SOLAR ENERGY BASED DC GRID WATER MANAGEMENT SYSTEM

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ABSTRACT:

This paper is primarily focused on the design and development of an efficient and cost effective solar photovoltaic generator (PVG) based water pumping system implying a DC Motor drive. The maximum extraction of available power from PVG is attained by introducing a perturb & observe maximum power point tracking (MPPT) controller with boost converter as a power conditioning stage. The CCM (continuous conduction mode) operation of DC-DC converter helps to reduce the current and voltage stress on its components and to realize the DC-DC conversion ratio independent of the load. The efficient utilization of SPV array and limiting the high initial inrush current in the motor drive is the primary concern of a Paper. In the recommended design DC motor will be fixed at a home. PV energies are harnessed to charge the battery. The battery power will drive the pump and fill the tank automatically. In the absence of PV power, the battery is charged through the existing AC system. Whenever the tank has been emptied, it will be sensed and communicated to the controller automatically, thereby eliminating the need for manual intervention. The water tank can be filled automatically whenever it is empty and at the same time, it will be refilled with water without any overflow. A single controller can manage the entire requirement of the motor coupled pump. Through this work the demand of AC power from the Government has been reduced and also the requirement of manual intervention, wastage of water due to overflow can be avoided. This system can also be deliberated as a potential alternative in areas having deficient power or in areas inaccessible to the main supply grid. The Solar PV power system consists of Photo Voltaic (PV) array, MPPT controller, Battery, Boost converter, Solenoid valve and DC motor pump. The main objective of this Paper is to replace the currently existing Grid connected system by PV powered system to save grid energy and to ensure pollution free environment with conservation of fuel cost.

KEYWORDS: Photo voltaic (PV), Maximum Power Point Tracking (MPPT), Dc-Dc Converters, Ac-Dc Converter, Dc motor, battery bank, level sensors, controllers.

INTRODUCTION

Photovoltaic (PV) generation is turning into more and more necessary as a renewable supply since it offers several benefits resembling acquisition no fuel prices, not being polluting, requiring very little maintenance, and emitting no noise, among others. PV modules still have comparatively low conversion potency because of the nonlinear V-I and P-V characteristics, that rely upon the irradiance, the in operation temperature and cargo condition of the cell. Therefore, high potency is needed for the facility acquisition system (PCS), that transmits power from the PV array to the load. In general, a single-phase PV PCS consists of 2 conversion stages (i.e., DC-DC conversion stage and DC-AC conversion stage). The DC-DC convertor is that the initial stage and it's to manage the variation of the utmost power-point of the cell output. In alternative words, modulation of the duty magnitude relation of the DC-DC convertor controls most electric outlet pursuit (MPPT).

I. PHOTOVOLTAIC CELL

A photovoltaic cell or photoelectric cell may be a semiconductor unit that converts lightweight to power by electrical phenomenon impact. If the energy of gauge boson of sunshine is larger than the band gap then the lepton is emitted and therefore the flow of electrons creates current.

However a cell is completely different from a photodiode. during a photodiode lightweight falls on n-channel of the semiconductor junction and gets regenerate into current or voltage signal however a cell is often forward biased.

II. PV MODULE

Usually variety of PV modules area unit organized nonparallel and parallel to satisfy the energy necessities. PV modules of various sizes area unit commercially out there (generally sized

from 60W to 170W). Parenthetically, a typical little scale desalinisation plant needs a number of thousand watts of power.

III. PV MODELING

A PV array consists of many electrical phenomenon cells nonparallel and parallel connections. Series affiliations are chargeable for increasing the voltage of the module whereas the parallel connection is chargeable for increasing this within the array.

Typically a photovoltaic cell is often modelled by a current supply associate degree an inverted diode connected in parallel to that. Its own series and parallel resistance. Series resistance is thanks to hindrance within the path of flow of electrons from n to p junction and parallel resistance is thanks to the leak current.

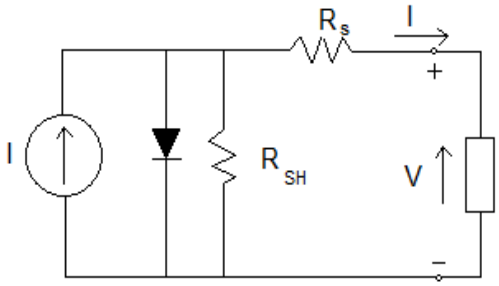

Figure 1.1: Single diode model of a PV cell

In this model we have a tendency to contemplate a current supply (I) in conjunction with a diode and series resistance (Rs). The shunt resistance (RSH) in parallel is extremely high, contains a negligible impact and may be neglected. The output current from the electrical phenomenon array is

$$I = Isc – Id \quad (1.1)$$

$$Id=Io(eqVd/kT-1) \quad (1.2)$$

Where Io is that the reverse saturation current of the diode, Q is that the lepton charge, contagious disease is that the voltage across the diode, k is Boltzmann constant (1.38 * 10-19 J/K) and T is that the junction temperature in Kelvin (K).
From eq. 1.1 and 1.2

$$I = Isc – Io (eqVd/kT - 1) \quad (1.3)$$

Using suitable approximations,

$$I = Isc – Io (eq((V+IRs)/nkT) - 1) \quad (1.4)$$

Where, I is that the electric cell current, V is that the PV cell voltage, T is that the temperature (in Kelvin) and n is that the diode quality issue.

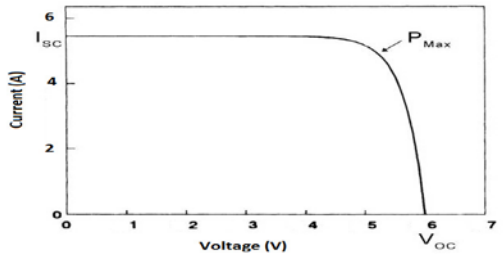

Figure 1.2: V-I characteristics of a photovoltaic cell

The V-I characteristics of a typical solar cell are as shown in the Figure 1.2. When the voltage and the current characteristics are multiplied we get the P-V characteristics as shown in Figure 1.3. The point indicated as MPP is the point at which the panel power output is maximum.

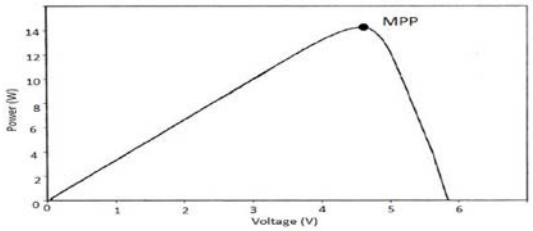

Figure 1.3:P-V characteristics of a photovoltaic cell

OPERATION:

In this chapter the overall block diagram of the proposed system is discussed. After that the operation of the individual blocks namely, Ac Grid, 3Phase Relay, three phase diode rectifier, Buck Converter, Solar Panel, Boost converter, MPPT, Battery Bank, DC machine, DC Relay, Level Sensors, current Sensors, Arduino were dealt with the necessary schematics.

IV. Block Diagram

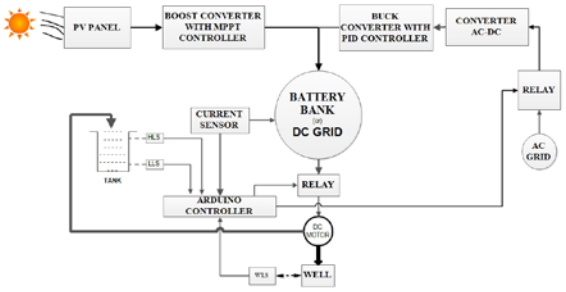

Fig. 2: block diagram

V. SIMULINK MODEL OF THE PROPOSED WORK

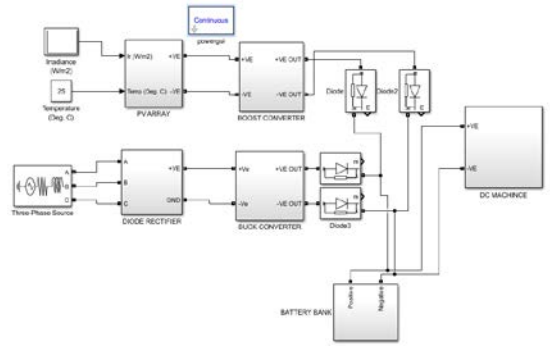

Fig. 3: Simulation circuit of proposed system

1. Boost converter

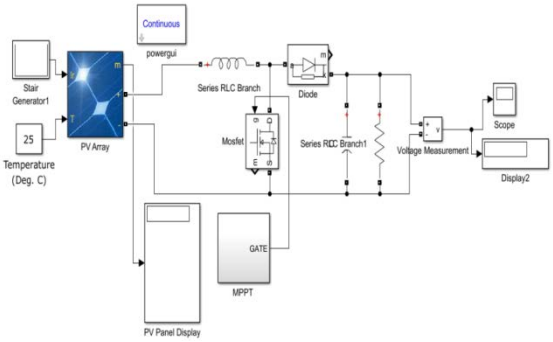

Fig. 4: Simulation circuit of PV with Boost Converter

A boost converter (step-up converter) is a power converter with an output DC voltage greater than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor or a MOSFET or an IGBT or a BJT) and at least one energy storage element. The boost converter is constructed with the design value of L= 22 mH, C=19µF, and R=15.16Ω.

2. Maximum Power Point Tracking

A typical solar panel converts only 30 to 40 percent of the incident solar irradiation into electrical energy. Maximum power point tracking technique is used to improve the efficiency of the solar panel.

According to Maximum Power Transfer theorem, the power output of a circuit is maximum when the Thevenin impedance of the circuit (source impedance) matches with the load impedance. Hence our problem of tracking the maximum power point reduces to an impedance matching problem.

In the source side, an interleaved soft switched boost converter is used, which is connected to a solar panel in order to enhance the output voltage so that it can be used for different applications like motor load. By changing the duty cycle of the ISSBC appropriately we can match the source impedance with that of the load impedance.

3. PERTURB & OBSERVE

Perturb & Observe (P&O) is the simplest method. In this we use only one sensor, that is the voltage sensor, to sense the PV array voltage and so the cost of implementation is less and hence easy to implement. The time complexity of this algorithm is very less but on reaching very close to the MPP it doesn't stop at the MPP and keeps on perturbing on both the directions. When this happens the algorithm has reached very close to the MPP and we can set an appropriate error limit or can use a wait function which ends up increasing the time complexity of the algorithm. However the method does not take account of the rapid change of irradiation level (due to which MPPT changes) and considers it as a change in MPP due to perturbation and ends up calculating the wrong MPP. To avoid this problem we can use incremental conductance method.

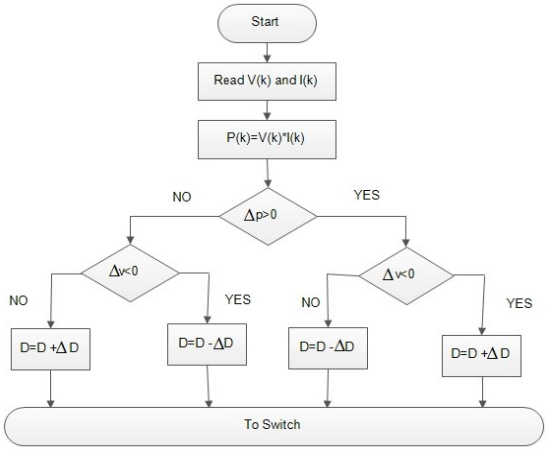

Fig 5: Flow chart of P&O algorithm

4. Buck converter

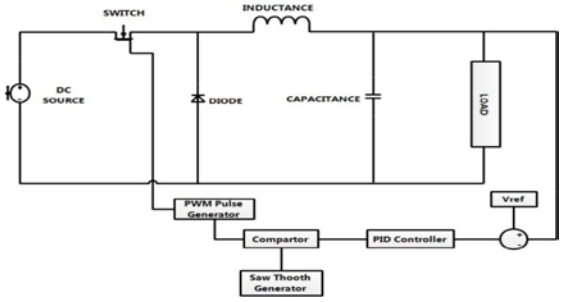

Fig. 6: Diagram of buck converter

A buck converter (step-down converter) is a power converter with an output DC voltage less than its input DC voltage. It is a class of switching-mode power supply (SMPS) containing at least two semiconductor switches (a diode and a transistor or a MOSFET or an IGBT or a BJT) and at least one energy storage element. A controller suitable for DC-DC converter must match with their nonlinearity and input voltage and load variations, ensuring stability in any operating condition. The values of Kp, Ki and Kd are obtained using the above procedure for the given buck converter and the values obtained are Kp=0.001; Ki=49.7859; Kd=5.0215e^(-7), The buck converter is constructed with the design value of L= 11 mH, C=81.5µF, andR=15.16Ω.

5. Three phase diode rectifier

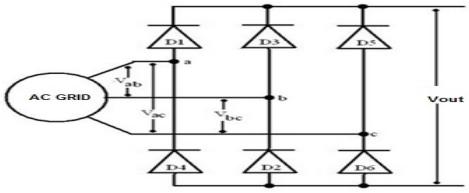

Fig. 7: Three phase diode bridge rectifier

The diode rectifier is the most simple, cheap, and rugged topology used in power electronic applications. The most disadvantage of this diode rectifier is its disability to work in bi-directional power flow. The output dc voltage from three-phase diode bridge rectifier can be obtained from Equation.

Vin= (3√2 Vab)/π
Vin: input dc voltage for the boost converter.
Vab: line to line voltage of ac grid.

6. DC micro -grid (battery bank)

Battery is a device consisting of one or more electrochemical cells. Battery is a device that converts stored chemical energy into electrical energy. It has 3 components such as Anode, Cathode, and Electrolyte. The battery used has a rating of 12 Vdc, 150A, for 10 series And 2 parallel string battery bank.

7. DC Machine

A DC Machine is an electro-mechanical energy conversion device. There are two types of DC machines; one is DC generator, and another one is known as DC motor. A DC generator converts mechanical power (ωT) into DC electrical power (EI), whereas, a DC motor convert's DC electrical power into mechanical power. The AC motor is invariably applied in the industry for conversion of electrical power into mechanical power, but at the places where the wide range of speeds and good speed regulation is required, like in electric traction system, a DC motor is used. The Dc Machine used has a rating of 5 HP, 240V, 1750 rpm, flied: 150V. The single phase dc from the battery bank (DC GRID).

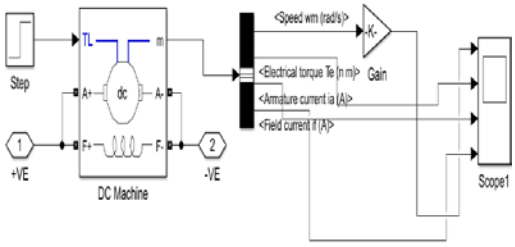

Fig. 8: Dc Machine Subsystems

VI. SIMULATION RESULTS FOR SOLAR POWER SYSTEM

The complete system design of the Solar input/ output analysis of the proposed system was simulated by MATLAB/SIMULINK, the battery bank is designed, the simulated of hybrid AC Grid, solar and battery as in fig [7], then load as been Dc Machine load. The characteristics of the proposed system were analyzed by changing these element, which the Ac Grid and solar energy system as maintain the constant 240V.

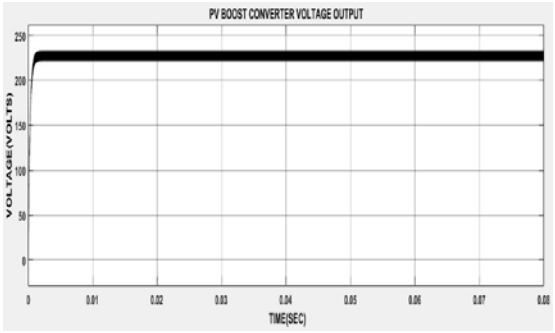

Fig. 9: Output voltage of Boost Converter

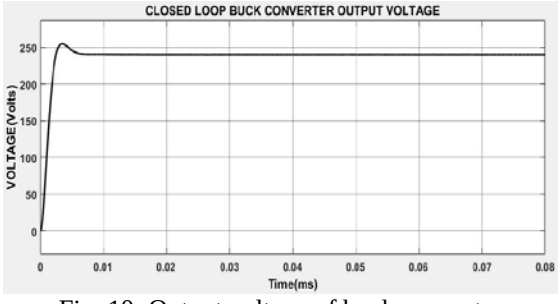

Fig. 10: Output voltage of buck converter

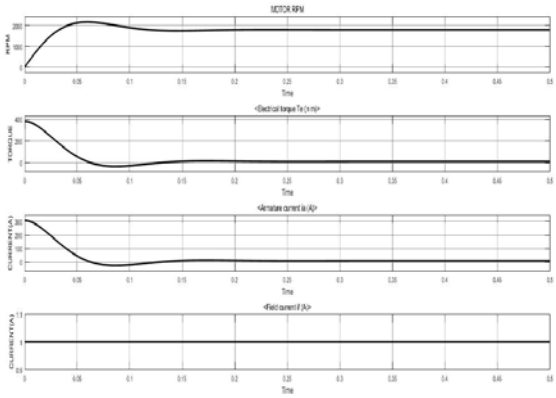

Fig. 11: Simulation Result of Dc Machine Output

8. Arduino Program

Arduino board styles use a spread of microprocessors and controllers. The board's area unit equipped with sets of digital and analog input/output (I/O) pins which will be interfaced to numerous enlargement boards (shields) and alternative circuits. The boards feature serial communications interfaces, together with Universal Serial Bus (USB) on some models that also are used for loading programs from personal computers. The microcontroller's area unit usually programmed employing a non-standard speech of options from the programming languages C and C++. Additionally to victimisation ancient compiler, the Arduino paper provides associate degree integrated development atmosphere (IDE) supported the process language paper.

The Arduino Program is written for to glow Automatic Water management on and off conditions, and it shows the two hundredth of water level on condition within the motor at same time H2O level is gift. Then water level show the one hundred pumps is off condition.

9. Proteus Software

The Proteus style Suite could be a proprietary package tool suite used primarily for electronic style automation. The package is employed in the main by electronic style engineers and technicians to form schematics and electronic prints for producing computer circuit boards. The micro-controller simulation in Proteus works by applying either a hex file or a rectify file to the microcontroller half on the schematic. it's then co-simulated together with any analog and digital natural philosophy connected thereto.

The Arduino program is interface with the proteus package. In proteus package the ARDUINO UNO pins is connected to as per circuit association, here Automatic Water management Shows.

When motor is in OFF condition

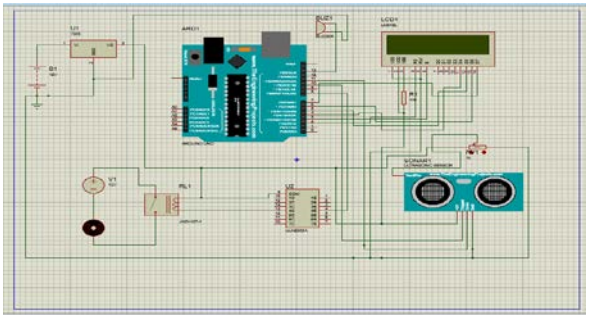

Fig 12: Motor in OFF condition with water level is high

When Motor is in ON condition

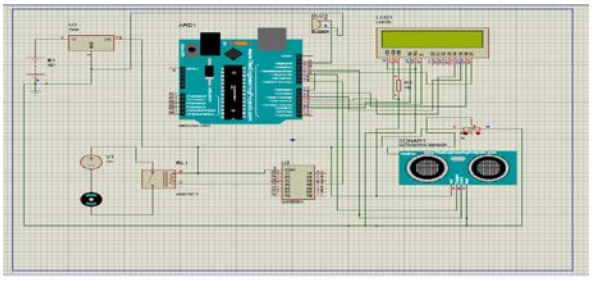

Fig 13: Motor in ON condition with water level is low

10. Advantages of this system

1. Water Management System
2. Direct Renewable Energy Used For DC Water Pump
3. Level Control For Water Tank & Under Ground Water
4. Continues Load Used for Both Energy System

11. Applications

1. Rural Area Water Management
2. Any Institutional Water Management System
3. College & Hostel Water Management System

CONCLUSION

This thesis proposed to the Solar PV powered automatic water management system. These systems reduce the waste and reduce the human intervention. Solar pumps can also offer clean solutions with no danger of borehole contamination. Currently photovoltaic technology is suitable for remote site applications that have small power needs, or small power consuming applications even where the grid exists. However the falling prices of PV's over time will make many

more applications of photo voltaic economically competitive in the future. Hence in this paper the power for water pumping system is given by Solar PV power. Solar PV panel (174), Boost converter (174/240) along with MPPT controller (240) are all simulated using Mat LAB/Simulink. The water management system is obtained from Arduino controller simulated from Proteus software. This paper can be extended for many applications like Street light system, irrigation management system etc.

REFERENCE:

[1] Ahmed T. Elsayed, Student Member, IEEE, Christopher R. Lashway,(MAR 2016) "Advanced Battery Management and Diagnostic System for Smart Grid Infrastructure, Ieee Transactions On Smart Grid, VOL. 7, NO. 2.

[2] Biao Zhao, Qiang SongJianguo Li, Wenhua Liu, Guowei Liu, and Yuming Zhao(JULY 2016) "High-Frequency-Link DC Transformer Based on Switched Capacitor for Medium-Voltage DC Power Distribution Application, IEEE TRANSACTIONS ON POWER ELECTRONICS, VOL. 31, NO. 7.

[3] B. Sri Hari Priya, V. Sridevi, R. Santhoshi Kumari, M. Tukaram Bai(Dec 2015) "Review on Water Desalination using Renewable Solar Energy" IJIRST –International Journal for Innovative Research in Science & Technology Volume 2 Issue 07 .

[4] BHAVESH DAVE,(OCT 2013)"Design & Simulation Of Buck-Boost Converter Modulation Technique For Solar Application" Journal Of Information, Knowledge And Research In Electrical Engineering. VOLUME – 02, ISSUE – 02.

[5] Geetha D. K., P. Pramila(OCT 2016) "A Survey on Efficiency in PV Systems with DC-DC Converter; Communications on Applied Electronics (CAE) – ISSN : 2394-4714 Foundation of Computer Science FCS, New York, USA Volume 6 – No.1.

[6] I.OUACHANIa, A. RABHIb, I.YAHYAOUIc, B. TIDHAF, T.Fernando Tadeo (SEB-16) "Renewable Energy Management Algorithm for a Water Pumping system" 8th International Conference on Sustainability in Energy and Buildings, SEB-16, 11-13.

[7] K.Manohar, 2,P.Sobha Rani(DEC 2012) "Mppt and Simulation for a Grid-Connected Photovoltaic System and Fault Analysis", The International Journal Of Engineering And Science (IJES)Volume 1 Issue2.

[8] K. T. Tan, B. Sivaneasan, X. Y. Peng and P. L. So,(JUNE 2016) "Control and Operation of a DC Grid-Based Wind Power Generation System in a Microgrid", IEEE TRANSACTIONS ON ENERGY CONVERSION, VOL. 31, NO. 2.

[9] Mahir DURSUN and Semih OZDEN (April 2012) "Application of Solar Powered Automatic Water Pumping in Turkey" International Journal ***of*** Computer and Electrical Engineering, Vol.4, No.2.

[10] Mehdi Karbalaye Zadeh, Roghayeh Gavagsaz-Ghoachani, Serge Pierfederici,Babak Nahid-Mobarakeh,(MAR 2016) "Stability Analysis and Dynamic Performance Evaluation of a Power Electronics-Based DC Distribution System With Active Stabilizer", Ieee Journal Of Emerging And Selected Topics In Power Electronics, VOL. 4.