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Control Scheme for a Stand-Alone Wind Energy Conversion System for Better Efficiency of Battery Storage

Dr. S.Ezhilarasan [#1], V. Ananthapadmanabhan [#2], Dr. P.Avirajamanjula,[#3]

[#1] Associate Professor, [#2] PG student, [#3] Professor
Department of Electrical and Electronics Engineering, Ponnaiyah Ramajayam Institute of Science and Technology, Vallam, Thanjavur, Tamilnadu, India

Abstract

The Power system requirement for isolated, low populated area is un-economical, if power is to be transmitted from far end, the initial cost, maintenance, will be too high, the line loss will also be more. Hence for such places stand alone wind energy conversion system (Non grid) with battery storage is a better option; provided the geographical attitude is higher and minimum velocity of wind is between 15 – 25 m/h. In general the wind force is not uniform throughout the day, it varies time to time. Hence the output power and frequency cannot be maintained uniformly to the consumer satisfaction. A control system is deployed for uniform power output and frequency under varying wind force. For obtaining this control pitch control is used, by adjusting the pitch control the power output and frequency maintained constantly. The next topic is storage device. Without storage device continuity of supply could not be maintained. The storage device generally costlier and the life expectancy will be short. To enhance the life expectancy some advanced technique like maximum power point tracking (MPPT) is used. By this control system the charging of battery is continuous and by adding some ripple the battery charging is better and the harmonic content is eliminated by avoiding overheating of the battery. The battery control system uses both constant current and constant voltage for making the high efficiency of battery banks and enhancing the life of the battery.

INTRODUCTION

Energy is the considered to be the pivotal input for development. At present as a result of the depletion of to be had conventional sources and concern concerning environmental degradation, the renewable resources are being applied to meet the ever growing strength call for Due to a fantastically low free of power manufacturing wind electricity is considered to be one of the ability resources of clean energy for the future. But the nature of wind flow is stochastic. So rigorous checking out is to be completed in laboratory to broaden efficient manipulate method for wind strength conversion gadget (WECS). They have a look at of WECS and the related controllers are, consequently, becoming more and more significant with each passing day. Nowadays, many stand-alone masses are powered by using renewable source of energy. With this renewed hobby in wind generation for stand-on my own packages; a extraordinary deal of studies is being completed for selecting a suitable generator for stand-by myself WECS. A special comparison among asynchronous and synchronous mills for wind farm software is made. The fundamental gain of asynchronous device is that the variable velocity operation allows extracting most energy from WECS and decreasing the torque fluctuations. Induction generator with a lower unit cost, inherent robustness, and Operational simplicity is considered because the maximum viable choice as wind turbine generator (WTG) for off grid programs. However, the induction generator requires capacitor banks for excitation at remoted locations. The excitation phenomenon of self-excited induction generator (SEIG) is explained. The energy output of the SEIG relies upon on the wind flow which by way of nature is erratic. Both amplitude and frequency of the SEIG voltage vary with wind pace. Such arbitrarily varying voltage while interfaced immediately with the weight can deliver rise to flicker and instability at the load give up. So, the WECS are incorporated with the weight by way of power digital converters with a view to make certain a regulated load voltage. Again due to the intermittent traits of the wind power, a WECS desires to have electricity garage device. An evaluation of the to be had garage technology for wind electricity application is made. The gain of battery electricity garage for a remoted WECS is discussed. With battery electricity garage it's far possible to seize maximum energy from the to be had wind.

RELATED WORKS

In A. D. Sahin et al presents in a small time, wind energy is welcome by society, industry and politics as a clean, sensible, economical and environmentally friendly alternative. After the 1973 oil crisis, the RE sources in progress to emerge in the agenda and hence the wind energy gained important interest. As a result of general studies on this topic, wind energy has lately been applied in various industries, and it started to struggle with other energy resources. In this manuscript wind energy is evaluation and opened for additional discussion. Wind energy narration, wind-power meteorology, the energy–climate relatives, wind-turbine knowledge, wind economy, wind–hybrid applications and the topical position of mount wind energy capacity all over the world appraisal intensely with additional enhancements and novel explore leaning bearing suggestions.

In [2] R. D. Richardson and G. M. Mcnerney et al presents Wind power nowadays represents a chief and growing source of renewable energy. Huge wind turbines (with capacity of up

to 6-8 MW) are extensively installed in power distribution networks. Escalating numbers of onshore and offshore wind farms, acting as power plants, are associated directly to power transmission networks at the level of hundreds of megawatts. As its height of grid dispersion has begun to increase noticeably, wind power is starting to have a significant impact on the operation of the modern grid system. Advanced power electronics technologies are being introduced to get better the characteristics of the wind turbines, and make them more suitable for integration into the power grid. Meanwhile, there are some emerging challenges that still need to be addressed. This paper provides an overview and discusses some trends in the power electronics technologies used for wind power generation. First, the state-of-the-art technology and global market are generally discussed. Several significant wind turbine concepts are discussed, along with power electronics solutions either for entity wind turbines or for entire wind farms. Some technology challenge and future solution for power electronics in wind turbine systems are also addressed.

In [3]] R. Saidur, M. R. Islam, N. A. Rahim, and K. H. Solangi et al presents To conquer the pessimistic impacts on the surroundings and other problems connected with remnant fuels have forced many countries to inquire into and change to environmental friendly alternatives that are renewable to sustain the increasing energy demand. Solar energy is one of the best renewable energy sources with least negative impacts on the environment. Different countries have formulated solar energy policy to plummeting assurance on relic fuel and increasing domestic energy production by solar energy. This paper discusses a review about the different solar energy policies implemented on the different countries of the world. BP numerical Energy evaluation, the earth improvement installed solar energy capacity was 22928.9 MW in 2009, a adjust of 46.9% evaluate to 2008. Also these papers discuss the existing victorious solar energy policies of few chosen countries. Based on literatures, it has been instigate that FIT, RPS and incentive are the nearly all valuable energy policy implemented by loads of countries roughly the world. These policies provide significant motivation and interest for the development and use of renewable energy technologies

In [4] Mohammad Taghi Ameli, Saeid Moslehpour, Amin Mirzaie et al presents as of the global energy crises, the impulsiveness of the non-ending price fluctuations of fossil fuels and the complexities of the construction and maintenance of the nuclear power plants, wind energy and utilization of wind farms has gained an increasing importance and interest. Several wind farms are creature utilize, the nearly all significant of which is the instance ranch power-station. In this power station, all units have induction generators with gearboxes of various power capacities. Of the four producer types, specifically, collector cage induction, synchronous with endless magnet, induction with winded rotor, and synchronous with restless field, the first two types' there improved advantages to wind farm power plants. And comparing these two, the synchronous generator with permanent magnet is significantly superior to the squirrel cage induction generator, in terms of higher power coefficient, higher efficiency

In [5] G. K. Singh et al presents the increasing importance of fuel saving has been responsible for the revival of interest in so-called alternative source of energy. Thus, the drive towards the decentralization of power generation and increasing use of non-conventional energy sources such as wind energy, bio-gas, solar and hydro potential, etc. has happen to critical to adopt a low cost generating system, which is proficient of in commission in the isolated areas, and in conjunction with the variety of major movers. With the renewed interest in wind turbines and micro-hydro-generators as an alternative energy source, the induction generators are being considered as an alternative choice to the well-developed synchronous generators since of their inferior unit cost, intrinsic ruggedness, prepared and preservation simplicity. The induction generator's ability to generate power at varying speed facilitates its application in various modes such as self-excited stand-alone (isolated) mode; in parallel with synchronous generator to supplement the local load, and in grid-connected mode. The explore has been happening for the most recent three decades to investigate the different issues connected to the use of induction generator as potential unusual to the synchronous generator to employ the small hydro and wind energy to accomplish the potential energy requirement, and to feed the power to isolated locations and far flung areas, where conservatory of grid is cheaply not feasible.

PROPOSED SYSTEM

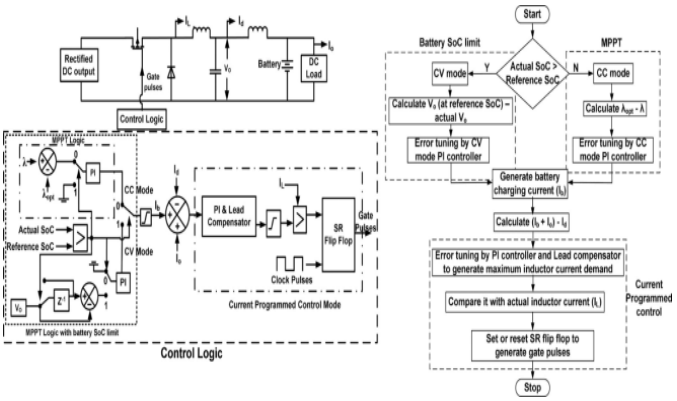
A hybrid wind-battery organization is measured to meet the load command of a stand-alone base telecom station (BTS). The BTS load requirement is modeled as a dc load which requires a nominal regulated voltage of 50 V. The WECS is interfaced with the stand-alone dc load by means of ac–dc–dc power converter to regulate the load voltage at the desired level. The proposed control conspire uses the turbine most extreme power following method with the battery SoC confine rationale to charge the battery in a controlled way.

HYBRID WIND-BATTERY SYSTEM FOR AN ISOLATED DCLOAD

The proposed hybrid gadget accommodates of a four-kW WECS and 400 Ah, C/10 lead acid battery bank. The gadget is designed for a 3-kW stand-by myself dc load. The format of the whole device together with the control strategy is proven. The specifications of the WT, SEIG, and battery bank are tabulated inside the Appendix. The WECS consists of a 4.2-kW horizontal axis WT, tools box with a tools ratio of one: eight and a 5.Four hp SEIG because the WTG. Since the weight is a stand-alone dc load the stator terminals of the SEIG are related to a capacitor financial institution for self-excitation. The ac output is rectified by way of 3-phase uncontrolled diode rectifier. However, there's a need for a battery backup to satisfy the weight demand all through the period of unavailability of sufficient wind strength. This hybrid wind-battery machine requires suitable control common sense for interfacing with the burden. The out of control dc output of the rectifier is carried out to the rate controller circuit of the battery. The rate controller is a dc–dc dollar converter which determines the charging and

discharging charge of the battery. The battery financial institution related to the system can both act as a source and load depending on whether or not it is charging or discharging. However, regardless of this the battery guarantees that the burden terminal voltage is regulated. The proposed control conspire uses the turbine most extreme power following method with the battery SoC confine rationale to charge the battery in a controlled way. The incorporated exploit of the battery charge and pitch controller guarantee consistent procedure of the stand-alone WECS.

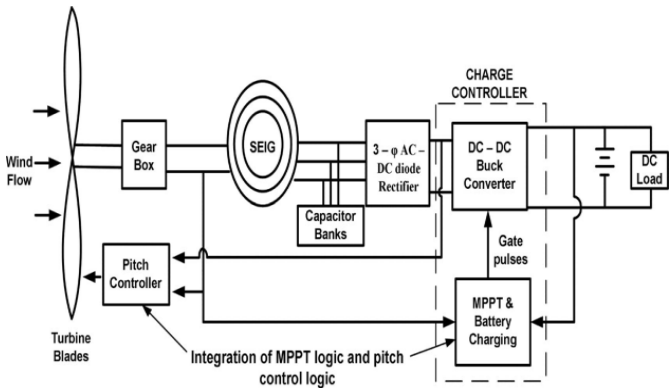
CHARGE CONTROLLER BLOCK DIAGRAM



CONTROL STRATEGY FOR STAND-ALONE HYBRID WIND-BATTERY SYSTEM

The wind flow is erratic in nature. In this manner, a WECS is coordinated with the heap by methods for an ac– dc– dc converter to stay away from voltage flicker and consonant age. The control scheme for a stand-alone hybrid wind-battery system includes the charge controller circuit for battery banks and pitch control logic to ensure WT operation within the rated value. The control rationale guarantees successful control of the WECS against every conceivable unsettling influence.

CIRCUIT DIAGRAM



A. Charge Controller for the Battery Bank

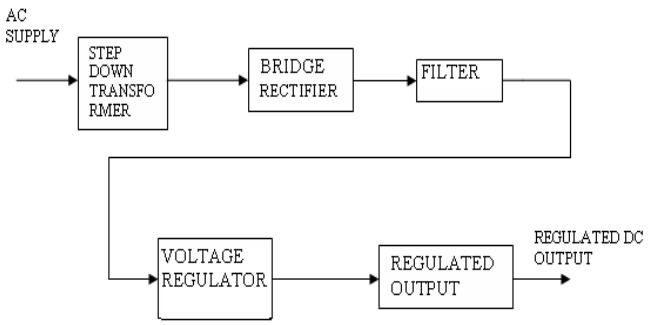
This section discusses in detail the development of charge controller circuit for a 400 Ah, C/10 battery bank using a dc–dc buck converter in MATLAB/SIMULINK platform. Generally, the batteries are charged at C/20, C/10, or C/5 rates depending on the manufacturer's specifications where C specifies the Ah rating of battery banks. So, the battery bank system considered in the design can be charged at 20, 40, or 80 A. But, in this paper, C/10 rate (i.e., 40 A) for battery charging is chosen. However, the current required for charging the battery bank depends on the battery SoC. A typical battery generally charges at a constant current (CC), i.e., C/10 rate mode till battery SoC reaches a certain level (90%–98%). This is referred to as CC mode of battery charging. The CC mode charges the battery as fast as possible. Beyond this SoC, the battery is charged at a constant voltage (CV) which is denoted as CV mode of battery charging in order to maintain the battery terminal voltage.

B. Control Strategy

The implementation of the charge control logic as shown is carried out by three nested control loops. The outer most control loop operates the turbine following MPPT logic with battery SoC limit. To implement the MPPT logic, the actual tip speed ratio (TSR) of turbine is compared with the optimum value. The error is tuned by a PI controller to generate the battery current demand as long as the battery SoC is below the CC mode limit. Past this point, the SoC control rationale tries to keep up steady battery charging voltage. This thusly diminishes the battery current request and consequently keeps the battery bank from cheating. The buck converter inductor current command is generated in the intermediate control loop. To plan the controller, it is fundamental to display the reaction of the battery current (Ib) as for the inductor current .

HARDWARE DETAILS

POWER SUPPLY UNIT



As we all recognize any discovery of newest knowledge cannot be activated lacking the resource of power. So it this fast moving world we intentionally need a proper power source which will be apt for a particular requirement. All the electronic components starting from diode to Intel IC's only work with a DC supply ranging from -+5v to 0-+12v. We are using for the same, the least expensive and normally accessible vitality wellspring of 230v-50Hz and venturing down, redressing, sifting and directing the voltage. This will be dealt briefly in the forth-coming sections.

STEP DOWN TRANSFORMER

At the point when AC is connected to the essential twisting of the power transformer it can either be ventured down or up contingent upon the estimation of DC required. In our course the transformer of 230v/0-12v is worn to execute the step down process where a 230V AC appears as 12V AC crosswise the inferior winding. One change of info makes the highest point of the transformer be certain and the base negative. The following modification will incidentally cause the switch. The current rating of the transformer used in our project is 1A. Apart from stepping down AC voltages, it gives isolation between the power source and power supply circuitries.

DIODE BRIDGE RECTIFIERS

The ac input from the main supply is stepped down using a 230 /30V step down transformer. The stepped down AC voltage is converted into dc voltage using a diode bridge rectifier. The diode bridge rectifier consists of four diodes arranged in two legs. The diodes are connected to the stepped down AC voltage. For positive half cycle of the ac voltage, the diodes D1 and D4 are forward biased (ref fig). For negative half cycles diodes D2 and D3 are forward biased. Thus dc voltage is produced to provide input supply to the DC-DC Converter.

BRIDGE RECTIFIER

When the optimistic half cycle is functional to the diode bridge rectifier, the diodes D1 and D4 are ahead biased. The diodes start conduct and the load in progress flows through the positive of the supply, diodeD1, the load, the diode D4 and the negative of the supply. The diode D2 and D3 are reverse biased and do not conduct. During the negative half cycle, the diodes D1 and D4 are b reverse biased and they stop conducting. The diodes D2 & D3 are forward biased and they start conducting. The load current flows in the same direction for both the half cycles. Thus the ac supply given to diode bridge rectifier is converted into pulsating dc.

FILTERING UNIT

Filter circuits which are usually capacitors acting as a surge arrester always follow the rectifier unit. This capacitor is also called as a decoupling capacitor or a bypassing capacitor, is used not only to ‘short’ the ripple with frequency of 120Hz to ground but also to leave the frequency of the DC to appear at the output. A load resistor R1 is connected so that a reference to the ground is maintained. C1R1 is for bypassing ripples. C2R2 is used as a low pass filter, i.e. it passes only low frequency signals and bypasses high frequency signals. The load resistor should be 1% to 2.5% of the load

VOLTAGE REGULATORS

The voltage controllers assume an imperative part in any power supply unit. The primary purpose of a regulator is to aid the rectifier and filter circuit in providing a constant DC voltage to the device. Power supplies without controllers have an innate issue of changing DC voltage esteems because of varieties in the heap or because of vacillations in the AC liner voltage. With a regulator connected to the DC output, the voltage can be maintained within a close tolerant region of the desired output IC7805 is used in this project for providing +12v and –12v DC supply. There are numerous circumstances where signs and information should be exchanged starting with one subsystem then onto the next inside a bit of gadgets gear, or from one bit of hardware to another, without making a direct ohmic electrical connection. Often this is because the source and destination are (or may be at times) at very different voltage levels, like a microprocessor, which is operating from 5V DC but being used to control a MOSFET that is switching at a higher voltage. In such situation the connection among the two should be an isolated one, to defend the microprocessor from over voltage injure.

OPTOCOUPLER

Optocoupler ordinarily arrive in a little 6-stick or 8-stick IC bundle, however is basically a mix of two unmistakable gadgets: an optical transmitter, normally a gallium arsenide LED (light-radiating diode) and an optical receiver such as a phototransistor or light-triggered diac. The two are isolated by a straightforward obstruction which hinders any electrical current stream between the two, yet allows the section of light. The basic idea is along with the usual circuit symbol for an Optocoupler Typically the electrical associations with the LED segment are conveyed out to the pins on one elevation of the package and those for the phototransistor or diac to the other side, to actually disconnect them as much as potential. This usually allows Optocoupler to withstand voltages of anywhere between 500V and 7500V between input and output Optocoupler are basically, computerized or exchanging gadgets, so they're best to transfer either on-off control signals or advanced information. Analog signals can be transferred by means of frequency or pulse-width modulation.

The most critical parameter for most Optocoupler is their exchange proficiency, generally estimated as far as their present exchange proportion or CTR. This is simply the ratio between a current change in the output transistor and the current change in the input LED that produced it. Typical values for CTR range from 10% to 50% for devices with an output phototransistor and up to 2000% or so for those with a Darlington transistor pair in the output. Note, however that in many gadgets CTR has a tendency to differ with total current level. Typically it peak at a LED existing stage of about 10mA, and cascade absent at both higher and lower existing levels.

MOSFET SWITCH-IRFP250N

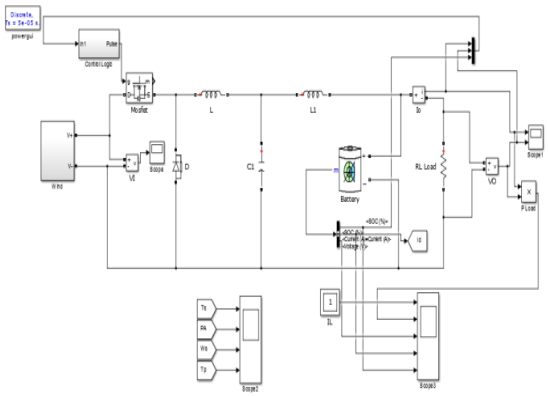
(Metal Oxide Semiconductor Field Effect Transistor). The most popular and widely used type of field effect transistor (see FET). MOSFETs are in calculation NMOS (n-channel) or PMOS (p-channel) transistors, which are manufacture as incoherently place together disjointed machinery for prominent power applications as well as by the hundreds of millions bordered by a particular chip (IC).

INDUCTORS

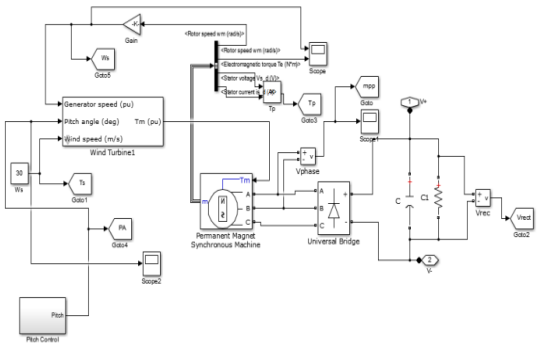
An inductor or reactor is a passive electrical component that can store energy in a magnetic field created by the electric current passing through it. An inductor's ability to accumulate magnetic energy is deliberate by its inductance, in units of henries. Typically an inductor is a conducting wire fashioned as a coil, the loops help create a strong magnetic field inside the coil due to Faraday's law of induction. Inductors are one of the basic electronic mechanism used in electronics where current and voltage change with time, due to the ability of inductors to delay and reshape alternating currents.

An "ideal inductor" has inductance, but no conflict or capacitance, and does not disperse energy. A real inductor is corresponding to a grouping of inductance, various resistances due to the resistivity of the wire, and some capacitance. At numerous frequencies, naturally a lot greater to the working frequency, genuine inductors behave as a resonant circuit (due to its self capacitance). In addition to dissipating energy in the resistance of the wire, magnetic core inductors may dissipate energy in the core due to hysteresis, and at high currents may show other departures from ideal behavior due to nonlinearity.

SIMULATION RESULT

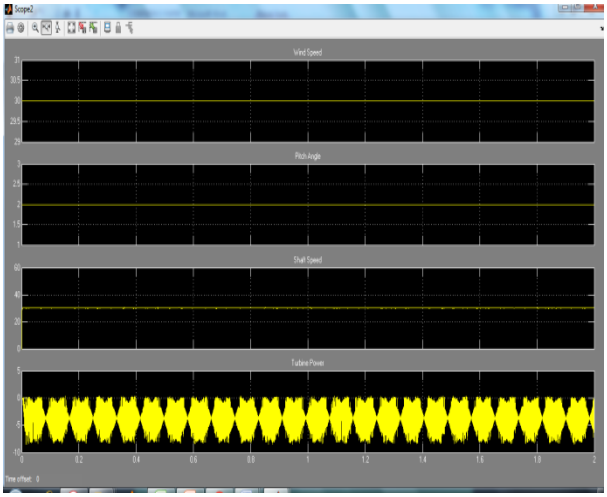


WIND SYSTEM

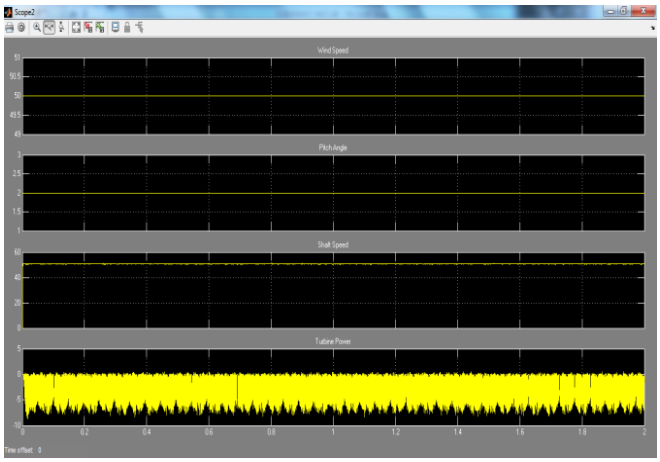


SIMULATION OUTPUT

In this process wind source is given to 30. But if any changes is present output power will be constant.

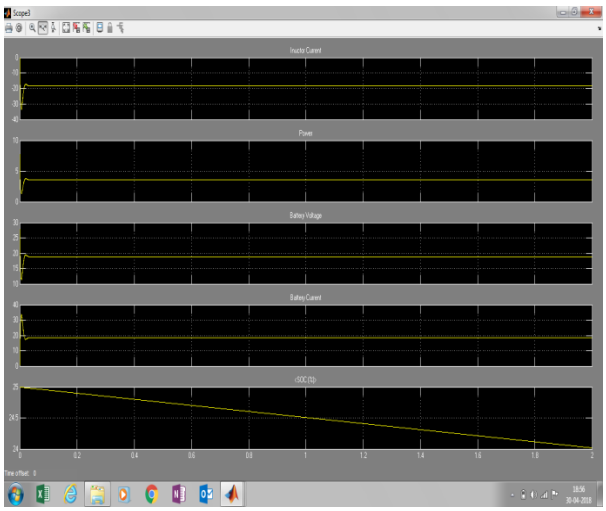


In this process wind source is given to 50. But if any changes such as varying velocity automatically changes output power will be constant.



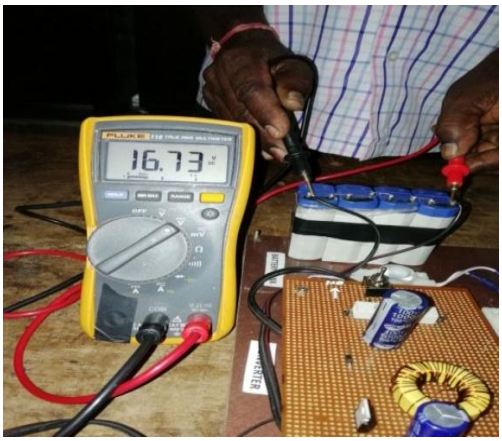
OUTPUT

Output is constant for both wind source 50km/hr and wind source 30km/hr



WIND MILL

BATTERY VOLTAGE



SOURCE VOLTAGE

CONCLUSION

The power presented from a WECS is very untrustworthy in scenery. So, a WECS cannot guarantee uninterrupted power stream to the load. In order to meet the load requirement at all instances, suitable storage device is needed. Therefore, in this manuscript, a hybrid wind-battery organization is selected to provide the preferred load power. To alleviate the unsystematic distinctiveness of wind flow the WECS is interfaced with the load by suitable controllers. The control logic implement in the hybrid locate up includes the charge organize of battery bank using MPPT and pitch control of the WT for assure electrical and unconscious protection. The charge controller tracks the maximum power accessible to charge the battery bank in a controlled manner. Further it also makes sure that the batteries discharge current is also inside the C/10 limit. The in progress programmed control practice intrinsically protects the buck converter from over existing situation. However, at times due to MPPT organize the source power might be more as compared to the battery and load authority. During the power divergence circumstances**,** the pitch action can control the pitch angle to condense the WT output power in agreement with the total demand. Besides manipulative the WT independence, the pitch control logic guarantees that the rectifier voltage does not lead to an overvoltage condition.

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