Performance Evaluation of 1.6 KW Hybrid Solar and Horizontal Axis Wind Turbine

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Abstract - The presented method is applied to evaluate the current and future potential of integrated hybrid photovoltaic & wind turbine system to produce electricity for the Institute called Sri Satya Sai college of engineering, Gandhi Nagar. Applying this hybrid system of 1.6kW capacity, sustainable and uninterrupted energy is achieved without any pollution as well as a positive contribution towards global warming. we have analyzed the cumulative data of wind speed and solar energy data throughout the year and evaluated the average energy output throughout different seasons. We have decreased the pollution by these resources compare to non-renewable resources. As a result, based on observations and technical data using this hybrid system integrating PV-cells and Wind Turbine we may fulfill the energy demand of future in large scale with elevated efficiency.

We have used small storage capacity at our institute as a feasible Model for the justification of its efficiency and usability with Hybrid system. In future we may develop & install large solar and wind plant which would be cheaper as compared to small plants. This work can be considered as joining any of these research groups with an objective of giving electricity through wind and solar energy to the population living in rural as well as urban areas of Bhopal.

KEYWORDS: Hybrid system, Wind turbine (Horizontal axis), Solar photovoltaic Panel, Storage capacity

I. INTRODUCTON

Energy is one of the most important things which direct the world toprogress and opulence through various means of growth, like education, technology, transportation, trade, health and various other important aspects. In the beginning we had adequate amount of natural resources and fossil fuel storage by which we used to accomplish our energy needs, but in view of the fact that 3 decades enormous development in all kinds of technological over and above in socio- economical areas took place. Our former source of energy is electricity, and the demand of electricity is increasing day by day on escalating rate as the population of the world is increasing.

This disaster escorts researchers and scholars to move towards the alternate and sustainable source of energy i.e. renewable source of energy. Renewable energy may be obtained or extracted through sun, wind, tides, ocean, geothermal, hydel power plant etc. These all are received from the nature directly and are never ending.

On the other hand, Wind Energy may be generated through the specially designed vertical or horizontal axis speed in the wind is prerequisite for the generation of electricity as a wind with high velocity about 12m/s may contribute in the generation of electricity through aerodynamically designed wind turbine blades this speedy wind strikes the blade of wind turbine and made it ready to rotate at a faster rate which in turn generate the electricity which can be stored in the battery bank. The shaft connected to generator through optimized & specially designed gear trains producing electricity all weather, this energy is then stored in series of batteries, hence becoming the best ever growing renewable energy technology all over the world.

Photovoltaic panels and wind turbines are now extensively used globally in such locations where it might be difficult or costly to use conventional grid supplies. People who are selecting the non-conventional energy resources prefer to connect their energy system to the grid as a huge battery for some convenient grid-tied situation. On the contrary, especially in rural areas electricity grids are frequently non- existing and all forms of energy are generally very pricey in several developing countries. Here PV modules and wind turbines may be highly cutthroat with other forms of energy supply. However, the fact that natural energy resources are irregular and storage batteries are costly, this has led to the utilization of supposed hybrid renewable energy systems. Any power system that incorporates two or more of the following is referred to as a hybrid power system: PV panels, wind turbines, or diesel, propane, gasoline generators. For small loads, the most common combinations are PV-wind hybrid system. PV and wind is a good match, because inland wind speeds are poorer in summer, which may be compensated by peak sunshine, and in winters, when sunlight falls to very low levels, the wind speeds are usually sufficient.

1.1 Basic Theory about Wind Energy

Those areas around equator need aid warmed that's only the tip of the iceberg Toward those sun over whatever remains of the globe. The warm colors, red, orange and yellow show the high temp regions in the infra-red picture from claiming ocean surface temperatures (taken from an nasa satellite, NOAA-7 to July 1984). Mossy cup oak renewable vitality Eventually goes from the sun Furthermore 1-2 % of the sun's vitality arriving at the earth is changed over under wind [Danish wind, 2008]. Contrasts in pneumatic force created Eventually Tom's perusing the uneven warming of the earth's surface Eventually Tom's perusing the sun powers air circulation; and air streams starting with territories of high point should regions from claiming low weight.

Concerning illustration an aftereffect of temperature What's more weight differences, and also the Coriolis Effect, there would different worldwide wind examples toward diverse latitudes. Exchange winds, prevailing westerlies, what's more polar easterlies are some of the sorts that could make said in this respect. The coriolis power may be the clear redirection about air starting with its way Likewise it moves starting with helter skelter will low weight ranges due to those revolution of the world. Other wind assets for example, Geostrophic Winds, surface Winds, neighborhood Winds (as for ocean Breezes), mountain winds, and so forth throughout this way, observing and stock arrangement of all instrumentation may be enhancing. Ought further to bolster Additionally make noted [Danish wind, 2008].

1.2 Basic Theory related with the solar Energy

General information about solar power is found in the following references [Duffie and Beckman, 1991] [Markvart, 2000]. The sun radiates energy radially, from an effective surface temperature of about 5760 K, as electromagnetic radiation known as `solar energy' or sunshine. The earth is situated at about 150 million km from the sun with a total surface area of about 510 million km2, of which only about 21% is land. A substantial portion of the solar radiation, on its way to reaching the earth's surface, is attenuated due to atmospheric interventions. Additionally, because of the sun-earth angle concept, the solar radiation received at the earth's surface varies on hourly, daily, or monthly basis. Hourly variation is due to the motion of the sun from east to west, and also due to the presence of clouds, whereas daily variation and monthly (seasonal) variation is due to the position of the sun. Longitude and latitude give the location of a place on the earth's surface. The Sun comes overhead twice a year in the tropical belt. Ethiopia is in the equatorial region which is probably the most favorable region for solar energy. According to the findings of this work, disregarding the rainy season, July and August, the average daily duration of sunshine is approximately 8-10 hours [Bekele and Palm, 2009a]. It is well known that most developing countries do not have properly recorded radiation data. What usually available is sunshine duration data. Solar radiation data is the best source of information for estimating the 26 solar energy potential of a certain location, which is necessary for the proper design of a solar energy conversion system. Ethiopia is one of the developing countries without properly recorded solar radiation data and, like many other countries, what is available is sunshine duration data. However, given a knowledge of the number of sunshine hours and local atmospheric conditions, sunshine duration data can be used to estimate monthly average solar radiation, with the help of empirical equation 2-1 [Duffie and Beckman, 1991].

In this thesis, a PV-wind hybrid system is presented that is installed on the roof of Sri Satya Sai college of Engineering, Gandhinagar Bhopal of 1kW wind turbine and 600 watts PV panels which may be able to produce 1.6kW power to supply power to the department of Mechanical Engineering. The aim of this study is to introduce the local PV-wind hybrid system working principle by reviewing one case where the system is connected to the grid.

1.3 Hybrid System model

The hybrid system consists of 3 Solar panels of 200 watts each and a wind turbine of 1 kW to generate 1.6 Kw power. This system has been designed and installed on the rooftop of SSSCE RKDF University Bhopal. The hybrid system model is purely Renewable energy system model which receive both the energy Wind as well as solar energy and convert it into useful form of electrical energy. Its our attempt to use both the energy simultaneously to recover the losses. This project will be helpful to install the system in the remote area to produce electricity for the rural people without interruption. Because wind is available twenty-four hours while the solar energy is available for 8-10 hours so that the energy supply from the hybrid system is uninterrupted, although the energy receive from the system is stored in the suitable form for the intermittent supply.

1.4 Problem statement

In whatever phrase were on be used to depict those the long run done which we need aid living, it might a chance to be "renewable vitality." to decades now, this haul need created many organizations should outline Also fabricate items over deliberations from claiming pushing this phrase. The expense Furthermore straightforwardness from claiming transportation, however, will be the greatest issue these organizations would confronting. For as long as couple years, new organizations need been Creating little force frameworks that could be utilized within areas the place there will be no power alternately for areas that fair consistent control outages. Unique in relation to a generator which is as well heavy, excessively awful boisterous Also obliges fuel these organizations need aid centering on little mixture frameworks that utilization just the sun and the wind should produce power. Dissimilar to A generator, a mixture framework utilization clean energy, runs quietly and cam wood make effortlessly transported when contrasted with standard frameworks [11]. Searching from the purchaser point of view those expense of a mixture framework is at present the greatest issue which could cosset anyplace between $5,000 to $10,000 dollars. Acknowledging that a versatile mixture framework may be intended to convey a restricted measure for power, short of what 1. 5 kW-hr, this is an helter skelter cost for such framework. With the end goal this framework to ended up additional magnetic of the public, we necessity with outline What's more create an item which will profit their pockets.

II. LITERATURE SURVEY

Literature survey has been carried out to formulate the problem for the current research work. An exhaustive review of available literature mainly published in IEEE transactions has been carried out. This review of available literature consists of several papers which are already published in the IEEE conferences and the journals.

E. Muljadi, C.P. Butterfied [1] worked on the wind turbine with variable speed with pitch control. They also explained about the loads and minimum acceptable speed of the generator to control the wind speed at very high speed. They added that how the wind turbine controls the power production.

They have been suggested two methods to control the power:

(1) Through controlling the Pitch line velocity

(2) Through controlling the generator load.

Meei-Song [2] worked on power system and applied a fuzzy logic to wind generation capacity to calculate the demand of various consumers in different times. He proposed a method and profiling chart of the demand and usage of different consumer.

It can control the cost of energy production from the available energy wind energy effectively by assessing the load summary of particular consumer. It is observed that the wind power generation can substitute economically and efficiently with the diesel power plant and provide partial power supply capability for the net peak load demand.

T. Tanabert, T. Sato [3] discussed on system controls which can be used to fulfill the requirement. Each control system was verified to be practically feasible by simulation result based on an actual network and usage data. Using these data, we can determine adequate capacity of battery which can be enough sufficient for loads. He also discussed about the scheduling of power generation by wind and other plants by controlling direction and speed of wind mill blade and how much energy we can receive from that system. A control system was developed to meet the technical requirements prescribed by the electric power company. These requirements will extend the acceptance limit of connecting wind power generation into the utility grid.

If the demand is fulfilled through the wind generation then it can be practiced in large scale in the form of wind farms.

Through the meteorological data in which regression analysis is to be carried out then the comparison of power production from the available amount of wind energy in a given specific area can be evaluated.

Takaaki Kai and Akio Tanka [4], worked on the performance of conventional power fluctuation to make it smooth running system. They applied two generators to control the power factor and variable speed of wind energy, integrated with (EDLC-electric-double-layer-capacitor system). The circuit of the system consisting from mainly two inverters- (I_a) and (I_b) with a capacitor (C_a) placed between them.

I_a = Inverter a

I_b = Inverter B

C_a = Capacitor

S_1 = active power of the stator and

R_2 = active power of the rotor

W P_g = Sum of wind power generation

The sum of the power fluctuation system output and wind power generation output power (Pg) is defined as the composite output power.

Composite output power= fluctuation system power output + wind power generation output

In this new wind power generation method, the EDLC system is connected to a DC circuit between inverters through a bi-directional DC to DC converter, and the power fluctuation smoothening system is added in the control system of inverter (A). The rated voltage is 1500V of DC circuit between Inverters, and the capacitor of 5 farads is connected to the circuit. The EDLC system is formed by cell module 600S1 (2 in series and 85 in parallels). with rated voltage 150-volt, capacitance 4.7 farads and internal resistance 0.55 Ω.

(Electric double-layer capacitors (EDLC) are electrochemical capacitors which stores energy, and the energy density is determined by specific capacitance (farad/gram or farad/cm^3) and the operating voltage of the battery.

Hiroyuki Mori and Akira Await [5] worked on the effect of several parameters which affects the wind energy either directly or indirectly. This method can be applied to detect the real-time data. The variable parameters may be depending upon the winter and summer condition and it is also depending upon the sea level pressure and direction of air. Sea level pressure affects the speed of wind.

Noriyuki Kimur a, Tomoynki Hamada [6] has been given an idea about Suppression of current peak of PFC converter to induction generator for wind power generation excited by voltage source converter. This work is about the combination of induction generator with electronic equipment's. The induction generator cannot generate electricity at lower rotor wind speed. To overcome this problem, expensive synchronous generators with permanent magnets are used. The diode rectifier used to convert the real power from the induction generator to dc voltage. If we use induction generator with VSC, the cost of the wind power generation system may be reduced, as a substitute of using expensive synchronous generator a low-cost cage induction motor is used with Capacitors to compensate the reactive power.

Lu Yuegang, Xi Peiyu [7] discussed about the layers of wind turbine in their work and presented apaper on wind turbine with two control layers

(1) Supervisory Layer & (2) Control layer. The one layer i.e. supervisory layer is designed by Lab VIEW which gives the graphical user interface to control and monitor, whereas the control layer is used to replicate the working of wind power generation system and it is based on MATLAB. In this preparation a mathematical model of wind turbine is designed with the help of these programming software and analyzed the result obtained. Control strategy of Double-fed induction generator, variable speed constant frequency (VSCF) wind power generation training system is presented in the work. Major operations taken into consideration like control, MPPT (maximum power point tracking) at lower wind speeds and variable pitch and power control on rated wind speed. By making comparison among these curves correctness and feasibility of these systems are offered.

Ming-Shun Lu et.al. [8] presented a paper on integrated system of the wind power generation with energy storage equipments. With the advancement and rapid growth of wind turbine technologies, the cost of power production from wind energy becoming competitive with other fuel-based resources. Due to the globally increasing demand of energy and accelerating rate of the fossil fuel and no doubt the alarm of the global warming, wind power generation has rapidly developed since the last two decades.

Since it is easier said than done to predict forecast and control the output of the wind generation and its potential impacts on the electric grid are unlike from the conventional energy sources. A system may be generated to compensate short-fall of power output at times when abrupt change of wind takes place at high penetration level and respond fast to use the reserve capacity. To facilitate a proper supervision of the ambiguity, this study presents an approach to make wind power become more reliable source on both energy and capacity by using energy storage devices. Combination of these generation system with energy storage will reduce fluctuations of overall power output. Even though high assets investments for these storage systems are required, so it is important to estimate reasonable storage capacities for desired applications. In addition to that energy storage application for reducing output variation during the flurry wind is also studied.

Bongani Malinga et.al [9] studied the dynamics and control of distributed resources (DRs) in non-regulated power industry'. Since arrival of wind energy is not just limited to selective geographical areas it has now deep penetrated the possibilities of its arrival and feasibility globally and as a result of this deep penetration researchers favors to look at large wind farms as future possibilities of power plants, To achieve most favorable incorporation of high output of wind energy in the generation system ecology, the wind power plant must be able to replace other usual plants, i.e. able to participate in the control and stabilization of the power system. This research covered a way to a different approach to wind turbine modeling and control design methodology. All the outcome be in close agreement with outcome from other studies. The main approach of the controller is to regulate the rotor angular speed and the power demand to equivalent the required profiles. Further continued research illustrates that the most efficient wind turbine has not been build yet and rest of the work lies on how it is controlled.

Wijarn Wangdee, et.al [10] presented that the acceptance to use clean wind energy has increased in last decade as due to being unlike from any more renewable resource. The power generation from wind energy depends upon the location and graphical condition in hilly areas the speed of wind is more so we may generate the large amount of energy. The transmission of power which is generated by wind energy can be considered on the load demand. MECORE software may be used, using a DC-based power flow algorithm. it is a composite generation and transmission system reliability analysis tool. As previously noted, the voltage stability is prevailing to limit the transfer capabilities of the system.

A usual AC-based power flow program was primarily used to explore the transfer limits under system normal (N- 0) and contingency (N-1) situations. After the transfer limits based on voltage stability study. The voltage stability limit can be measured by MECORE using DC based optimal power flow solution. The load duration curve during winter period in which 1,000,000 samples were taken in all MECORE studies in order to achieve the coefficient of variation with tolerance error less than 1.

Mohammad Zakir Hossain and A.K.M. Sadrul Islam [23] presented a paper on PV-wind hybrid system modeling which is appropriate for operations in rural and remote areas. A PV-wind hybrid setup was developed to simulate a stand-alone power system with battery storage. This model was applied to a typical consumer peak load of one kW at a remote community in Bangladesh. Using the model, various parameters are evaluated for one-year at full operation of the system. Furthermore, an economic analysis has also been carried out to evaluate the feasibility of such a system at considered locations.

Mel George [12] focused on the worldwide handling of renewable energy in utility scale applications continues to increase, it is important to assess the impact on the grid and conventional generation. This report unites the analysis of load and generation characteristics, generation capability and base and peak load variations to gain insights into the future role of wind generation. A simulation of Tamil Nadu state in India which possesses a high penetration of wind power (27% by installed capacity) is also presented here. The savings achieved in traditional generation due to installation of wind power are computed as the capacity credit, using a power system reliability based approach.

Rickgonzalel, Rana Muke Ji [13] observed on the rapidly growing number of renewable power generation locations in the USA. Over the times of yore few years this number has increased significantly. Wind-powered projects plays and important and dominant part of the future NYISO programme. It will support the users to generate and utilize independently.

Florzn Lov et.al [14] have been discussed about the very general and detailed description of the wind turbine models through their studies and work they have presented in this paper. During their studies they have developed a toolbox “Simulation Platform to model, optimize and design wind turbines”. This report mainly focuses on the descriptions of important mathematical models that encountered during design and development in the toolbox.

Jiang Chang and Shu-Yun Jia [15] discussed the modeling and application of wind-solar energy hybrid power generation system based on multi-agent technology. Multi-agent system is society made up of several agents, with collaboration of multi-agent, it can optimize control system and enhance its intelligence and reliability. Wind and solar energy hybrid power generation is a novel and promising power system. Complex as well as unpredictability of the climate makes wind and solar hybrid power generation system a complicated system. In this paper, they first introduced advanced agent technology into wind and solar energy hybrid power generation system, establish the wind and solar energy hybrid power generation multi-agent system (WSHGMAS) and analyze multi agents’ collaboration relationship.

V.J. Yeshwenthet.al. [16] reported that a purpose of a DC connection for capacitor Energy storage in Wind Power generation system. For meeting the requirement firstly, they have analysed the performance of two wind power generation system with the energy storage at the dc side.

Energy storage is advantageous to be installed to keep constant output from the wind power generation system. The DC connection of two wind power generation system helps to exchange power between the two systems and may suppress the disturbances of the output power to the utility systems longer than the stand-alone system. the performance of two wind power generation system with the energy storage at the dc side through simulation. And the system is modeled and simulated through Simulink/MATLAB and the effectiveness of the system is evaluated.

This effect is easily achieved and implemented without any additional control. The controller measures only the common dc side capacitor voltage of the local system. MATLAB/Simulink simulation verifies the better performance in a certain situation.

III. METHODOLOGY

Our methodology for the project is more or less based on the selection of such parameters which may affects the performance of the proposed system directly or indirectly. Firstly, we select the parameters and then instruments and equipment’sfor their measurement.

Computation of the measured parameters in the form of table has been carried out then show the effects of those considerable parameters on the performance of the hybrid system and the plot the graph for the comparison for them.

Our methodology includes Electric Motor Selection, Solar Panel Selection, Battery Bank Sizing, Charge Controller Selection, Wind Blades Selection, Electrical Wiring, Electrical Wiring, Control Panel and instrumentation.

3.1 Electric Motor Selection

The determination of the motor is those The greater part critical and only any wind turbine framework. There need aid large portions modern motors in the business sector that camwood make utilized Likewise a wind generator. The point when selecting a motor, it may be extremely critical with decide a turbine that is fit about generating those battery voltages during low rpm.

Porousness magnet Motors are recognized those best decision to little wind turbines since they need aid broadly available, modest Furthermore oblige low rpm will begin generating power. There would permanent magnate Alternator that generates Possibly AC or dc current and they both could be utilized within wind turbines. Permanente Motors alternators for a AC yield are called PMA Also would recognized that's only the tip of the iceberg productive that point motors with dc yield.

There need aid different sorts from claiming lasting order Alternators. Automotive Alternators are not recommended should make utilized within wind turbines since it obliges high rpm to produce high amount of power. This motor might have been planned will a chance to be utilized within little wind turbines, furthermore it will start transforming the battery voltage during Extensively low rpm.

3.2 Solar Panel Selection

For the hybrid system design, we will be using a solar 600w power 3 solar panel 200 watt each Solar Panel made by Renogy. Renogy uses top quality solar cells and superior accessories to produce high performance solar modules.

The maximum power of this solar panel is 600 W. Considering that this system will be used in areas with at least five hours of strong sunlight this panel will produce at least 600 watt-hours in a single day. Now we can estimate how much power this whole system will produce. According to our evaluation this hybrid system will produce an average of 1,600 watt-hour daily. This estimation is based on ideal conditions such as no obstruction to the wind turbine and clear sky for the solar panels.

Fig.3.1 Picture of the Solar Panel with frame

Table 3.1 Total power generation by the combine system

Component	**Watt-hours (Wh) per Day**
Wind Turbine	1,000 (1 Kw)
Solar Panel	6 00 (200x3)
Total Power Generation	1,600

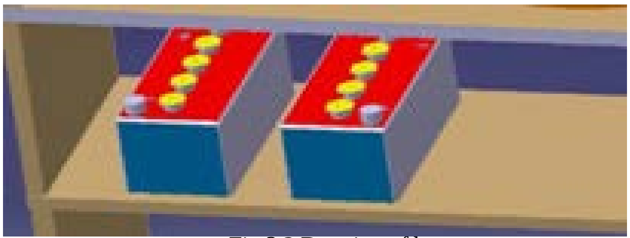

Fig.3.2 Drawing of battery

The storage capacity of the batteries has to be increased in order to have a more efficient system. By connecting the batteries in parallel the following storage capacities were calculated based on the usage of two and four batteries.

Storage capacity with two batteries: $StorageCapacity=12V \times 100Ah$ =1200X2 $W \cdot hr$-2400VA.

For this design, we will be using two batteries connected in parallel so the voltage will remain the same and the amperage will increase two times. This battery bank will have a total capacity of 2400 watt-hour; however, the system is designed to use only 1,600 watt-hours (54% of bank capacity). By using only 54% of the battery bank capacity the useful life of the batteries will increase dramatically so we can expect these batteries to last a long time. The remaining 46% will serve as a reserve and will be consumed when the system is not generating enough power.

3.3 Charge Controller Selection

For this design, we will be using a charge controller that is made for solar and wind hybrid systems. This controller will serve to maintain the proper charging voltage on the batteries. The controller has one output for the battery bank and two inputs; one for the solar panel and one for the wind turbine.

Fig. 3.3 Picture of Charge Controller

3.4 Control Panel

It is created in the department, through the power transmission line it is connected to the power system (solar and wind hybrid power generation system). It consists of a cabinet of wood in which battery bank and one inverter are placed inside the cabinet. Ventilation is provided with the cabinet to cool the equipment placed inside the cabinet. One wind charge controller and one solar charge controller are also placed over the cabinet for the computation of the data. One-month record of data can be stored easily in the charge controller.Control panel of the hybrid system is shown below in the fig.3.4.

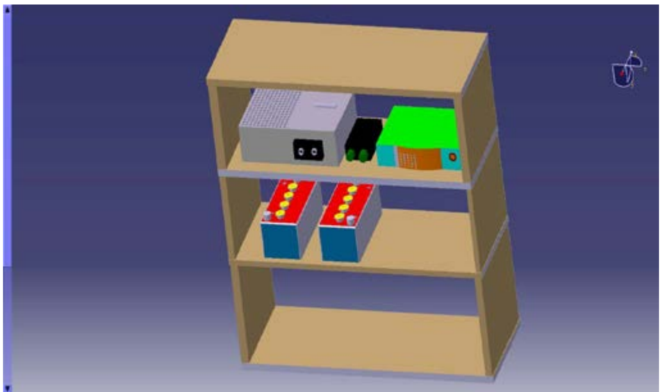

Fig.3.4 Control Panel drawing of the hybrid system set up

IV. EXPERIMENTAL SET UP AND ITS INSTALLATION

The unit contains a 1000 W wind turbine, installed on a 100 ft. (30.48 m) tower at the campus. It is connected and synchronized in parallel to the power grid as part of mechanical laboratory activities on wind power systems and grid-tie interactions. The overall project block diagram is presented in Figure4. 1.There are three solar panels with a capacity of 200 W each. A best-case scenario of 3 X 200W (a total DC power of 600 W) is hypothetically available from the PV panels, although this would be equal or less than 600 W, due to the location of the solar panels. A 1000W wind turbine was selected because of its strong features, low maintenance, and safety features. The output power of the selected wind turbine is1000W, based on its rated speed of 12 m/s, or 43.2 kmph. One of the important features of the fiberglass wind blades is its blade deformations as the turbine reaches its rated output. This feature allows the blade to change its shape, causing the blades to go into a stall mode.

The Hybrid system consists of the following main components: -

1. A horizontal axis wind turbine
2. solar panels of 200 watts each three in numbers.
3. A Control Panel consists of the following: -
   (a) A wind and solar charge controller
   (b) Two batteries for the storage
   (c) Electrical insulated wiring for the power transmission
   (d) Inverter
   (e) A wooden cabinet

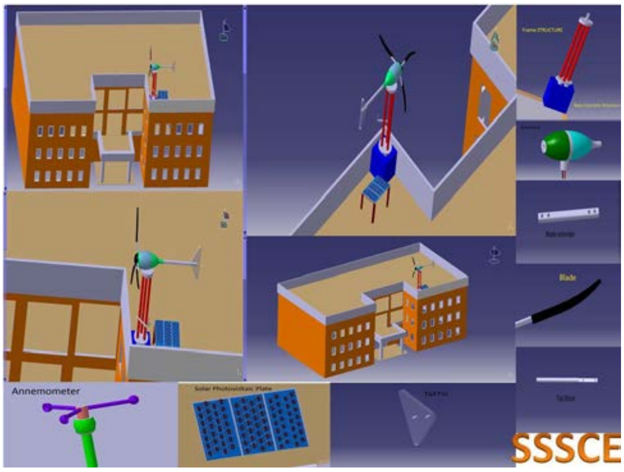

Fig.4.1 CAD modeling of Component of the hybrid System

V. RESULTS AND DISCUSSIONS

Experimentation has been carried out on the system during a year from 2nd Jan2017 to 5th Nov. 2017.Data computed for the power estimation from the horizontal axis wind turbine is tabulated in table no.5.1

5.1 Power Estimation from the Wind Power System

The basis of a work of a wind turbine is that Kinetic energy which is present in the wind and it is first converted into mechanical energy and then into Electrical energy or power through a generator. While designing or installing a wind turbine system it is important to find the expected power output

Mathematical Model

The following table 5.1shows the definitions of the variables used in this model [1]

Table 5.1 Definition of the variables

E = kinetic Energy (J)	A = Swept Area (m^2)
m = Mass (Kg)	C_p = Power Coefficient
V = Wind Speed (m/s)	r = Radius (m)
P = Power (W)	x = distance (m)
ρ = Density (kg/m^3)	t = Time (s)

The following equation (1) represents the total energy available in the wind [24]

$$P=\frac{1}{2}\rho AV^3 \quad (1)$$

In 1919 a German physicist Albert Betz explained that for a wind turbine to convert more the 59.3% of the kinetic energy available in the wind into mechanical energy is not possible by turning blades of a rotor. This is called as the Betz Limitand is the theoretical maximum power efficiency of any wind turbine. This is called the maximum coefficient of power and is defined as [24]:

$$C_{P\max}=0.59$$

Hence, the coefficient of power must be included in equation no.(1) and the new equation for the power extraction from the wind in any wind turbine is given by [24]:

$$P_{\text{avail}}=12\rho AV^3 C_P(2)$$

Calculations:

The Following Data is taken into consideration

Blade length, l = 0.762 m (This is the actual length used on this deign)

Average max. wind speed, $V = 12$ m/sec

Assumed power Coefficient, C_P= 0.4

Air density, ρ = 0.4

Inserting the value for the blade length into equation (3) we get:

$l = r$ = 0.762m

$A= \pi r^2$

= π x 0.7622

= 1.824m^2

Now we can calculate the power output of the turbine using equations (2):

$$P_{\text{avail}}=12\rho AV^3 C_P$$

= 0.5 x 1.23 x 1.824 x 123 x 0.4

= 775 W

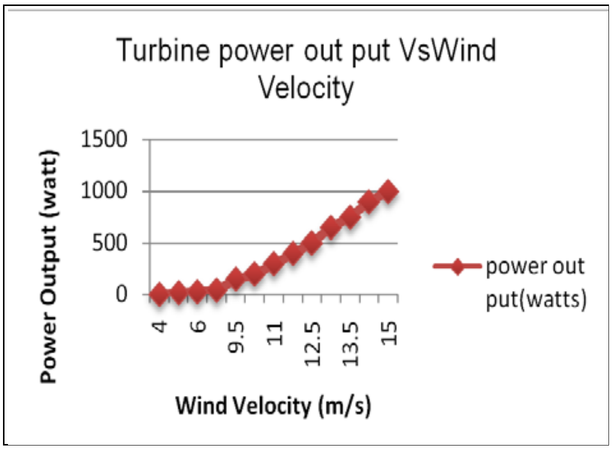

Fig.5.1 Power Output

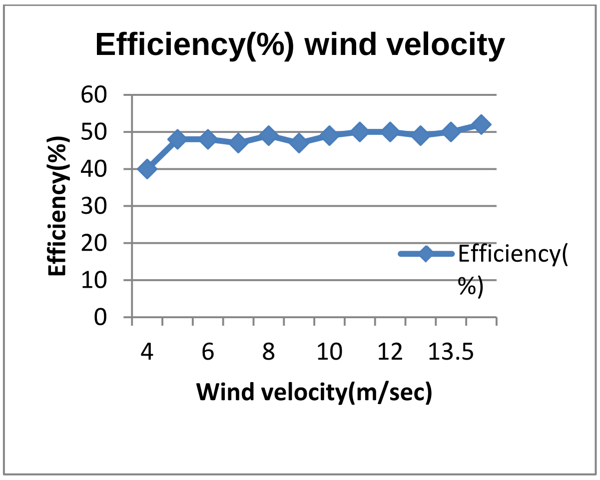

Fig.5.2 Efficiency of wind turbine

According to the figure above, our turbine is more efficient at proximally 12 MPS wind. It is important to understand that this 12 MPS only means that at this point the turbine is doing a better job in converting the kinetic energy in the wind into mechanical power, however, at higher wind speeds the turbine will still deliver more power, but just not as efficient as the 12 MPS mark.

5.2 Power Estimation from the Solar Power System

Since we need aid planning an arrangement that combines both a wind turbine Furthermore a photovoltaic solar panel it may be import to figure out those effectiveness from claiming our solar panel. The effectiveness in a photovoltaic solar panel measures the capacity of the panel to change over daylight under usable vitality [26] Also it will be honestly not difficult to figure.

Mathematical Modeling

The following table 5.2shows the definitions of the variables used to calculate the efficiency of any solar panel [28]:

Table 5.2 Definitions of Variables

η = *Efficiency*	I = Incident radiant heat flux (w/m^2)
P_m= Maximum power output (W)	Ac= Area of collector (m^2)

The maximum efficiency of a photovoltaic solar panel is given by [26]:

$$\eta = Pm/E \text{ x} A_C \quad (5)$$

In order to perform this calculation, it is safe to assume an incident radiation flux of 1000 W/m^2. Since we know that our solar panel is rated at a maximum power of 200 W and that the area of the collector is approximately 0.6 m^2 of each of 3 panels we get:

$$\eta = P_{m/}\text{I x } A_C$$
$$= 600/\ (1000 \text{ x } 0.62\text{X}3)$$
$$= 0.33 \text{ or } 33.33\%$$

As our project objective is to enhance the efficiency of the system so we combine both the system in such a manner which has been shown in the fig.5.1 to get maximum out put the system became efficient enough because it works all 24 hours due to the wind availability

Whole day and whole night.

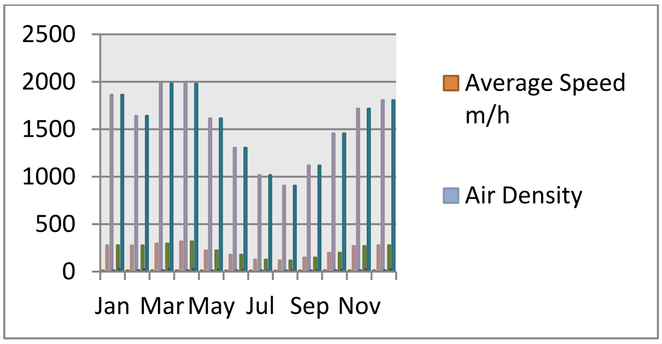

Fig.5.3 Average values of all the parameters throughout the year

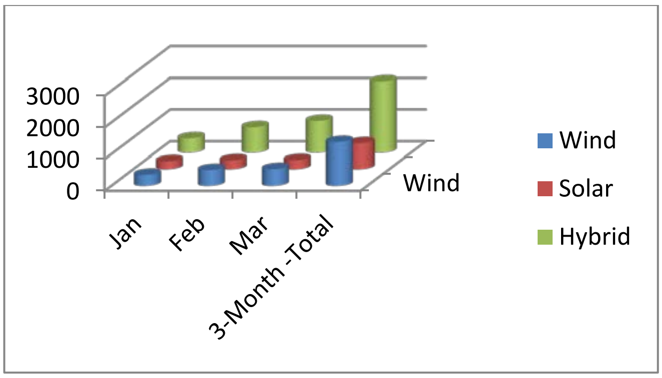

Fig.5.4 comparison of energy generated from all three systems

VI. CONCLUSION

A complete 1600W wind-solar power and instrumentation/data acquisition system was completed and the power generated from the system is stored in the battery bank of 2X100A 12 V this DC power is used for the mechanical Engg.Deptt of SSSCE current applied load for the system is very low only seven fans of 100 watts each and seven tube lights of 20 watts each is drawing power from the current system. The wireless sensors collecting data on wind, temperature, voltage, current, power, and load changes at wind power systems is stored and recorded for at least one month in the wind charge controller.

valuable hands-on experience in setting up a real-time data acquisition system, specifically in off grid- wind and solar hybrid power systems. In terms of student learning and satisfaction, the project was a success. With the increasing importance of renewable energy resources in present and future energy scenarios, an ability to design and analyze renewable energy systems is essential for educators and students in engineering and technology. I was involved in the project which showed improved learning and understanding of concepts about renewable energy sources by complementing theory-based lectures with hands-on experimentation. As I belong the Industrial engineering and production branch So I worked in such a manner that how to enhanced the production rate from a system. For the system I have considered a hybrid solar and wind system so I worked at its each aspect from the installation to the power generation.

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