

Review of Solar Photovoltaic Based Water Pumping System for Irrigation System and Drinking Water Supplies

K.Kalyani ¹, M.Marimuthu ², B.Paranthagan³, R.Balasubramanian ⁴, G.Yoga ⁵

^{1,5} PG Scholar, ² Assistant Professor, ^{3,4} Associate Professor

Abstract- This paper discusses about scope and review of solar photovoltaic based water pump system. The amount of electricity and high diesel costs affects the necessary condition of pumping water supplies and irrigation. The usage of solar energy based water pumping method is a promising alternative to conventional electricity and diesel based pumping systems. Solar based water pumping depends on photovoltaic (PV) innovation that believes sun powered into electrical power to run a DC or AC motor based water pump. The principle goal of the examination is to introduce an extensive writing survey of sunlight based pumping innovation, assess the financial reasonability, distinguish explore holes and hindrances in the broad engendering of solar powered water pumping system and technology. The study focuses on update on solar based water pumping technology, execution investigation, ideal measuring, debasement of PV generator providing energy to pump, financial and ecological viewpoints and advances in PV materials and productivity enhancements. A report on flow condition of research and usage of sunlight based water pumping innovation is exhibited. Components influencing execution of PV water pumping framework, debasement of PV modules and proficiency enhancing methods of PV water pumping technology are distinguished. Solar based water pumping is observed to be financially suitable in contrast with power or diesel based technology for water system and water supplies in rural, urban and remote area. The investment payback for some PV water pumping technology is observed to be 4– 6 years. The current Indian motivations for PV pumping and arrangement activities for the advancement of sun based water pumping in creating nations are likewise examined. Potential follow-up research areas are recognized.

Keywords: Photovoltaic water pumping system, Irrigation Technology, Renewable energy, sustainable solution, motors.

1. INTRODUCTION

Photovoltaic water pumping system is one of the nice alternative strategies for irrigation. The variant of spatial and temporal distribution of available water for irrigation makes full-size demand on water conservation techniques. Hence solar powered automated irrigation device presents a sustainable strategy to enhance water use performance inside the agricultural fields using renewable electricity gadget removes workmanship this is wanted for flooding irrigation. Environmental pollutant is prevented with renewable power and power production from neighborhood assets is endorsed. The use of this photo-irrigation system may be capable of make contributions to the socio-monetary improvement. It's far the proposed answer for the present electricity disaster for the Indian farmers. This device conserves power by way of lowering the usage of grid strength and conserves water via lowering water losses. proposed system is simple to put into effect and environment pleasant solution for irrigating fields.

The system was found to be successful when applied for bore holes as they pump over the entire day. Solar pumps also provide smooth solutions with no danger of borehole infection. The device requires minimal preservation and interest as they are self-beginning. solar power is the most abundant supply of energy inside the international. sun strength isn't always most effective an answer to today's energy crisis but also an environmental pleasant shape of

energy. photovoltaic generation is a good approach for the usage of the solar power. solar panels are actually a day drastically used for going for walks avenue lighting fixtures, for powering water. Heaters and to satisfy home masses. The fee of sun panels has been continuously lowering which inspires its usage in numerous sectors. one of the applications of this generation is used in irrigation structures for farming. Solar powered irrigation gadget may be a suitable alternative for farmers inside the present kingdom of electricity crisis in India. This is inexperienced manner for electricity manufacturing which offers loose strength as soon as an initial investment is made in recent times, because the increasing scarcity of water assets, promote water saving irrigation generation and has end up the inevitable desire to fill the water crisis.

These days the technology is heading toward extremely-technology. Water pumping has an extended records so many methods were advanced to pump water. Human beings have used a selection of electricity resources, specifically human power, animal power, hydro strength, wind, sun and fuels this kind of diesel for small mills. The maximum common pumps utilized in remote communities are:

- Direct drive diesel driven borehole pumps
- Hand pumps.
- Solar submersible pumps
- Electric submersible pumps with diesel generator

II. PHOTOVOLTAIC CELLS

Photovoltaic cells are devices which 'accumulate the light and convert it into electricity. The cells are stressed out in collection, sealed among sheets of glass or plastic, and supported inside a steel body. These frames are known as solar modules or panels. They're used to power a variety of application ranging from calculators and wrist-watches to finish home systems and massive electricity power plant. PV cells are made of thin silicon wafers; a semi-conducting material just like that used in computer chips. When sunlight is absorbed by these materials, the solar energy knocks electrons unfastened from their atoms, permitting the electrons to float via the material to produce electricity. This technique of converting lights (photons) to electricity (voltage) is known as the "photovoltaic effect".

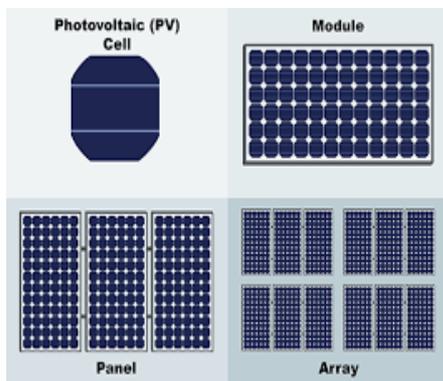


Fig 1. Structure of PV cell, Module, Array, panel.

A. Photovoltaic Applications

Solar panels are used in a number of applications. The application vary from small simple method to large elaborate power plants.

- Communities, small industries and institutions like school, for lighting as well as for powering television, computers etc.
- Water pumping system, Telecommunication.
- Health centre vaccine refrigeration in rural area. Such solar refrigeration are also utilized to store blood plasma. WHO Supports programmers that install solar power for medical purposes.
- Urban and rural households for domestic purpose like lightning.

III. SOLAR PV BASED WATER PUMPING TECHNOLOGY

A. Current state of technology

A SPV water pumping system includes a PV array, a DC/AC surface established/submersible/floating motor pump set, electronics. The PV array is mounted on a suitable shape with a provision of manual or automatic monitoring. Water is pumped at during day and stored in tanks, to be used throughout day time, night time or under cloudy situations.

The water tank acts as storage and usually battery is not used for storage of PV energy; but for specific reliable requirements it can be used. The component used in the PV water pumping system should conform to the national/international specifications, whichever is applicable in a country.

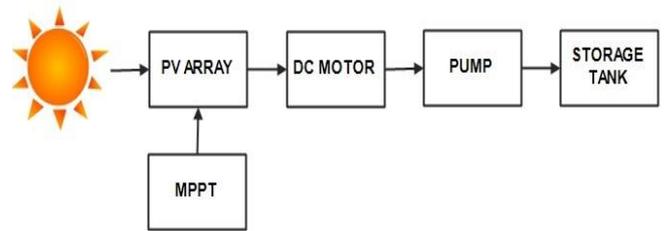


Fig 2. Block diagram of direct coupled solar based water pumping system with MPPT

B. Types of solar water pumps

The various types of current configurations of direct coupled DC and AC solar water pumping systems being used worldwide are shown in figs 3-5

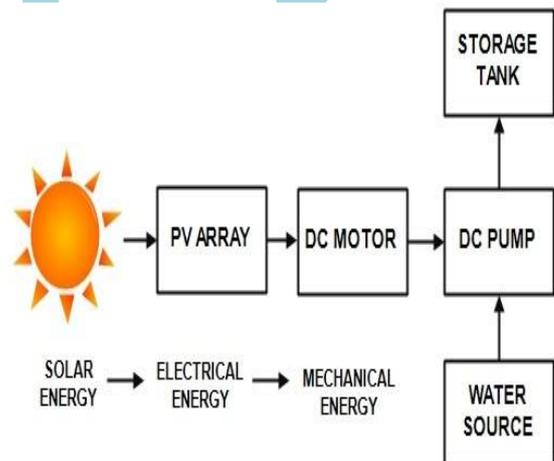


Fig 3. Block diagram of direct coupled solar PV DC water pumping system

Direct coupled dc solar pumping was first introducing in the field in the late 1970s. In advance PV water pumping systems have boundaries of standard overall performance of the device due to lack of proper layout. Since then, manufactures have refined their Product to enhance the overall performance and reliability. The consistent fall in charges of solar photovoltaic (PV) panels have led to making solar pumping economically possible for an increasingly more extensive variety of applications. Direct coupled dc solar pumps are easy and reliable however cannot function at most electricity factor of PV generator as the solar radiation varies all through the day from morning until evening. but, including a maximum energy factor tracker (MPPT) and controls/protections enhance the overall performance of a PV pump.

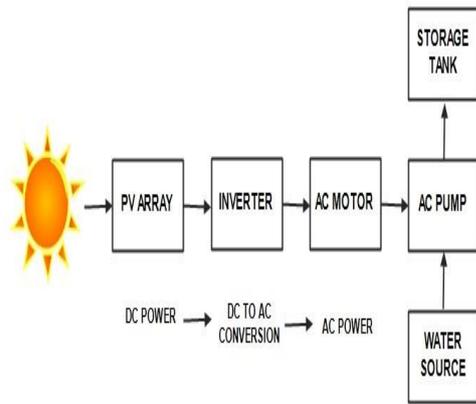


Fig 4. Block diagram of direct coupled solar PV AC water pumping system

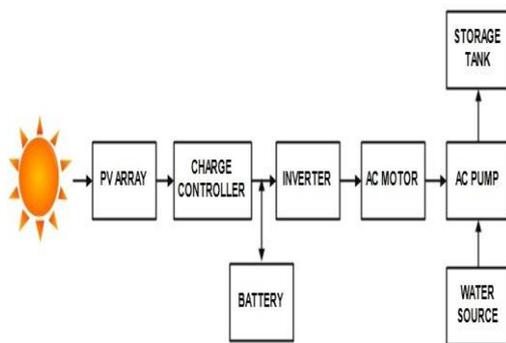


Fig 5. Block diagram of direct coupled solar PV water pumping system with Battery storage.

C. Function of PV Water Pumping System

A 50-watt photovoltaic solar panel can power a 12-volt pump, that could pass 1,300–2,600 liters in per hour or (350–700 gallons). Standard plastic fittings and half-inch piping join these factors to a water saving tank of 500–1,000 liters. A sturdy stand have to be built for the water tank to provide gravity flow, and a frame need to also be built to provide the high-quality attitude for the solar panels. More than one filters are needed to defend the lifestyles of the pump and reduce clogging in sprinkler emitters and tubes. A solar pump blended with lower priced drip irrigation kits may be used with a wide variety of high value crops to increases water performance, decrease fertilizer loss, and irrigate hilly terrains.

IV. LITERATURE SURVEY

In this paper Anna Mathew, A. Immanuel Selvakumar [1]-proposed a paper “MPPT Based Stand-Alone Water Pumping System”. Renewable energy source have become a possible substitute for conventional strength resources because of will increase in international's electricity demand and scarce resources. solar pump operated with ac drive provide higher preference in term of length, ruggedness, performance and maintainability. In this work, dc energy from solar panel is boosted and fed to an inverter which gives ac output. inverter drives the motor coupled to the water pump. To get the maximum power to be had at any immediately an MPPT

controller is used to control the converter. Of various types of MPPT algorithms artificial intelligence (AI) techniques are famous. Artificial neural networks (ANNs) & fuzzy logic (FL) two exclusive forms of AI strategies which can be used to design the MPPT controller for PV machine. On this proposed paintings, depending on sun radiation and temperature, the MPPT controller offers optimized duty cycle. Neural network and fuzzy logic are two MPPT controllers, simulated to give foremost duty cycle[20]. Those MPPT controllers are as compared based totally at the strength acquired from the increase converter. Simulation effects also presented.

K. Ramya, S. Rama Reddy [2]- proposed a paper “Design and Simulation of a Photovoltaic Induction Motor coupled water pumping system”. Efficiency is the sense of power saving is a major trouble in photovoltaic pumping. The objective of this design and simulate an efficient battery less pumping machine powered from photovoltaic panels, comprising a new push pull converter with induction motor. In a photovoltaic pump storage, while sunlight is available as ability energy in water reservoir and consumed according to the demand. There are advantages in keeping off using large banks of lead acid batteries, which might be heavy and costly and have one fifth lifetime of photovoltaic panel. The dc/dc converter used on this system is the push pull converter. It's far generally a -transfer topology. The primary advantage of push-pull converter is their simplicity and capacity to scale as much as excessive electricity throughput[17]. For this reason a pumping system based on an induction motor may be an attractive thought to conquer the downside with dc motor and make certain dependable, costless and maintenance-free operation. Through this method the drawbacks during the dc motor usage are triumph over and a excessive energy throughput is obtained from the designed push pull converter because it gives you correct output fee with low power losses and less output ripple because the converter has its very own filter.

Sujay Sarkar Subhro Paul, Satyajit Samaddar, Surojit Sarkar, Pradip Kumar Saha, Gautam Kumar Panda[3] - proposed a paper “Modeling, Analysis and Simulation of Split Phase Type Single Phase Induction Motor” AC Drive systems were broadly regularly occurring for industrial applications. In preferred, they take the advantage of a better power density and a higher performance than dc drive systems. This paper offers a novel chaotic-speed control of split-phase induction motor drives, mainly for utility to cooling fan[16]. Primarily based on the state vector evaluation of the device, the d-q axis model of the split phase induction motor is deduced. It reveals the periodicity and chaos for numerous system parameters. Mathematical analysis, simulation and experimental effects are given to testify the proposed chaotic-speed fan.

Shridhar Sholapur, K. R. Mohan, T. R. Narsimhegowda [4] - proposed a paper “Boost Converter Topology for PV System with Perturb And Observe MPPT Algorithm” In this paper utilization of a boost converter for manage of photovoltaic power using Maximum power point tracking (MPPT) control mechanism is offered. First the photovoltaic module is

analyzed using simulink software program. For the principle intention of the assignment the Boost converter is for used along with a maximum power point tracking control mechanism. The MPPT is responsible for extracting the most viable strength from the photovoltaic and feed it to the load via the boost converter which steps up the voltage to required value. The principle purpose can be to track the maximum power point of the photovoltaic module so that the most feasible energy may be extracted from the photovoltaic[18-19]. The algorithms utilized for MPPT are generalized algorithms and are smooth to version or use as a code. The algorithms are written in m file of MatLab and utilized in simulation. Both the boost converter and the solar cell are modeled using Sim power system blocks.

Deshmukh Priyanka, Hotkar pradnya, shelke dnyaneshwari, Prof. Anupma komboj [5], proposed a paper "PV based solar water pumping system" In this paper due to the non-stop decrease of the solar cells fee, photovoltaic electricity is utilized in numerous packages. the most vital one is the batteries-coupled water pumping system powered by using photovoltaic generator. The usage of batteries permits the system to deliver a constant water flow for the duration of the low light durations and night time. with the increased use of this utility, extra interest has been paid to their most excellent utilization. Microcontrollers provide attractive capabilities inclusive of fast response, accuracy and exact performance in comparison to the classical controllers. The photovoltaic pumping system is composed of a PV generator, inverter, batteries, AC motor and centrifugal pump[13]. The surplus energy produced by PV panels during light hour charges the batteries and the batteries in turn supply strength to the pump during backup power. A simulation have a look at is supplied under variable weather situations and the consequences display the effectiveness of the studied method.

Suhagiya falcon, Dave Siddharth, Seju Nirav, Patel Vashishtha [6] proposed a paper "Development of solar powered water pumping" In this paper Providing clean, environmentally safe water for livestock in enough quantities remains a first-rate problem for farmers and ranchers. Abundant water in remote locations in had to insure that grasslands are grazed lightly. A solar powered water pumping system designed for remote location became operated to determine the overall performance and reliability of the system and components. The device commenced pumping water while the sun radiation intensity passed. Flow increased linearly with radiation intensity and reached a maximum flow of intensity. Maximum flow depending on the usage of the correct controller adjustment in addition to the radiation intensity. Solar water pumping system operates on direct current. The output of solar power system varies throughout the day and with changes in weather conditions[14]. photovoltaic module, the electricity source for solar pumping, have no moving components, required no maintenance and last for decades. A proper designed solar pumping system could be efficient, simple and reliable. solar powered pumping systems are used basically for three applications town and city water supply, livestock watering and irrigation.

P.D.Narale, Dr N.S.Rathore, Dr. S. Kothari – proposed a paper "Study of solar PV water pumping system for irrigation of horticulture crops" In this paper gives design and economic analysis of efficient solar PV water pumping system for irrigation of banana. The device changed into designed and mounted in solar farm of Jain irrigation system constrained (Jisl), at Jalgaon (Maharashtra). The have a look at area falls at $21^{\circ} 05' n$ – latitude, $75^{\circ} 40' E$ –longitude and at an altitude of 209 m above mean sea level. The PV system sizing changed into made in this type of way that it become able to irrigating 0.165 ha of banana plot with a each day water requirement of 9.72m³/day and general head of 26m. Additionally, the life cycle cost (LCC) evaluation changed into performed to evaluate the financial viability of the machine[7]. The effects of the have a look at recommended the use of the PV structures for water pumping software to irrigate orchards.

Binoy Seal, Omkar Shirke, Siddhesh Shewale, Abhilash Sirishkar, Prof. Priya Hankare[8], proposed a paper "Solar Based Automatic Irrigation system". In this paper deals with the design of solar tracking system to harness maximum solar power that is transformed into electrical energy which in turn is used to electricity the irrigation system. The designed single axis solar tracker device, on the idea of LDR sensor values, orients the PV panel according with the position of the sun[12]. The irrigation pump can be controlled in two modes particularly 1. Automatic mode 2.GSM mode. In automatic mode the water pump is switched on and off automatically based on moisture sensor value. In GSM mode the farmer at his own discretion can send a message to ON and OFF the water pump without actually going to the field.

T.A. Binshad, K. vijaykumar, M. Kaleeswari[9] proposed a paper "PV Based water pumping system for Agriculture irrigation" This paper investigates the operation and evaluation of the photovoltaic water pumping system in detail. Power electronic controllers had been designed and evolved for the water pumping system the use of a boost converter in along with an inverter observed via an induction motor pump set. The proposed system may be employed in agricultural irrigation under any working condition of varying natures of sun irradiances and temperatures[11]. The configuration and implementation of the device have been defined in element. in addition, the designated technique of analysis and simulation traits of such PV water pumping system become additionally offered. With the concern of scarcity of fossil fuel, global warming and electricity protection, the proposed PV based water pumping device can meet the great demand of electricity and serve for the agricultural area.

Balkeshwar Singh, Anil Kumar Mishra [10] proposed a paper "Utilization Of Solar Energy For Driving A Water Pumping System" Renewable power assets in preferred, and solar electricity supply in particular, has the capability to offer electricity offerings with zero or nearly zero emission. The solar energy is considerable and no other source in renewable energy is like solar energy. The solar-powered pumping system may be used everywhere but it's miles suitable for rural areas that is facing power disaster. Because of

geographical position, sultanate of oman and gulf place has ample sunshine at some stage in the year which makes it best region for utilization of sun energy. Small farms, villages, and animal herds in developing countries require hydraulic output power of much less than a kilowatt[15]. Many of these capability users are too a ways from an electrical grid to economically tap that supply of energy, and engine-pushed pumping has a tendency to be prohibitively steeply-priced in addition to unreliable due to the excessive value of bought gasoline and insufficient. protection and restore competencies. A solar powered pump is a normal pump with an electric powered motor. Strength for the motor is generated onsite through a solar panel which converts solar energy to direct-current (dc) energy. Due to the fact the character of the electric output from a solar panel is dc, a solar powered pump requires a dc motor if it's miles to operate without extra electrical components. If a pump has an alternating-current-day (ac) motor, an inverter would be required to transform the dc electricity produced by way of the solar panels to ac electricity. Because of the multiplied complexity and value, and the reduced performance of an ac system, most solar-powered pumps have dc motor. Dc motor has been used to force solar energy water pump system. This paper consists of frame of solar water pump, dc motor, pump, solar panel, suction pipe, delivery pipe, ON/OFF control switch and water tanks.

V. CONCLUSION

A review of current status of solar photovoltaic water pumping system generation studies and programs is provided. The observe focuses on replace on solar water pumping technology, overall performance evaluation studies carried out worldwide, most advantageous sizing techniques, degradation of PV generator supplying strength to pump, monetary assessment, environmental elements and recent advances in materials and efficiency improvement of photovoltaic technology and enjoy of using solar PV pumps worldwide. Based totally at the study important conclusions are as follows:

- PV water pumping technology is dependable and economically possible alternative to electric and diesel water pumps for irrigation of agriculture crops.
- PV water pumping for urban, rural and community water substances and establishments, is some other potential possible area but is not still broadly utilized. The remote inaccessible places without a grid strength additionally want special interest. These sectors depends on conventional energy or diesel based pumping system resulting in expanded ordinary prices to the customers.
- Keeping in view the excessive set up expenses of solar water pumps especially for big irrigation and water substances, extra incentives are required to be provided by way of governments to make the generation similarly appealing alternative to diesel and electrical water pumping.
- Factors affecting the overall performance and efficiency improving strategies, use of pretty efficient PV modules which includes bifacial modules and degradation of PV generator are regions for similarly research for reducing

the price, enhancing the performance and improving pumping device existence time.

Solar pumping is an appealing opportunity for irrigation and rural, urban ingesting water pumping programs I growing international locations in particular India, china, different Asian and African international locations, keeping in view massive solar potential and the fact that substantial rural population lives in the remote area which requires water for drinking and irrigation of crops.

REFERNCE

- [1] Anna Mathew, A. Immanuel Selvakumar - "MPPT Based Stand-Alone Water Pumping System" International conference on Computing, Communication and Electrical Technology[ICCCET] 18-19 March2011.
- [2] K. Ramya, S. Rama Reddy "Design and Simulation of a Photovoltaic Induction Motor coupled water pumping system" International conference on computing, Electronics and Electrical Technology[ICCEET]2012.
- [3] Sujay Sarkar Subhro Paul, Satyajit Samaddar, Surojit Sarkar, Pradip Kumar Saha, Gautam Kumar Panda "Modeling, Analysis and Simulation of Split Phase Type Single Phase Induction Motor" International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol 2, Issue 5, May 2013.
- [4] Shridhar Sholapur, K. R. Mohan, T. R. Narsimhegowda - proposed a paper "Boost Converter Topology for PV System with Perturb And Observe MPPT Algorithm" IOSR Journal of Electrical and Electronics Engineering Volume 9, Issue 4 Ver. II (Jul-Aug 2015).
- [5] Deshmukh Priyanka, Hotkar pradnya, shelke dnyaneshwari, Prof. Anupma komboj, proposed a paper "PV based solar water pumping system" International Engineering Research Journal(IERJ) Vol 2, Issue 2 2016.
- [6] Suhagiya falcon, Dave Siddharth, Seju Nirav, Patel Vashishtha proposed a paper "Development of solar powered water pumping" International Journal for Innovative research in Science & Technology Vol 1 Issue 12 April 2015.
- [7] P.D.Narale, Dr N.S.Rathore, Dr. S. Kothari – proposed a paper "Study of solar PV water pumping system for irrigation of horticulture crops" International Journal of Engineering Science Invention, Vol 2 Issue 12, Dec 2013.
- [8] Binoy Seal, Omkar Shirke, Siddhesh Shewale, Abhilash Sirishkar, Prof. Priya Hankare proposed a paper "Solar Based Automatic Irrigation system" International Journal of Research in Advent Technology, Vol 2 , No.4 April 2014.
- [9] T.A. Binshad, K. vijaykumar, M. Kaleeswari proposed a paper "PV Based water pumping system for Agriculture irrigation" Frontiers in Energy Vol 10, Issue 3 September 2016.
- [10] Balkeshwar Singh, Anil Kumar Mishra proposed a paper "Utilization Of Solar Energy For Driving A Water Pumping System" International Research Journal of Engineering and Technology, Vol 2 Issue 3, June 2015.
- [11] Aditi Bajpai, Aravind Mittal, "Solar Powered DC TO DC Buck-Boost Converter With MPPT Control" International Journal of Electronics, Electrical and Computational System IJECS Volume 3, Issue. 5 July 2014

- [12] Pradeep, R. Ganeshmurthy, K.Sekar, E. Arun, "Automation of PV Farmers Pump" Second International Conference on Sustainable Energy and Intelligent System (SEISCON 2011) July. 20-22, 2011.
- [13] K. Umadevi, Dr. C. Nagarajan, – "Photovoltaic System With DC-DC Boost Converter Topology Using PSIM Software" International Journal of Current Research and Modern Education (IJCRME) Special Issue, NCFTECCPS 2016..
- [14] Miss S.S.Pokalekar, Prof.R.T.Patil, "Development and implementation of Solar Panel based power management system" SSRG International Journal of Electronics and Communication Engineering - (ICRTESTM). April 2017
- [15] Michael James Case, Ernest Edward Denny, "A Novel Approach To Photovoltaic Powered Water Pumping Design" 13th International Power Electronics and Motion Control Conference (EPE-PEMC 2008).
- [16] Michael E. Ropp, Member, IEEE, and Sigifredo Gonzalez "Development of a MATLAB/Simulink Model of a Single-Phase Grid-Connected Photovoltaic System" IEEE Transactions on Energy Conversion 2008.
- [17] Naintara Wasnik, Prof. M. V. Palandurkar, April – "Simulation Of Induction Motor Modelling In MATLAB Software" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue 4 2013.
- [18] Ram Naresh Bharti, R Ajib Kumar Mandal, "Modeling and Simulation of Maximum Power Point Tracking for Solar PV System using Perturb and Observe Algorithm" International Journal of Engineering Research & Technology (IJERT) Vol. 3 Issue 7 July – 2014.
- [19] Sunil Kumar Mahapatro 5, "Maximum Power Point Tracking (MPPT) Of Solar Cell Using Buck-Boost Converter" International Journal of Engineering Research & Technology (IJERT) Vol. 2 Issue May – 2013.
- [20] S.Gomathy, S.Saravanan, Dr. S. Thangavel "Design and Implementation of Maximum Power Point Tracking (MPPT) Algorithm for a Standalone PV System" International Journal of Scientific & Engineering Research Volume 3, Issue3, March -2012.