Design Solar and Wind Turbine Hybrid Power System for Mobile Charging and Lighting System

Vikas Govind Rao (1901220200067)

Krishna Gopal (1901220210006)

Under the guidance of

Er. Satyendra Kumar Gupta

Abstract

Energy is the need of the day, energy generated from conventional source is under exploited. The conventional energy pollutes terrain severely and its least vacuity. So, India turned to produce electricity on the operation of unconventional energy resources like solar, wind, hydro etc. According to the development of India, Electricity generation on non-conventional energy sources also plays a major part. On behalf of this, the operation predicated solar- wind crossbred system systems is more important than other combined sources. crossbred energy system is the combination of any two energy sources in a power system to fulfil the demand of consumers. This system can be designed for both off grid and on grid and also furnishing the uninterrupted force in various climatic conditions. Some of the cold- thoroughbred generation systems are solar- wind, solar- diesel, wind- hydro and wind- diesel. This design mainly on non- grid connected solar and wind crossbred power system.

Keywords

Solar Panel, Wind Turbine, Mains Power Supply, Converter, Battery, Step-up Transformer, Direct Current(dc), Alternating current (ac), Bulb/load, Renewable energy, Hybrid system

Introduction

Our demand of electricity for operation all the appliances in our day- to- day life. So, it becomes an necessary part in our life. Now there are two ways for producing electricity as renewable and non-renewable sources. The electricity product from non-renewable sources causes pollution in atmosphere similar as ash in case of coal power factory, similar as bank in diesel power factory, some radioactive waste from nuclear power factory and also depleting in nature [1].Such difficulty can be reduced through the use of renewable energy resources. The standalone renewable energy systems in electricity product have less effective than combination of two systems to overcome the demand in the world. Hybrid energy system is the combination of any two energy sources in a power system to fulfil the demand of consumers[2][3]. This system can be designed for both off grid and on grid and also furnishing the continued force in colourful climatic conditions. Some of the cold-blooded generation systems are solar- wind, solar- diesel, wind- hydro and wind- diesel. Among these, solar- wind mongrel system is the most eco-friendly and profitable system. Because the vacuity of solar and wind are further than other combinations. It can also be installed anywhere in the world. The new source should be dependable, pollution free and provident[4]. The non-conventional energy coffers should be good indispensable energy coffers for the conventional energy coffers. There are

numerous non-conventional energy coffers like geothermal, tidal, wind, solar etc. the tidal energy has downsides like it can only enforced on ocean props[5]. While geothermal energy requirements veritably lager step to prize heat from earth. Solar and wind are fluently available in all condition. The non-conventional energy coffers like solar, wind can be good indispensable source[6]. Solar energy has debit that it couldn't produce electrical energy in stormy and cloudy season so to overcome this debit use of three energy coffers so that any one of source fails other source will keep generating the electricity and in good rainfall condition uses all sources combine[7]. In this design used a VAWT rather of HAWT. Hence this design is grounded on the combination of two energy source mains, wind and solar. To prize energy from wind and to convert that energy into electrical power, our need, Wind Turbine setup which can convert the mechanical power into electrical power. The blades of the wind turbine are fixed to the rotor part of the creator set which is mounted on the turbine using gear- arrangement. Wind with a speed of 5km/hr or further causes the gyration of the blades of the turbine. As the blades rotate, the mechanical power also converts into electrical power with the help of creator set[8][9][12]. Hybrid energy system is the combination of two energy sources for giving power to the cargo. Hybrid energy system has good trust ability, effectiveness, lower emigration, and lower cost[12].

Mains

Battery chargers are necessary for any 12V electrical setup because it allows the battery to charge itself and be usable again by the 12V circuit system. There are different chargers that use different energy sources to charge the battery, e.g., solar cell uses solar energy, wind turbine uses wind energy or mains can be used to charge the battery directly using the grid system.

RENEWABLE ENERGY SYSTEM

Solar energy is the energy which we receive from the sun in the form of radiation and it does not cause any harm to the environment. Its greatest feature is its abundance and free of cost nature. The system effectiveness is pretty good too and the availability of the energy source is continuous. The average periodic radiation received by earth is 1000w/m^2[10].
When the wind blows it generates some kinetic energy which can used to create electricity with the help of a suitable wind turbine and circuit system and the production cost is fairly low too. The advantageous part of this system is that wind is available nearly throughout the day and its efficiency depends on the speed of the wind. The hybrid system provides overall advantage over other conventional sources of energy[10][11]. It can be used on-grid or can be used by the consumers directly with the help of circuit system to charge battery for further use. We can say that the overall advantage of this is its effectiveness, long life span, low pollution and environment friendly1[13][14].

Objective of this project

- Make a solar and wind hybrid power system.
- The use of mains, photovoltaic cell and wind turbine for charging of battery.
- Display electrical power output through charging system.

- To provide alternate power solution for remote location.
- Use of renewable energy sources.

The layout of paper is divided in five section

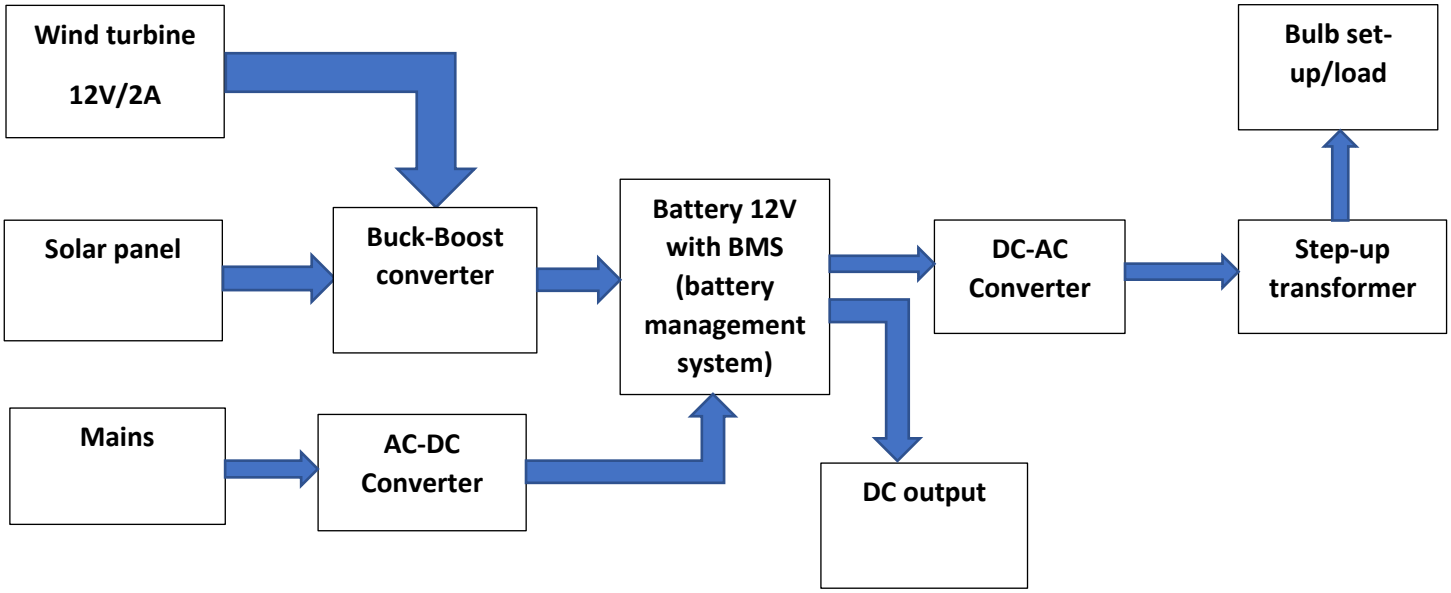
Section 1- Cover the introduction of various methods

Methods-

1. **Mains power supply**
2. **Renewable energy resources**

Working Methodology

The solar panel used give an output of 6V for steady charging of the battery. The wind turbine generates an output voltage of 7V dc. Now the voltage is stored in a 12V rechargeable battery[14]. Hence the system voltage of 13V dc can be converted into 220V ac using a step-up transformer after converting the DC output from the battery to AC. The solar panel and wind turbine can be used to charge the rechargeable battery[16]. The battery can also be charged using the mains directly. The system is also provided with a BMS (Battery management system) which shows the charging status of the battery. With the help of switch and socket, loads can be connected. Here the output is shown using a load which is a bulb setup that glows when the power is turned on[17][18].



Method

Mains power supply-

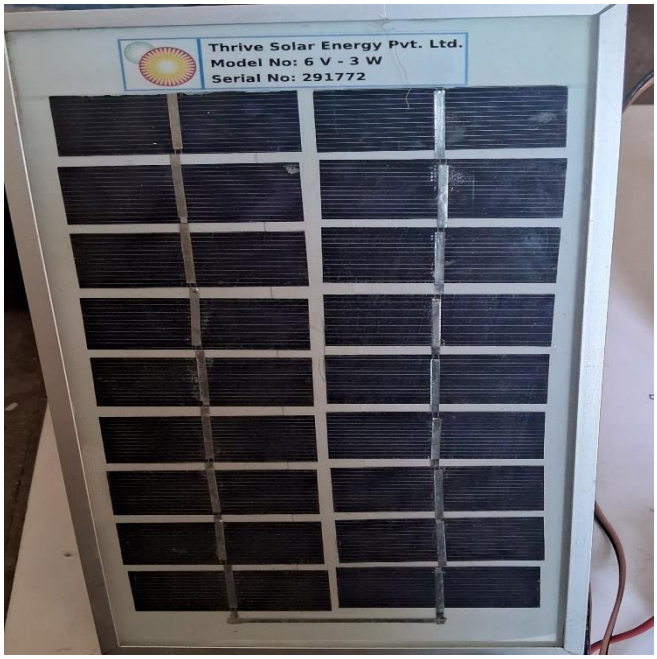
Battery chargers are essential to any 12V electrical setup, allowing you to replenish the charge that is drawn from your battery by your 12V circuits. The mains power supply uses the AC current to charge the 12V battery. The hybrid system is weather dependent, so if there is no wind or no sunlight then the mains charging system can be used to charge the battery. The supply from the mains is converted from AC to DC using bridge rectifier then it is used further to charge the battery.

Renewable energy resources

Solar energy system- when the solar radiation from the sun fall of the photovoltaic cell of the solar panel, then the panel converts the sunlight into electrical energy and the electrical energy generated is in the form of DC current. The average solar radiation received by the panel is 6 hours per day in all conditions of atmosphere[18][19].

Solar panel- A solar panel converts the sunlight from the sun to electrical energy and it is also known as photovoltaic cell. It consists of a thin layer of p-type semiconductor layer and a thick layer of n-type semiconductor, then a few electrodes are applied on the top of the p-type semiconductor layer. The solar panels used here have an rating of 6V/2amp[19][20]. The output produced by the solar panel depends on the intensity of the sunlight which causes unsteady production of DC current which causes fluctuation in the charging of the battery[21][22].

Figure 1: solar panel



Wind Energy System- The wind energy system consists of a wind turbine which converts the kinetic energy of the wind to electrical energy using Dynamo motor. The dynamo motor acts a generator to produce electricity, the output generated depends on the velocity of the wind. The power output generated by the turbine depends directly on the speed of the wind blowing (the higher the speed of wind the greater is the output generated by the turbine)[26][27].

Wind turbine- wind is a renewable source of energy and the wind turbine is used to convert the kinetic energy of the wind into electrical energy. Wind turbine is basically of two types: horizontal axis wind turbine and vertical axis wind turbine[23][24]. The power generated is then stored in a rechargeable battery for the load to use it. Wind turbines use the kinetic energy of the wind to produce clean and emission free energy for farm, house and small businesses. The generator of the wind turbine converts the mechanical energy of the blades into electrical energy. The wind turbine used here is horizontal axis wind turbine because their height gives them an advantage over vertical axis wind turbine and they receive wind at hight speed which helps them to generate more output[28]. The wind turbines are highly efficient and reliable [25][26][27][29].

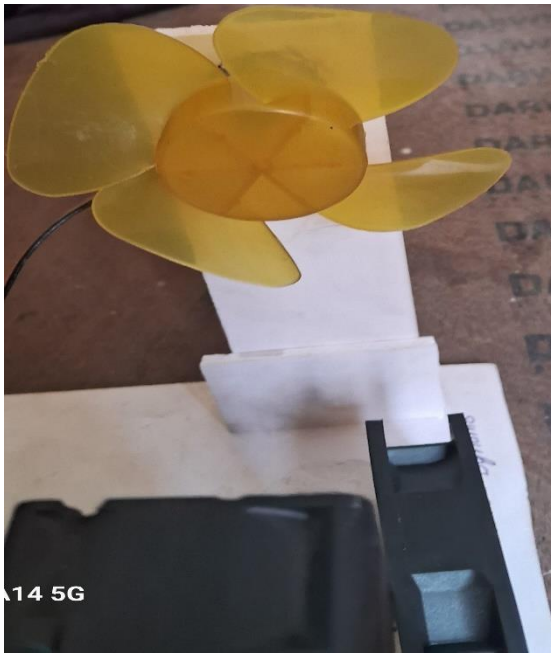


Figure 2: wind turbine with simulator

Calculation

Calculation for wind power plant-

Rated Voltage = 6.9 V
Rated current = 2 Amp
Total power generation
Generated electricity=6.9V,2 Amp
∴ 6.9V x 2 Amp = 13.8W
Consider, in one minute 13.8W power generated
∴ In 1 hour = 13.8x 60 = 828 watt

Calculation for solar power plant:

Maximum power of the solar panel is = 3W
Rated voltages=6V
Rated current=2A
Therefore, generation can be obtained from solar power plant is 12W/min.
We are getting the following result:

1. 800 to900 watt generation can be obtained from wind turbine power plant in 1 hour.
2. 700 to750 generation can be obtained from the solar power plant.

Overall, output obtained from this project is 750W in 1 hour

Hybrid System

The total power produced by renewable sources of energy produced in India is quite less as compared to non-renewable sources of energy. The wind power produced is: 41.9 GW, Solar power produced is: 63.3 GW, biomass/co-generation: 10.2 GW and small hydro power produced id: 4.93 GW[22]. It is also difficult to supply electricity to various parts of India like the hilly regions, villages, etc. To overcome this shortage of supply we can increase the use of renewable source of energy by using the hybrid system which uses the power of sun and wind to generate energy[19]. The hybrid system uses wind mill and solar panel to generate electricity from wind velocity and radiation from the sun. the use hybrid system can be very useful to reduce the power shortage as it can be used on grid as well as off grid. Places where it is difficult to provide electricity, there we can use hybrid system to generate and store electricity. Renewable sources are available

everywhere and can be used to produce clean and safe supply for daily purpose. The hybrid system provided here consists of three-way charging system, they are solar, wind and mains[19][22].

CONVERTER – There are mainly four types of converters - AC-DC Converter, AC-AC Converter, DC-DC Converter and DC-AC Converter. The type of converter being used here is AC-DC converter and DC-AC converter. First we use the AC-DC converter to convert the AC current from the mains to DC for charging of the battery and later in the stage we use DC-AC converter to convert the DC current from the battery to AC for the load to use it.

AC-DC Converter- AC/DC converters are electrical circuits that transform alternating current (AC) input into direct current (DC) output. AC/DC Converters are also called “rectifiers”; they convert the input AC voltage to variable DC voltage, then optimize it through a filter to obtain an unregulated DC voltage.

DC-AC Converter- A power inverter, inverter or invertor is a power electronic device or circuitry that changes direct current (DC) to alternating current (AC).

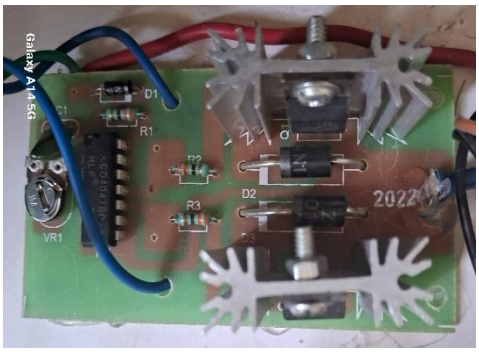


Figure 3: DC-AC Converter

figure 4: AC-DC Converter

Boost converter

A boost converter is a step-up, DC-DC converter. It increases the voltage while decreasing the current. The boost converter is used to amplify the input from solar and wind charging system to a fixed amount for the steady charging of the battery which helps increase the battery lifetime.

Figure 5: boost converter

Battery

A battery is used to store electricity that is produced from solar and wind energy systems. The capacity of a battery varies depending on the size of solar panel and wind turbine used. Battery requires low maintenance and low charge leakage. The number of batteries connected in series or in parallel to increase or decrease the capacity of a battery depending on the output of hybrid system[30]. The battery also consists of BMS(battery management system) to indicate the charging status of battery via phone or led display. The battery management system indicates whether the battery is being charged or not and it also indicates the active charge percentage of the battery, by using which we can prevent the battery from overcharging and extend the lifespan of the battery[30][31][32].

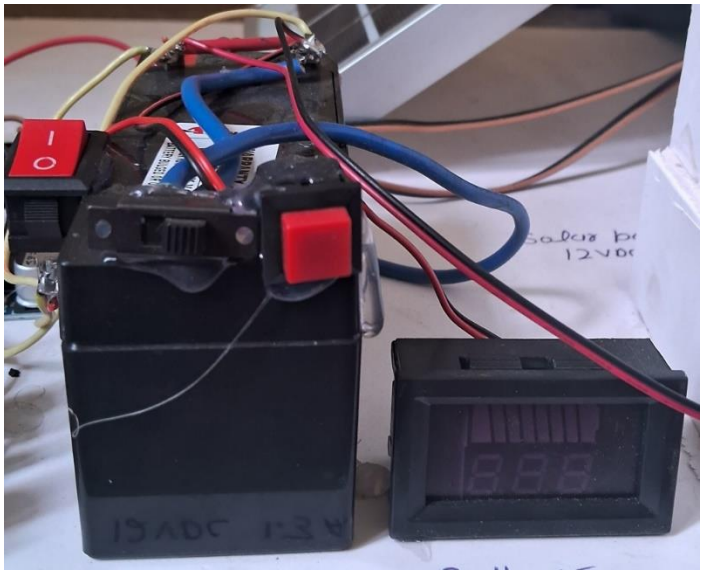


Figure 6: Battery with BMS

Step-up transformer

The transformer that increases the voltage from primary to secondary is known as a step-up transformer. The number of turns in this type of transformer is more on the secondary side than compared to the primary side. The use of step-up transformer here is to increase the voltage coming from the DC-AC converter (12V) to 220V for the load to use. The battery stores the power generated from the solar panels and wind turbine, then sends it to the step-up transformer which amplifies the 12V input to a 220V output which is then supplied to the bulb setup (load).

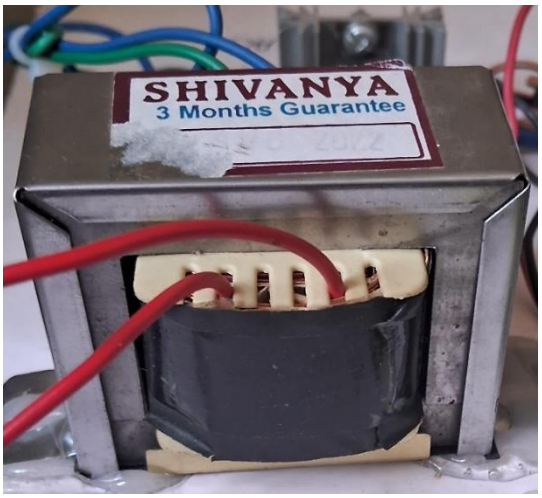


Figure 7: step-up transformer

Conclusion

From this project we conclude that hybrid power generation is a safe way to harness the renewable source of energy and it causes less damage to the environment. By using this we can reduce the transmission losses as well as the cost. It is way more safer and cleaner than the conventional sources of energy, the hybrid power generation system can be used to supply power to the places where the government struggles. This reduces the load on the power stations and also reduces power shortage. It is cost effective as it can be used at it can be used at the place where it is generated. It has a better life span and has overall advantage over conventional source of energy.

Future scope

This project provides a long-term solution for the power shortage around the world. Hybrid power generation can be used on grid as well as off grid. The hybrid system can be used to generate power at large scale which can solve the power shortage issue for remote location and research area.

REFERENCES

[1] A. Adejumobi, S.G. Oyagbinrin, F. G. Akinboro & M.B. Olajide, "Hybrid Solar and Wind Power: An Essential for Information Communication Technology Infrastructure and people in rural communities", IJRRAS, Volume 9, Issue1, pp 130-138, October 2011.
[2] Kavita Sharma, Prateek Haksar "Designing of Hybrid Power Generation System using Wind Energy-Photovoltaic Solar Energy- Solar Energy with Nanoantenna", International Journal of Engineering Research and Applications (IJERA) Vol. 2, Issue 1, pp.812-815, February 2012.
[3] Arjun A. K., Athul S., Mohamed Ayub, Neethu Ramesh, and Anith Krishnan," Micro - Hybrid Power Systems – A Feasibility Study", Journal of Clean Energy Technologies, Vol. 1, No. 1, pp27-32, January 2013.
[4] Sandeep Kumar, Vijay Kumar Garg, "A Hybrid model of Solar-Wind Power Generation System", International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering, IJAREEIE, Vol. 2, Issue 8, pp. 4107-4016, August 2014.
[5] Rakesh Kumar B. Shah, "Wind solar hybrid energy conversion system literature review," - International Journal of Scientific Research, ISSN, Vol. 4, Issue 6, pp 2277-8179, June 2015.
[6] Ugur FESLI, Raif BAYIR, Mahmut OZER, "Design & Implementation of Domestic SolarWind Hybrid Energy System", Zonguldak Karaelmas University, Department of Electrical and Electronics Engineering, Zonguldak, Turkey.
[7] Nazih Moubayed, Ali El-Ali, Rachid Outbib, "Control of a Hybrid Solar-Wind System with Acid Battery for Storage", Wseas Transactions on Power System, Laboratory of Science in Information and System (LSI), Axi-Marseille University, France.
[8] Pritesh P. Shirsath, Anant Pise, Ajit Shinde," Solar wind hybrid generation system", - IJERGS, volume 4, issue 2, pp 2091-2730, April 2016.
[9] Bharat Raj Singh, Bal Krishna Dubey- - "Solar wind hybrid power generation system", IRJET, volume 5, issue 1, pp 2395-0072, January 2018.
[10]. Mohamed, A. Al-Habaibeh, H., An investigation into the current utilisation and prospective of renewable energy resources and technologies in Libya, *Renewable Energy*, 50 (2013) 732-740.
[11]. Craig S. Turchi and Zhiwen Ma National Renewable Energy Laboratory Michael Erbes Enginomix, LLC To be presented at the ASME Turbo Expo 2011 Vancouver, Canada June 6-10, 2011.
[12]. Gelany A and ather. Must Hybrid Power Generation Systemin {Wind turbine (HAWT) & Solar (PV)} [Master thesis]. Faculty of Engineering. Misr University for Science & Technology 2017.

[13] Zeman, M. (2013). Photovoltaic Systems. Delft University of Technology. Chapter 9.
[14] Souliotis, M. (2013). Application Aspects of Hybrid PV/T Solar Systems. University of Patras. Physics Department.
[15] Léna, G. (2013). Rural Electrification with PV Hybrid Systems. International Energy Agency Photovoltaic Power Systems Programme. IEA-PVPS T9:13.
58
[16] "Residential Wind Energy Systems - Bergey Wind PowerBergey Wind Power." Bergey Wind Power. http://bergey.com/wind-school/residential-wind-energy-systems.
[17] Biswas, A., Bhanja D, Gangwar S. (2015). Cost, reliability, and sensitivity of a standalone hybrid renewable energy system. CrossMark. 013109
[18] Hybrid energy storage systems for renewable energy applications Thilo Bocklisch*,9th edition.
[19] RELIABILITY ANALYSIS OF HYBRID ENERGY SYSTEM ZHIGANG TIAN_,and Department of Mechanical Engineering University of Alberta, Edmonton, Canada Concordia Institute for Information Systems Engineering Concordia University, Montreal, Canada Published 7 May 2014.
[20] S. Jain, and V. Agarwal, "An Integrated Hybrid Power Supply for Distributed Generation Applications Fed by Nonconventional Energy Sources," IEEE Transactions on Energy Conversion, vol. 23, June 2008.
[21] A. O. Ciuca, I. B. Istrate, and M. Scripcariu, "Hybrid Power-Application for Tourism in Isolated Areas," World Academy of Science, Engineering and Technology 53 2009, pp. 264-269.
[22] Non-conventional energy sources by smt.C.K.Rai.
[23] Ahmed, N.A., Miyatake, M., and Al-Othman, A.K. "Power Fluctuations Suppression Of Stand-Alone Hybrid Generation Combining Solar Photovoltaic/Wind Turbine And Fuel Cell Systems, Energy Conversion.
[24] Deshmukh, M.K., Deshmukh, S.S. "Modeling Of hybrid Renewable Energy Systems", Renewable and Sustainable Energy Reviews, Vol. 12, No. 1, pp. 235-249
[25] Yang, H.X., Jurnett, B., and Lu, L. "Weather data And probability analysis Of hybrid photovoltaic-wind power generation systems In Hong Kong", Renewable Energy,Vol. 28, No. 11, pp. 1813-24, 2003.
[26] Yang, H.X., Lu, L., and Zhou, W. "A Novel Optimization Sizing Model For Hybrid SolarWind Power Generation System:, Solar Energy, Vol. 81, No. 1, pp. 76-84, 2007.
[27] Tina, G., Gagliano, S., and Raiti, S. "Hybrid solar/wind power system probabilistic modelling for long-term performance assessment", Solar Energy, Vol. 80, pp. 578-588, 2006.
[28] Celik, A.N. "Techno-Economic Analysis Of Autonomous PV-Wind Hybrid Energy Systems Using Different Sizing Methods", Energy Conversion And Management, Vol. 44,pp. 1951-1968, 2003.
[29] Read some paper on VAWT and solar panel through Wikipedia A. O. Ciuca, I. B. Istrate, and M. Scripcariu, "Hybrid Power-Application for Tourism in Isolated Areas," World Academy of Science, Engineering and Technology 53 2009, pp. 264-269.
[30] K. Ch. Karasavvas, "Modular Simulation of a Hybrid Power Systemwith Diesel, Photovoltaic Inverter and Wind Turbine Generation,"Journal of Engineering Science and Technology Review 1(2008), pp.38-40. Vol-4 Issue-2 2018 IJARIIE-ISSN(O)-2395-4396 7501 www.ijariie.com 241
[31] B. Chitti Babu and K. B. Mohanty, "Doubly-fed Induction Generator for Variable Speed Wind Energy Conversion Systems-Modeling &Simulation," International Journal of Computer andElectricalEngineering,Vol.2,No.1,February,2010,1793-8163,pp. 141-147.
[32] S. A. abbasi and Naseema Abbasi, "Renewable Energy Sources and Their Environmental Impact," Prentice Hall of India Private Limited shtra, India,.