Modular Hybrid Solar-Wind Power Plant

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Abstract - The Modular Hybrid Solar Wind Power Plant was created as a result of several studies into the viability of integrating renewable energy sources into a transportable system. It is a novel approach that now cogenerates two renewable energy sources to deliver portable power. By combining photovoltaic solar power with wind power to give both AC and DC output from rechargeable battery, this system substitutes the typical portable gas-powered generator. The complete system is neatly placed on a specially designed steel frame and is prepared for an immediate and effortless deployment on site. The deployment of this system has enormous potential for remote located government and business sites, calamity relief operations, army operations, and other tourist destinations.

Keywords—photovoltaic, internet of things, motor driver,stand alone power generation ,camera module.

I. INTRODUCTION

The main environmentally sociable sources of electricity are the power obtained from solar photovoltaic and wind turbines. They are an established universal phenomenon, the fastest-developing source of energy, and, efficient modern technology that offers a glimmer of hope for a future built on environmentally friendly, sustainable, pollution free source of energy. Modern wind turbines are at the cutting edge of technology; they are modular and take relatively little time to set up. Because of the worldwide increase in electricity requirement, it is now more important than ever to adopt renewable energy sources, such as solar photovoltaic and wind turbine generation systems.

An essential form of alternative source of electrical energy,are the small-scale stand-alone power generation technologies.It finds use in places where conventional generation is impractical. By combining photovoltaic and wind generators with a storage space terminology to smooth out output irregularities, it is feasible to obtain substantially larger generating capability. For consistent power, an effective energy storage structure is needed, and it must be simple to transform the electrical energy provided by solar and wind power into storage power. An energy capacitor system (ECS) or battery bank could carry out this conversion. The daily load changes are accommodated by the ECS or battery bank

II. LITERATURE SURVEY

Frequency histograms were created by hourly recorded data in order to identify the probability density functions (PDF) describing the wind speed and irradiance. For each hour of a normal day in a month that has 31 days, 930 pieces of data are processed to create the PDF. The wind speed was assumed to have a Weibull distribution for the purpose of predicting the long-term hourly average power of a typical day in each month, and the irradiance was modelled using one of the following PDF: Weibull, Beta, and Log-Normal. The Chi-Square or Kohnogorov-Smirnov tests were used to carry out the goodness of fit test [1]. It was discovered that 2.4 kW of PV and 44 kWh of battery storage space is the ideal combination that results in the lowest cost for the system with the appropriate LPSP given the TNE load profile, the 1.5 kW wind turbine, and the LPSP of one day in ten years. The performance of the system over a one-year period is reported in this study. Discussions of power quality, long-term supply loss probability estimation, system dependability, and the implications of wind speed and irradiance variations on system design are also covered.

Wind power and solar radiation are contingent in environment. When crafting systems using random variables, one of the main issues is that the amount of main power that will be transformed to electricity maynot be determined in advance. Traditionally, we have relied on probabilistic methods to perform resource evaluation by dealing out historical data. Because wind and solar emission vary from year to year, every day basis or hourly basis **,**these parameters are averaged over the past several years to recommend long-term data. Collecting all the averages produces a typical outline for a period of time, such as a year, season, month, or day. General period data is used to evaluate the availability of a resource for that particular period. For example, a typical year can be used to predict the long-term performance and economics of a system, assuming that the years are statistically the same. If site-specific data are not available, data from the nearest weather station is used, which has an unidentified degree of similarity but reflects local ecological conditions.

Nevertheless, due to inadequate storage capability, some of the surplus may not be able to be stored, depending on energy production pattern. Therefore, even if the battery runs out, it may not be recovered. Partial periods characterized by successive days of small energy accessibility tend to lift up the demand for battery capacity. Conversely, partial periods of clear skies and sunny days tend to reduce the required PV and battery capability. Therefore, when power production is unevenly dispersed, it becomes difficult to meet the long-term LPSP. However, by compiling the annual data for the worst month of both periods, we find an optimal solution that satisfies the long-term LPSP over both periods. For example, to select January, compare his January in both periods and choose the one with the bad resources. The results for the worst consecutive 12 months are shown in the third row of Table V. However, this method is limited in that it is only used for data spanning more than two years. Validity over longer periods of time (e.g.30 years) needs to be confirmed. .However with limited storage capacity, depending upon the energy production pattern, it can happen that some of the excess cannot be stored; therefore cannot be retrieved from the batteries in time of deficit. Sub periods characterized by consecutive days of low availability of energy tend to increase the need for battery capacity; on the contrary, subperiods characterized by consecutive days of clear sky sunshine tend to lower the needed PV and battery capacity. As a result, the less the energy production is uniformly distributed, the more difficult it is to satisfy a long term LPSP.However, by composing a year data out of the worst months of both periods, an optimum solution is found that satisfies the long-term LPSP over both periods. For example, to select January, in the month of January, both periods are compared and the one with the worst resources is chosen. However, this method has a limited temperament in that it has been utilised for data taken only over two years. Its validity over longer period of time (for example 25 years) remains to be evaluated.

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III. PROPOSED SYSTEM

It was suggested in "Design and Operation of Domestic Solar-Wind Hybrid Power System" that additional energy needs may be met by wind and solar energy, which are renewable energy sources. This can be done by connecting the integrated system to the network to obtain electric power that is fluctuation-free. In the scenario we've put out, the solar panel takes energy from the sun and emits electrical energy. In this situation, solar panels serve as a channel for the conversion of the sun's rays into electrical power. In a similar way, the wind turbine turns wind energy into force whenever the wind blows across the rotor blades. There are a few things that affect how wind is transferred. The surface area of the rotor, the density of air, and speed of the wind are some of the variables that affect how much wind the rotor can transport. DC power is generated by wind and solar power systems. The batteries are then filled with both powers. Inverters are devices that turn battery power into AC power for regulating purposes before supplying the load with electricity such as distribution and transmission.They are significantly greater than in other South Asian nations, which exacerbates the problem. by only building new power stations and electrical cables. The nation's present electrical difficulties can be solved by using sources of renewable energy, particularly wind and solar power. Numerous prospects exist for solar and wind energy, especially as a less expensive, more environmentally friendly alternate in remote and rural regions [18]. The amount of solar and wind energy in the mix of power is expected to rise in the next years, from about 2% at present to 24% by 2030.

IV. BLOCK DIAGRAM

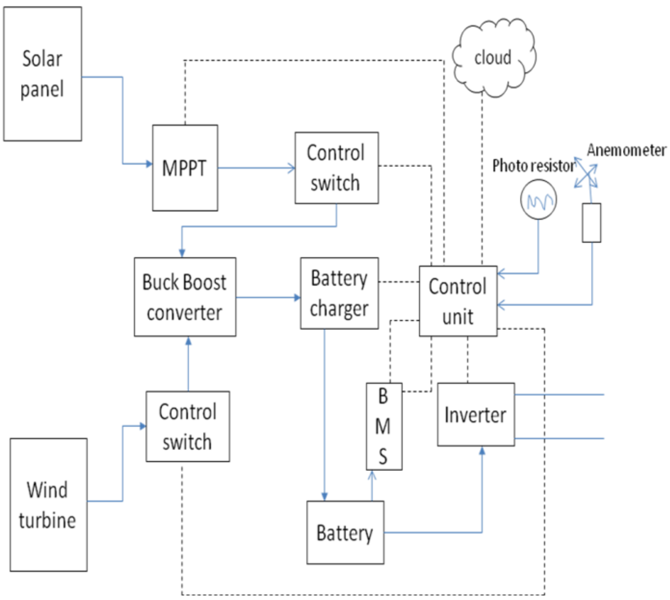

Fig 1.Block diagram

The hybrid power system, which has various benefits a, is an electric system that mixes solar energy and wind energy. In

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many places, during summertime when the sun shines the most and longest-have moderate wind speeds. Less sunshine is available and the wind is greater in the winter. Power is generated by hybrid systems when it is required. Wind and solar have varied peak operating hours throughout the day and year[11].Numerous hybrid power systems operate independently of an electrical distribution network [6]. The hybrid system uses batteries to provide power when the solar or wind systems are not producing any. When needed, the generators can power devices and recharge batteries., when the power is low. By adding a generator, which makes the system more complex, but the use of advanced electronic controllers make the systems to operate automatically. Due to the application of generator, additional system parts need to be compact. The storage space must be enough to meet electrical needs when charging is not occurring. The output of the wind and solar energy systems are combined since, in the event of a power outage, the other source can make up for it. Both solar and wind power systems have the ability to operate independently and in combination also.In order to extract the most power possible, the MPPT algorithm unit is always provided with solar energy supply.The extra energy stored in the battery is used by the controller circuit.

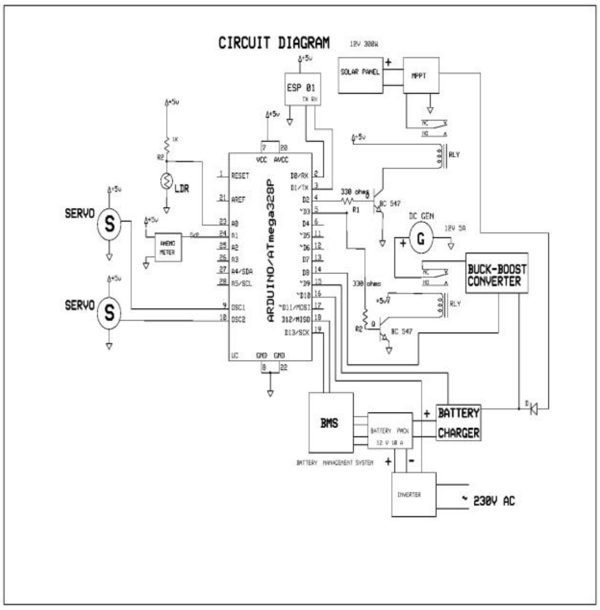

Fig 2.Proposed system

One of the widely used green energy sources that has grown rapidly in recent years is wind energy. A significant portion of the electrical energy demand in the world today can be satisfied by a large amount of wind energy. [3] The fact that the technologies are so successful but cannot generate enough energy on their own can be considered undesirable. [5] The distribution of electricity demand and supply, however, can be improved with the combination of photovoltaic and wind turbines. VAWT and HAWT are two different types of wind turbines. [6] While the rotor axis of a VAWT is perpendicular to the ground, that of a HAWT is parallel to the ground. [7] Compared to HAWT, the Vertical Axis Wind Turbine is more appropriate for this application since it can simultaneously accept input as wind from multiple directions by piloting and a YAW mechanism.. [8]. For solar energy to work, a solar panel needs a lot of sunlight. [9] Two coaxially mounted wind turbines (WT) with oppositely rotating horizontal axis wind turbines are employed. [10] This process uses less energy. By including a second wind turbine, which has a smaller diameter than the primary wind turbine, the power generated by the wind in the counter-rotating HAWT can be boosted. The result is more effectively produced with this system.

V. DESIGN AND COMPONENTS

In this section, the selected hardware components are to be used for this project are reviewed.

A) ArduinoMega 2560

The microcontroller chip based on the ATmega 2560 is called the Arduino mega 2560. It contains 16 analogue inputs, 4 hardware serial connections , a 15 MHz crystal oscillator, 54 electronic input and output pins a USB port, a power connector, an ICSP header, and a reset switch. It comes with whatever required to operate the microcontroller; to get started, just plug in a USB cable, an AC-to-DC adapter, or a battery. The majority of shields made for the Uno and earlier boards like the Diecimila can be used with the Mega 2560 board.

B) Solar pannel

For the project, two Sun module [7] 250 Watt silicon monocrystalline solar panels with 50 cells per module were chosen. The 38-1/2" by 66' modules are installed on a thin sliding rack system that enables easy sliding of one panel on rails beneath the other panel for small-space storage. For best performance, each panel can be slanted at different angles during the expansion process in steps of 8 degrees. About 340 pounds are in the solar panel arrangement. In order to someday control the positioning of the solar panels, solar energy tracking is being studied.

C) Inverter

The inverter converts the dc voltage produced in the battery to ac voltage source. Here battery pack is of 12V,10A the dc voltage produced is converted to approximately near to 230V.
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D) Buck Boost converter

If the voltage attained from the solar energy is low the voltage is boosted by the means of this buck boost converter.If the voltage attained is more ,it is then reduced to a particular voltage.Here voltage after boosting must be 15v ,similar way buck boost converter is performed accordingly.

E) MPPT(Maximum power tracking system)

It is used for extracting maximum available power from pv module under certain condition 300W/12V =25A, add 25% safety margin ,30A MPPT is best fit.

RESULTS AND DISCUSSIONS

The modular hybrid solar wind power plant has demonstrated remarkable results in generating clean and sustainable energy. The solar panels in the plant produce an average voltage of 14 volts and a current of 10 amps, harnessing sunlight with an irradiation level of 160 watts per square meter. The wind turbines, on the other hand, generate a voltage of 14 volts and a current of 5 amps, utilizing the wind speed measured by the anemometer at an average of 8 meters per second. This modular hybrid system has proven to be highly efficient and reliable, providing a consistent power supply by effectively combining the advantages of both solar and wind energy sources. In comparison to other solar wind hybrid systems, the modular design allows for easy scalability and customization based on specific energy requirements, making it an adaptable and cost-effective solution for diverse applications.

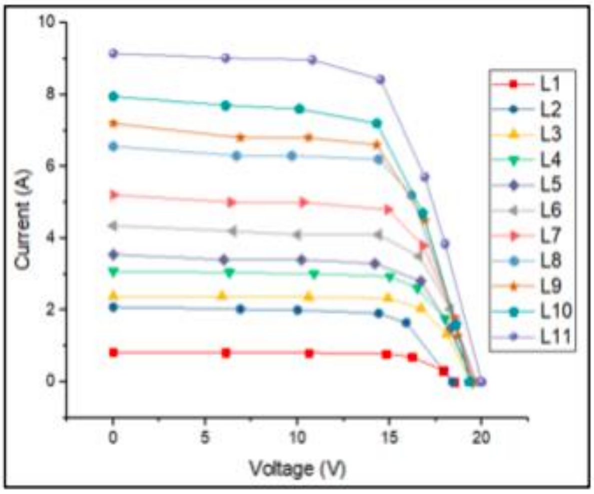

Figure 3.Current-voltage characteristics of peak solar panels.

OBSERVATION L1:

IRRADIANCE = 102-104 W/M2 , TM = 30.46 ˚C. L2: IRRADIANCE = 240-257 W/M2 , TM = 39.13 ˚C. L3: IRRADIANCE = 303-307 W/M2 , TM = 34.15 ˚C. L4: IRRADIANCE = 381-391 W/M2 , TM = 37.91 ˚C. L5: I

IRRADIANCE = 447-453 W/M2 , TM = 39.74 ˚C. L6: IRRADIANCE = 545-555 W/M2 , TM = 40.38 ˚C.

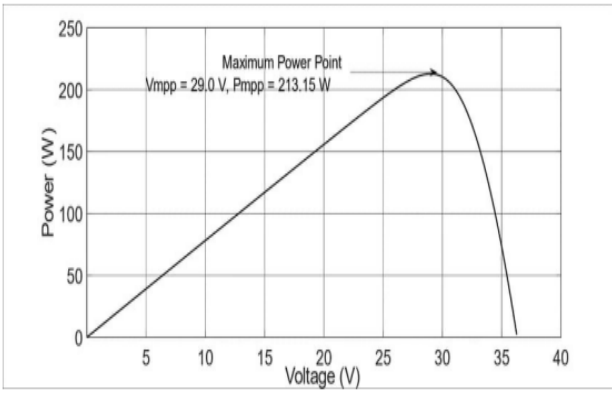

FIGURE 4. POWER -VOLTAGE CURVE OF MPPT

The project focuses on the design and implementation of a sustainable composite generation method based on solar power (PV) and wind energies. The aim is to provide a reliable, efficient, and flexible solution to meet the energy demands of isolated areas with limited access and low energy requirements. By combining the power generation capabilities of both solar PV and wind technologies, the system can effectively overcome the challenges associated with individual systems and offer a more stable and consistent power supply. One of the key aspects addressed in the project is the reliability of the system, particularly the inverters. By implementing specially designed inverters for parallel operation, the overall system reliability is enhanced. Parallel operation of inverters ensures that even if one inverter fails, the others can continue to operate, minimizing downtime and maintaining power generation. The assimilation of both wind and solar energy PV in a hybrid structure provides advantages over individual systems. The power fluctuations inherent in individual PV and wind systems are less dependent on environmental conditions in a hybrid configuration. This stability is further augmented by the inclusion of a battery, which helps to smooth out power fluctuations and ensures a consistent power supply even during periods of low generation. While this project has successfully addressed the challenges associated with power fluctuation in the hybrid system, there is still room for further improvement and optimization. Future work can focus on refining the battery storage system, exploring advanced control strategies, and evaluating the system's performance under various operating conditions. By continuously improving the reliability, efficiency, and flexibility of the hybrid generation system, it can serve as a sustainable and viable solution for providing clean energy to isolated areas and contribute to the overall transition to a greener future. In conclusion, the project demonstrates the feasibility and potential of a sustainable composite generation scheme based on PV panel and wind energies. The integration of these technologies, along with effective power management and storage solutions, offers a reliable and efficient energy solution for isolated areas. By harnessing the power of renewable resources and addressing the challenges associated with power fluctuations, the system contributes to a more sustainable and environmentally friendly energy landscape.

Figure 5. Actual system

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