renewable; however, they are inherently intermittent and dependent on environmental conditions such as sunlight availability and wind speed.



To overcome the limitations associated with individual renewable energy systems, hybrid energy systems have been developed. A hybrid solar-wind power generation system integrates both solar and wind energy sources to provide a more reliable and continuous electricity supply. This approach ensures that when one energy source is unavailable or insufficient, the other can compensate, thereby improving overall system efficiency and reliability.

1.2 Problem Statement

Despite the advantages of renewable energy systems, standalone solar or wind systems face several challenges. Solar energy systems cannot generate electricity during nighttime and are less efficient during cloudy or rainy conditions. Similarly, wind energy systems depend heavily on wind availability, which can be unpredictable and inconsistent.

In many regions, particularly remote or rural areas, access to a stable electricity supply remains a significant challenge. Extending conventional grid infrastructure to such areas is often

costly and impractical. Therefore, there is a need for an efficient, cost-effective, and reliable alternative solution that can ensure continuous power supply under varying environmental conditions.

The integration of solar and wind energy into a hybrid system presents a viable solution to these challenges. However, designing and implementing such systems requires careful consideration of system components, control strategies, energy storage, and load management to ensure optimal performance.

1.3 Aim and Objectives of the Project

The main aim of this project is to design and implement a hybrid solar-wind power generation system capable of providing a sustainable and reliable electricity supply.

To achieve this aim, the following objectives are identified:

To study the principles and characteristics of solar and wind energy systems.

To design a hybrid system that integrates both solar panels and wind turbines.

To develop a control system for efficient energy management.

To incorporate energy storage (such as batteries) to ensure continuous power supply.

To evaluate the performance, efficiency, and reliability of the hybrid system.

To analyze the economic and environmental benefits of the proposed system.

1.4 Significance of the Study

This project is of great importance in the context of global efforts to reduce dependence on fossil fuels and mitigate climate change. By combining solar and wind energy, the hybrid system enhances energy reliability and efficiency while reducing environmental impact.

The significance of this study can be summarized as follows:

Environmental Benefits: The system reduces carbon emissions and promotes clean energy usage.

Energy Reliability: Combining two energy sources ensures a more stable and continuous power supply.

Cost-Effectiveness: Reduces long-term energy costs, especially in off-grid areas.

Sustainability: Supports sustainable development goals related to clean and affordable energy.

Applicability: Can be implemented in remote areas, rural communities, and small-scale applications.

1.5 Scope of the Project

This project focuses on the design and implementation of a small-scale hybrid solar-wind power generation system. The scope includes:

Designing the system architecture including solar panels, wind turbine, charge controller, inverter, and battery storage.

Selecting appropriate components based on load requirements.

Implementing the system practically or through simulation.

Analyzing system performance under different environmental conditions.

Evaluating system efficiency and reliability.

The project does not cover large-scale grid integration or advanced forecasting techniques but focuses on a practical and educational implementation suitable for academic purposes.

Chapter Two

Literature Review

2.1 Introduction

The ultimate source of energy for power generation is from non-renewable sources of energy such as fossil-fuels. The alternate way to preserve these resources is to depend fully on the renewable sources available in plenty. This research aims in developing a hybrid system utilizing the solar and wind power available in nature to meet the energy demands of the world. The paper aims in describing the techniques involved for controlling and tracking of maximum power from solar and wind energy. Here the system includes a solar, wind, power converters and a battery. Here are some previous studies about hybrid solar-wind system.

2.2 Previous studies

Development and design of a hybrid system utilizing the solar and wind energy sources with the help of a microcontroller. This model is mainly adopted for domestic purpose applications. Photovoltaic cells help to convert the solar energy into electrical energy or heat energy. This system is mainly of two types one is line dependent and line independent. The line dependent system is not in need of batteries for storing energy. It directly supplies the energy to the demand with the help of an inverter. This line system is also used at times of low sun beam. The line independent system, as the absence of line electricity batteries or accumulators are required for supplying energy at times of demand. The dc output needs to be converted to ac for supplying to electrical appliances. The wind energy is based on the capacity for producing power.(Fesli, Bayir et al. 2009)

A solar-wind hybrid power generation system which is becoming economical on considering the life cycle cost and the environmental benefits. Hybrid systems have an advantage of maintaining a balanced system with uninterrupted power supply from any of the sources. The energy produced by this combination is fed to a hybrid controller. Then it is supplied to a battery for load requirements. The hybrid controller used here is a microcontroller. This controller has a control over the voltage generated by solar and wind to be fed to the battery. This system is supported by a relay which gives an alarm when an over current or over voltage is

detected. This paper also summaries the details regarding the life cycle cost of a hybrid system such as initial capital cost, replacement cost for a battery and maintenance and operation cost.(Katti 2012).

This paper describes about the hybrid PV-wind system connected to grid and the techniques involved for maximum power tracking in wind and solar. In wind energy system, variable speed wind turbines along with permanent magnet synchronous generator is used. This system provides high reliability and efficient output without the help of any external support. There are dc link converters connected to grid to maintain constant voltage. In PV systems, the load is connected directly to grid. The whole system is examined using the MATLAB software. (Gowtham and Royrichard 2014)

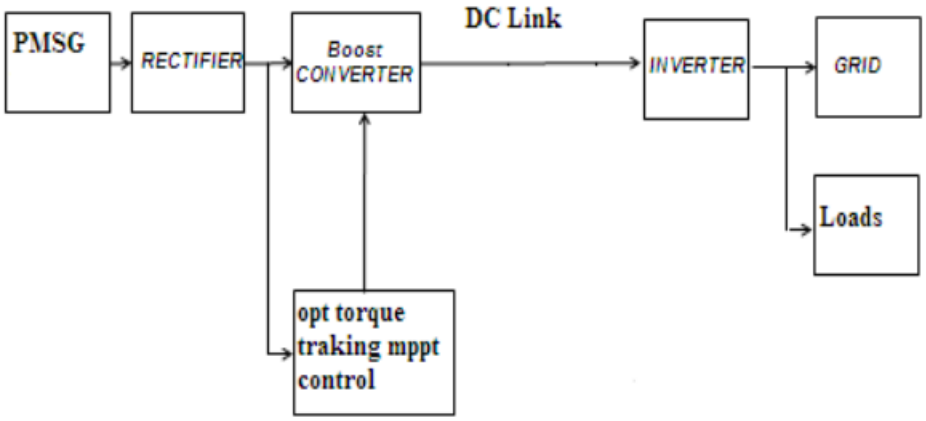


Fig.2.1 Block diagram for a wind energy conversion system(Gowtham and Royrichard 2014)

The above figure 2.1 is the block diagram for a wind energy conversion system. In a wind turbine system for energy conversion, the system has a permanent magnet synchronous generator, a threephase rectifier, a boost converter used to control the optimum torque tracking is connected to dc system which is further connected to grid through an inverter. The main purpose of optimum torque 11 tracking in wind energy conversion system is to attain maximum power from wind turbines. It also measures the speed produced, reference torque generated and the reference DC. The reference torque is compared with the calculated torque. If the reference torque is less

than measured torque the generator speed will increase. If the reference torque is higher than the measured torque the generator speed is decreased.

The paper highlights the different methods used for maximum power point tracking in hybrid solar wind system with the perturbation tracking algorithm. Due to DC/DC charging unit, the whole 12 circuit and control unit is simplified. With the maximum power point tracking technique, the output from the solar and wind is separately controlled. Due to control methods, the system becomes complex and the production cost is high therefore, the total output production is controlled by MPPT tracking at maximum power point. By recognizing the maximum power from wind or solar the MPPT algorithm tracks accordingly. This is simulated in MATLAB software for various tracking of maximum power. The MPPT techniques allows the system to work near to the maximum power point. For wind, tip speed ratio control, power signal control methods are used to have MPPT while in PV systems, observation perturbation method, constant voltage control method and incremental conductance methods are used to attain the MPPT. The simulation results apply not only for the controlling methods of the hybrid solar-wind system but also the output current of the system is stable and reliable. The impact of overcharging on batteries are reduced.(Huang, Xu et al. 2011)

Paper studies about the availability of solar and wind resource in India. The major drawback in implementing the solar and wind resource is the intermittency. This is mainly because of the varying climatic conditions. Sudden variations in the energy supply leads to destabilization of the grids causing interruption in the power supply. The problem of intermittency can be solved by choosing the geographical area where the availability of the one resource or the other is in abundant. Study aims in finding the site where the resource is available in plenty and the power to grid can be met without the intermittency.(Lolla, Roy et al. 2015)

A paper describes the renewable energy source in India and details about the solar and wind power target the country is about to achieve in the year 2022. This paper also pointed out the power quality issues the power sector faces on combining renewable energy sources for energy generation. The main reason to depend on renewable energy for power generation is high demand and exhausting of other natural resources due to continuous use. The solar and wind energy are combined to form a hybrid system which is integrated to grid for the generation of power by the converters to convert the DC power to AC power. Due to variation and unavailability of power, it may result in unstable operation, power fluctuations, transients, faulty conditions. Therefore the use of power electronic devices and depending on renewable energy these integration can lead to power quality issues. (Aggarwal and Nijhawan 2016).

For the complete modelling of solar PV system, it includes the MPPT of incremental conductance with internal regulator, a boost converter to boost up and regulate the DC output power of PV array, an inverter to convert the DC into AC output for that a three phase three level voltage source converter is being used. The inverter is controlled using the gate signal in the IGBT during its ON and OFF period. An inverter control loop is designed to generate the signals. With the help of these loops controlled PWM signals are generated and the IGBT switches in inverter is controlled. Thus, giving an output of three phase sinusoidal voltage and currents. To reduce the harmonics of inverter current LC filters are used at the output of inverter. The model designed with PV array connected to grid is observed for varying temperature and solar radiations. The studies say solar radiation has much more affect than temperature on the power output. At times of high irradiance, the output from inverter is higher than load demand therefore power flows to grid whereas at low irradiance if output is less grid supplies power. (Atiq and Soori 2016)

Based on the mathematical equations the PV model is made in Simulink. The PV cells directly converts the solar energy into electricity. It has output characteristics such as I-V and P-V. The system works under standard

conditions of temperature 28°C and solar irradiance of 1000W/m2 . The system includes the calculation of short circuit current, open circuit voltage, current at maximum power, voltage at maximum power, and photon current which altogether forms complete model of PV array. Wind energy is derived from the moving energy of wind. Kinetic energy is transformed to mechanical energy using wind turbine. The density of air and velocity of wind influence the magnitude of change in mechanical energy. The ideal wind energy model is designed based on three different operating regions with different wind speed and these are cutin-wind speed, rated wind speed and cut-out wind speed respectively. (Anjali Rana 2015).

The output from solar is dc therefore it needs to be converted to ac before suppling to grid. While the output energy generated from wind is directly supplied to the grid. The multilevel inverter used with PV system acts as a controller at the Point of Common Coupling (PCC) reducing the Total Harmonic Distortions (THD). Under standard conditions the solar PV model is simulated using a controller and without using controller. The results show that the load current, source voltage and source current while plotting with respect to time the source voltage is sinusoidal, and the current from the source and the current from load are same and nonsinusoidal. When the system is simulated using a seven-level multilevel inverter with level shifted carrier pulse width modulation. The output source voltage, source current and load current are in sinusoidal waveforms when using a controller. Controller helps to reduce THD in PV systems. In hardware model designed using hybrid solar and wind for a single phase is developed. The solar PV energy is supplied to grid through a multilevel inverter. This seven-level inverter reduces the voltage sag and swell in the PCC of the system. Power supply unit includes step down transformer, bridge rectifier, filter and voltage regulator. the output voltage is increased with use of controller. (Zade, Gaikwad et al. 2016).

Chapter Three

Mythology and Experimental Part

3.1 Introduction

Energy captured from the radiation of sun is called solar energy. It is present abundantly over the earth surface and is freely accessible. The energy from sun is pollution free and highly efficient source with low cost. PV panels are used for generating electricity from sun's energy. Solar panels are used as the medium for the conversion of energy into heat or electricity. The solar panels are made using semiconductor materials. The semiconductor material used in the solar cells are silicon where the sunlight strikes the surface of cell and gets absorbed. Basically, the solar cells functions like diode with PN junction formed in the material. As the sunlight falls over the surface of material energy gets absorbed allowing the electrons to move freely. The flow of electrons results in generation of electric current. The principle used behind the conversation of solar energy to electric power is termed as photo electric effect.(Sivaramakrishna and Reddy 2013, Ingole and Rakhonde 2015).

Solar panels are formed by combining the PV cells. PV cells are connected to form a PV module and PV modules are further interconnected to get the required PV panels or arrays. Usually, PV cells are normally in the range of 36 or 96 cells in a module. Based on the load demands the cells are connected either in series or parallel combination. Like the cell arrangement the modules will also be connected either in series or parallel combinations. For high output voltage the PV cells are arranged in series and for high output current the PV cells are arranged in parallel manner. Initially in a solar panel the cells are connected in series sequence to get the desired voltage and so formed strings are parallelly connected to obtain the desired current.(Sivaramakrishna and Reddy 2013, Ingole and Rakhonde 2015)

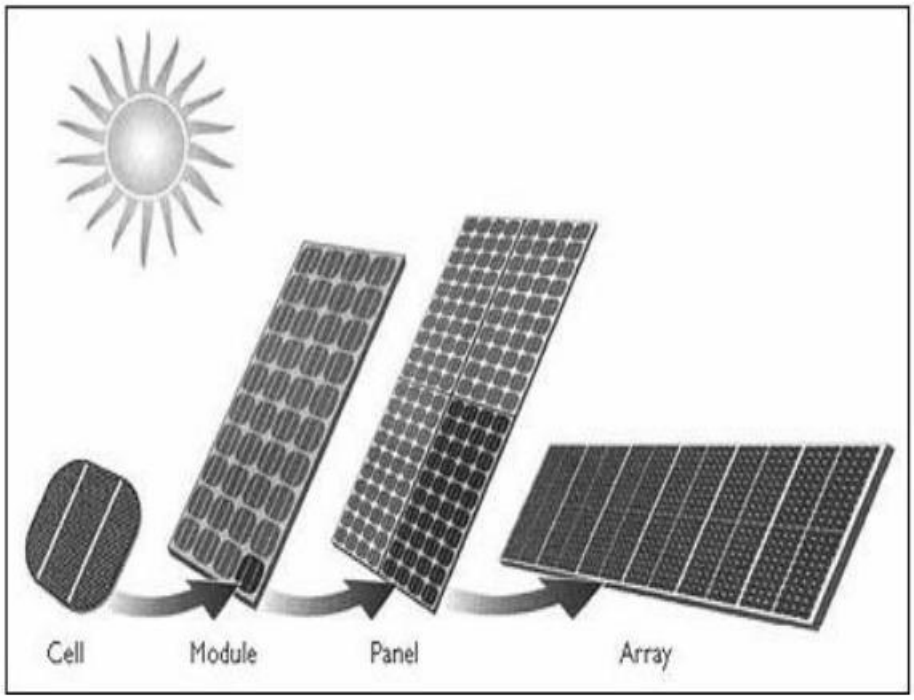


Fig 3.1: From PV Cell to PV Module to PV Panel to PV Array.

The radiation from the sun is made to fall on the solar panels. These solar panels are made from 21 Photovoltaic silicon semi-conductor materials. Due to the photoelectric effect of PV cells the sun's energy is directly converted to electricity. The DC output from the solar panels are fed to the input of converters. Maximum Power Point Tracking techniques are used along with the system to track the maximum solar energy and these pulses are supplied to the converter. Converters are used for supplying a regulated DC output by transforming the voltage from one level to other level. The converter takes the input signal from solar panels and gives a controlled DC output. The controlled DC output from converters are fed to the inverter input convert to AC output, which is to be supplied to the grid or the load.

3.2 Experimental Apparatus

The apparatus consists of a 670 watt solar panel connected to a wind turbine using MPPT, Two batteries of 12 volt each connected in series and Two lamps representing the load to test the generated electricity.

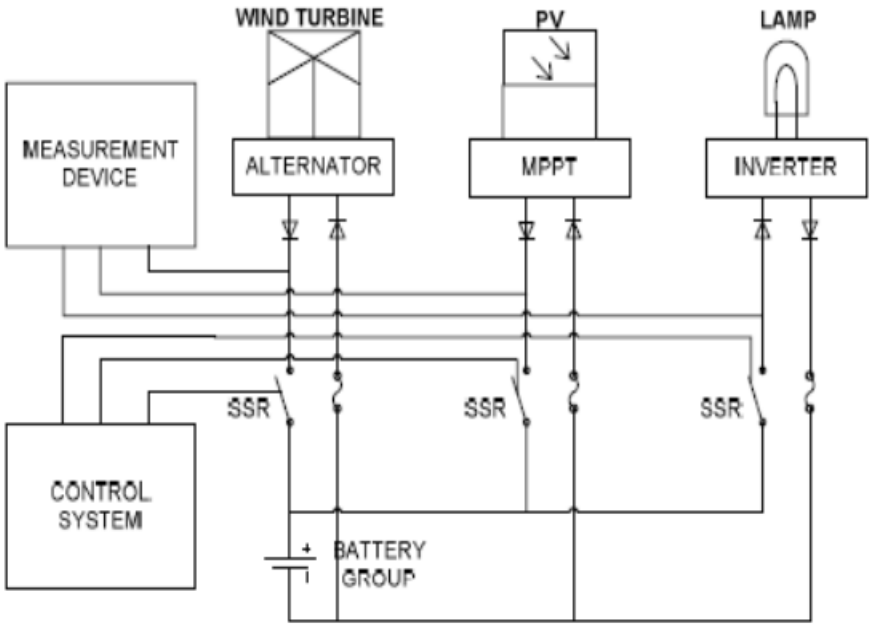


Fig.3.1: Block diagram represents the Hybrid solar-wind system

This paper details about a solar-wind hybrid power generation system which is becoming economical on considering the life cycle cost and the environmental benefits. Hybrid systems have an advantage of maintaining a balanced system with uninterrupted power supply from any of the sources. The energy produced by this combination is fed to a hybrid controller. Then it is supplied to a battery for load requirements. The hybrid controller used here is a microcontroller. This controller has a control over the voltage generated by solar and wind to be fed to the battery.

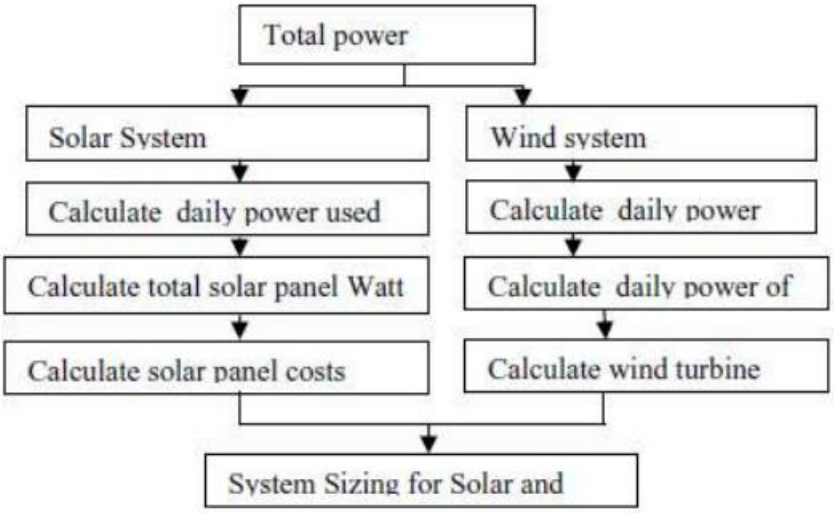


Fig.3.2: Flow chart



Fig.3.3 Experimental Appratus

3.3Wind Turbine

Wind energy is one the most promising renewable source of energy to meet the growing demands of the world. It is environmental friendly and clean form of energy. The motion of air is termed as wind. The kinetic energy derived from the wind using wind turbines are converted to mechanical energy. This mechanical energy is further converted into electrical energy using generators. Different types of generators are available for wind energy generation and the most commonly used are permanent magnet synchronous generator(PMSG) and induction generators(IG). The field of excitation is provided by permanent magnets rather than excitation coils in permanent magnet synchronous generators. This is most commonly used in commercial purpose for electricity generation. These generators are termed as synchronous generators because the rotor speed always matches with the supply frequency. In high power applications permanent synchronous generators are mostly used because of low cost and maintenance, doesn't require a dc supply for excitation and high efficiency.

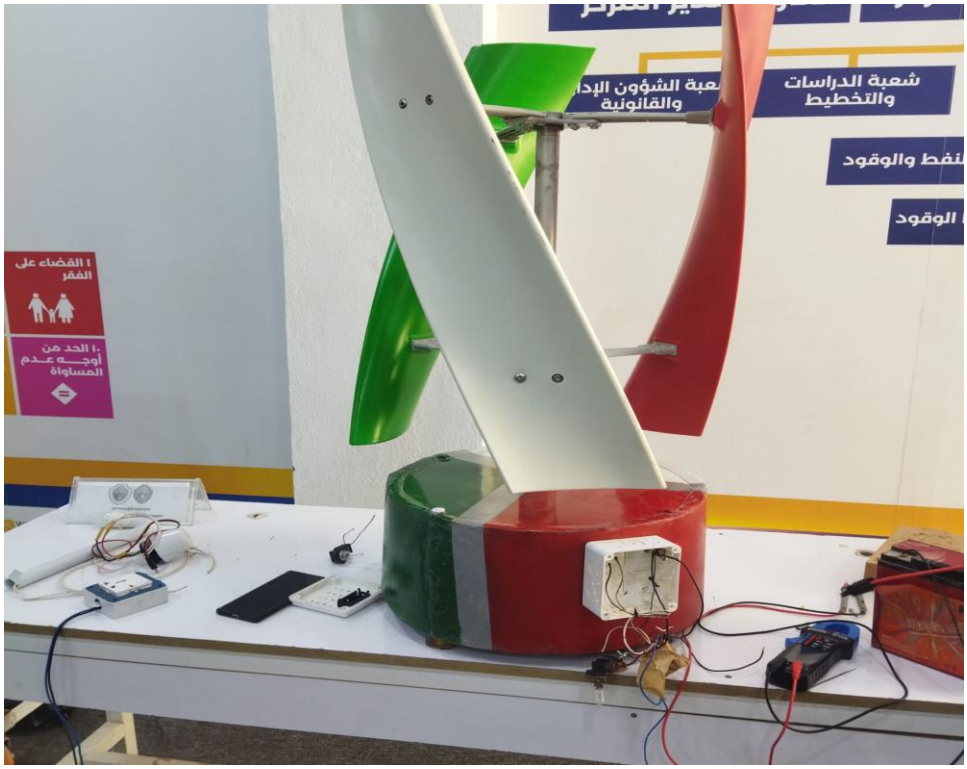


Fig.3.4: Wind Turbine

The permanent magnet synchronous generators convert the mechanical power produced by the wind turbine into electrical power. Later this power is fed to the grid or load through power electronic devices.

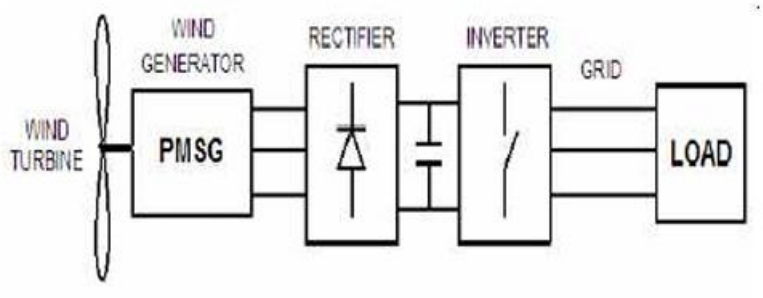


Fig.3.5: Diagram of wind energy conversion system

3.4 Solar Panel

Based on the mathematical equations the PV model is made in Simulink. The PV cells directly converts the solar energy into electricity. It has output characteristics such as I-V and P-V. The system works under standard conditions of temperature 28°C and solar irradiance of 1000W/m2. The system includes the calculation of short circuit current, open circuit voltage, current at maximum power, voltage at maximum power, and photon current which altogether forms complete model of PV array. A 660 watt solar panel was utilized.



Fig.3.6: Solar Panel as part of the hybrid system

3.5 Batteries

Two batteries were used in this apparatus of 12 volt each to give 24 volt since they were connected in series. The main porpuse of using batteries is to store the electric energy coming from the hybrid system and use it in the absence of the sun or wind.



Fig.3.7: Battery

3.6 MPPT

An MPPT (Maximum Power Point Tracking) charge controller is a high-efficiency solar regulator that converts excess voltage from solar panels into amperage (current), increasing battery charging efficiency by 20–45% compared to standard controllers. It works by continuously tracking the panel's optimal power output, even in changing weather or temperatures, to ensure maximum energy is stored. Moreover, it blends the energy coming from two sources(solar panel and win turbine) to give the stable output power.



Fig.3.8: MPPT

Wind energy is derived from the moving energy of wind. Kinetic energy is transformed to mechanical energy using wind turbine. The density of air and velocity of wind influence the magnitude of change in mechanical energy. The ideal wind energy model is designed based on three different operating regions with different wind speed and these are cut in-wind speed, rated wind speed and cut-out wind speed respectively

The complete hybrid model is designed to increase the efficiency thus increasing the output energy of the system thus reducing the need for a storage. The hybrid system is more efficient reliable and cost effective comparing to single systems. The generated DC output is converted to AC based on grid frequency with the help of MPPT .

Chapter Four

Results and Discussion

4.1 Experimental Values

The values of the electrical current were estimated and recorded within a week in normal conditions, where it shows the values from the solar panel, the wind turbine and combined together:

Table 4.1: Electric current

Day	Solar panel Current(A)	Wind turbine Current(A)	Combined Current(A)
Sunday	**2.7**	**2.5**	**5.2**
Monday	**2.8**	**3**	**5.8**
Tuesday	**2.9**	**2.7**	**5.6**
Wednesday	**3**	**2.1**	**5.1**
Thursday	**3.2**	**2.3**	**5.5**
Friday	**3.3**	**2.5**	**5.8**
Saturday	**3.3**	**3.7**	**7**

The results shows the values of the electric current measured in Ampere.

It is noticeable that the fluctuation in the values because of the fluctuations in the solar array and the wind speed.

It is important to mention that the temperature differences during seven days were clarified in the figure below starting from Sunday till Saturday in Hillah.

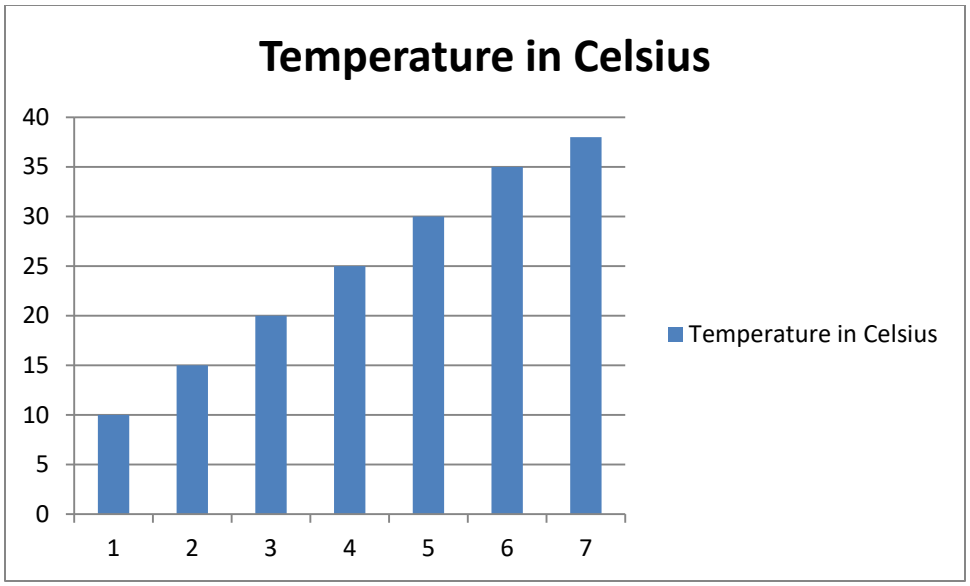


Fig.4.1: Temperature in Celsius starting from Sunday (day1) till Saturday (day7)

Moreover, The wind speed that was recorded can be shown in Table below:

Table:4.2 Wind Speed Values

Estimated Current	Wind Speed in m/s	Wind Speed in Km/h
2.5	6.2	22.8
3	7.4	26.6
2.7	6.1	22.7
2.1	5.2	18.7
2.3	5.4	18.9
2.5	5.8	19.3
3.7	8	28.8

It is worthy to mention that the evaluated current increases when the speed of the wind increased since the angular velocity of the turbine increases which will lead to an increase in the output power.

4.2 Power of the system

The power of the system can be calculated from the equation below:

Power = voltage x Current

$$P = v \times I \qquad 4.1$$

Power: measured in Watt

V: in volt

I: in Ampere

Since it is Hybrid system which means we have two sources of energy: solar+ wind so the equation becomes:

Total power = Solar power + Wind power

$$P_{Total} = P_{Solar} + P_{Wind} \qquad 4.2$$

It is important to mention that the power produced from the wind is directly proportional to the cubic Wind speed as shown:

$$P \propto v^3 \qquad \mathbf{4.3}$$

Moreover, Two batteries of 12 volt each were connected in series to produce 24 volt to the system.

This table shows the estimated power from the solar and wind hybrid system depending on equation 4.1:

Table4.3: Power Values

Total Power(watt)	Solar power(watt)	Wind power(watt)
124.8	64.8	60
139.2	67.2	72
134.4	69.6	64.8
122.4	72	50.4
132	76.8	55.2
139.2	79.2	60
168	79.2	88.8

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

For developing a hybrid power generation system using renewable energy the first and most required data is the availability of the renewable energy resources over an area. For solar energy, the irradiance and maximum sunshine hours must be known along the temperature. Sun’s radiation and temperature are the main factors influencing the generation of solar energy. While for wind energy, the

wind speed and the topographical changes effecting the wind speed needs to be known.

Chapter Five

Conclusion and Recommendation

5.1 Conclusion:

The thesis aims to focus on the study of a hybrid PV-Wind power generation system for a grid connected application . Estimation of the solar irradiance and wind speed data in Hilla was done as a reference to prove the feasibility and with the availability of energy it is possible to propose and develop a model. Hilla has an average solar irradiance of 5.68kWh/m2/day with an average temperature of 28°C. Annually Hilla is well exposed to sun's radiation which is approximately 8 hours of sunshine a day. In case of wind, study shows that Hilla has a good resource of wind energy .Wind speed direction and topography influence much on the wind speed. Generation of power from single source of renewable energy cannot meet the load demands therefore, hybrid PV-Wind model is proposed to compensate the effects of environmental factors and climatic variations of the resources affecting the continuous operation of power generation. The two energy sources are combined to power the grid to meet the demands. The results show that solar radiation and temperature influences the output of the system. As the solar irradiance increases the value of current increases simultaneously the output power increases while increase in temperature decreases the value of voltage which affects the decrement in power. the wind speed and direction of wind are main factors affecting the output and results show that sinusoidal AC power is obtained with slight variations due to the fluctuations in wind speed. Overall, the hybrid system gives an approximate maximum output of 168W. Combining these two renewable sources for generation of electricity to meet the demands gives a clean energy output.

5.2 Recommendations for Future Work:

1- Using this hybrid system at places that has usually high wind speed.

2. Applying this system at places where the intensity of the solar radiation and radiation hours are longer.

3- Adding more solar panels will increase the estimated solar power.

4- Trying different types of Wind turbines in this hybrid system and compare the results to estimate the highest power.

5- Increasing the area of application where solar radiation and wind is high .

References

1- Aggarwal, S. and P. Nijhawan (2016). Review on solar and wind power potential in India. Power Electronics

2- (IICPE), 2016 7th India International Conference on, IEEE.

3- Ali, R. B., et al. (2016). Design, modeling and simulation of hybrid power system (Photovoltaic-WIND).

4- Sciences and Techniques of Automatic Control and Computer Engineering (STA), 2016 17th International

Conference on, IEEE.

5-Anjali Rana, M. I. (2015). "Implementation of a Wind/PV Hybrid System using MATLAB/Simulink."

6-International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

4(7): 8.

7-Anupam, P., et al. (2017). "A Review on PMSG Based Wind Energy Conversion System."

8-Anurag, A., et al. (2016). "A review of maximum power-point tracking techniques for photovoltaic systems." International Journal of Sustainable Energy 35(5): 478-501.

9-Atiq, J. and P. K. Soori (2016). "Modelling of a Grid Connected Solar PV System Using MATLAB/Simulink." International Journal of Simulation--Systems, Science & Technology 17(41).

10-Australia, S. (2018). "What's the difference between 3 phase and single phase inverters." from

https://www.solarmarket.com.au/whats-difference-3-phase-single-phase-inverters.

11-Bogaraj, T. and J. Kanakaraj (2012). "Development of MATLAB/SIMULINK models for PV and wind systems and review on control strategies for hybrid energy systems." International Review on Modelling and Simulations 5(4): 1701-1709.

12-Bonkoungou, D., et al. (2013). "Modelling and Simulation of photovoltaic module considering single-diode equivalent circuit model in MATLAB." International Journal of Emerging Technology and Advanced Engineering 3(3): 493-502.

13-Ecetutorials.com (2018). "Boost converter-principle of operation-applications | ECE Tutorials."

14-Ecetutorials.com (2018). "Buck Boost converter-principle of operation-applications | ECE Tutorials."

15-Ecetutorials.com (2018). "Buck converter-principle of operation-applications | ECE Tutorials."

الخلاصة

ان الطلب المتزايد على الطاقة النظيفة والمستدامة شجّع على تطوير أنظمة الطاقة المتجددة الهجينة التي تجمع بين أكثر من مصدر للطاقة بهدف تحسين الاعتمادية والكفاءة. يقدّم هذا المشروع تصميم وتنفيذ منظومة هجينة للطاقة الشمسية وطاقة الرياح لإنتاج الطاقة المستدامة. تعتمد المنظومة على دمج الألواح الشمسية الكهروضوئية (PV) مع توربين رياح صغير لاستثمار الطاقة الناتجة من الإشعاع الشمسي وحركة الرياح.

تضمّن الجانب العملي للمشروع اختيار وتركيب المكونات الرئيسة للمنظومة، بما في ذلك الألواح الشمسية، وتوربين الرياح، ومنظمات الشحن، ووحدة خزن الطاقة (البطاريات)، ودائرة إدارة الطاقة. وتم دمج الطاقة الكهربائية المولدة من المصدرين وتنظيمها للحصول على خرج كهربائي مستقر مع ضمان كفاءة شحن البطاريات واستثمار الطاقة المتاحة.

أُجريت اختبارات عملية للمنظومة في ظروف بيئية مختلفة لتقييم أدائها. وأظهرت النتائج أن دمج مصدري الطاقة الشمسية والرياح يؤدي إلى زيادة إنتاج الطاقة الكلي وتحسين موثوقية النظام مقارنة بالاعتماد على مصدر متجدد واحد فقط. كما تمكنت المنظومة الهجينة من الاستمرار في توليد الطاقة خلال فترات انخفاض الإشعاع الشمسي أو ضعف سرعة الرياح، مما ساهم في تعزيز استمرارية توفير الطاقة المستدامة.

توفر منظومة الطاقة الهجينة المقترحة حلاً صديقاً للبيئة وذا جدوى اقتصادية لإنتاج الطاقة المتجددة، ولا سيما في المناطق التي تتسم بتغير الظروف الجوية. ويبرز هذا المشروع إمكانات تقنيات الطاقة المتجددة الهجينة في دعم التنمية المستدامة وتقليل الاعتماد على مصادر الطاقة التقليدية المعتمدة على الوقود الأحفوري

وزارة التعليم العالي و البحث العلمي

جامعة المستقبل

الكلية التقنية الهندسية

قسم هندسة تقنيات التكييف والتبريد

تصميم وتنفيذ نظام هجين لتوليد الطاقة من الطاقة الشمسية و طاقة الرياح لتجهيز الكهرباء المستدامة

مشروع تخرج مقدم الى قسم هندسة تقنيات التكييف و التبريد/جامعة المستقبل

استكمالا لمتطلبات الحصول على درجة البكالوريوس

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2026 A.D **1448 A.H**