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Solar Tracking with Telemetryin Irrigation System

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ABSTRACT: In our country, facing an acute energy scarcity which is hampering its industrial and agricultural growth and economic progress. Setting up of new power plants is inevitably dependent on import of highly volatile fossil fuels. Thus, it is essential to tackle the energy crisis through judicious utilization of the abundant renewable energy resources, such as solar, wind, bio-mass and geothermal energy. Presently the power crisis is in rural areas, this power cut directly affects our farmers. Due to frequent power cuts in the villages for as much as 3 to 6 hrs. And some rural areas don't have power supply yet. These farmers are entirely dependent on rain water for irrigation. This affects our farmers. As a result they are not able to irrigate their land. The irrigation system is mainly dependent on fossil fuel water pumps. The diesel water pumps now a day's causes emission of greenhouse gases that adds to the pollution. The main purpose is to use the PV tracking system is to maximize the solar energy consumption and to reduce the dependence on the fossil fuels. The solar tracking system has an added advantage over the fixed plate. The solar energy utilization could be maximized by the tracking plates. The energy is stored in the lead acid cell battery. The battery has good longevity high reliability, low discharge, and minimum maintenance. The PMBLDC motor coupled with centrifugal pump is used to pump the water out. The motor has high efficiency due to low losses. The motor has no brushes so sparking is less. The GSM technology is used to control the system by mobile phone. This gives an added advantage over the manual control. The switch ON and OFF could be done by mobile phone in anywhere. The water pumped by centrifugal pump could be automatically estimated. The water level in tank can be identified automatically by using the mobile technology.

KEYWORDS: PMBLDC Motor, Centrifugal Pump, GSM Modem, Solar panel, LDR.

I. INTRODUCTION

Energy plays an important role in the material, social and cultural life of mankind. The energy needs are increasing day by day. This is the result of population growth and increase in the standard of living which is directly proportional to energy consumption. As we know that mankind will be never lacking in energy [1]. Today, it is liquid fluid, tomorrow it may be uranium with an element of risk. Risk exists where ever there is human activity and production of energy. Just as the supply of fossil fuel is finite thus there will be the supply of uranium. Perhaps, uranium would be exhausted quickly if it is used on a large scale. It is therefore, harnessing the gigantic inexhaustible solar energy source reduces the dependence on fossil fuels. For the environmental concerned, the solar energy harnessing system offers advantages in that, it emits no pollutants in to the atmosphere as they are with the combustion of fossil fuels. Thus, as a long term option solar energy system can be considered as an alternate to all the finite fuel system. Therefore, there is no energy shortage today nor will there be in the near future? The lifting of water for drinking or irrigation purposes is of great importance in widely distributed villages with little or no rural electrification and where underground water is available [1] [9]. Solar energy is converted to mechanical energy to drive small water pumps it would be of great help to the rural inhibitions [5].

From many centuries, sun has been the primary source of energy for the globe [5]. Technically, solar energy can be defined as Electromagnetic energy transmitted from the sun (solar radiation).The amount of energy that reaches the earth is equal to one billionth of total solar energy generated. But is that small? No. The amount of energy which strikes the surface of the earth in one day exceeds daily consumption by 10,000 to 15,000 times. In other words, the amount of solar energy intercepted by the earth every minute is greater than the amount of energy the world uses in fossil fuels each year [2].Moreover, of all the renewable energy sources available, solar energy has the smallest environmental

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impacts. Electricity produced from photovoltaic cells does not result in air or water pollution, deplete natural resources, or endanger animal or human health [6].

II.LITERATURE SURVEY

J. RODRIGUEZ, JS. LAI, ANDF. Z. PENG, "A PHOTOVOLTAIC POWERED SEPARATELY EXCITED DC MOTOR DRIVE FOR RURAL/DESERT PUMP IRRIGATION," ELECTRICAL MACHINES AND DRIVES, 1993. SIXTH INTERNATIONAL CONFERENCE ON (CONF. PUBL. NO. 376), PP.406, 8-10 SEP 1993.

The authors present a photovoltaic powered pump drive scheme comprising a separately excited DC motor andDC/DC converter. The control strategy ensures maximum solarenergy utilization and effective load control. Economic sizes from 1kW-30 kW can be utilized. With the advent of separately excited DC motors it is advantageous to utilize solid state converter DC chopper. The authors present the full unified model development and control strategy for maximizing solarenergy utilization and ensuring maximum kWh energyusedby the pump load. The proposed scheme can be utilized in spray irrigationand greenhouse water supply management. In addition the authors present the digital simulation model development, component sizing, PV array switching and tracking controller to ensure online maximum solarenergy utilization. Laboratory testing of the drive scheme is also included.

G. CARRARA, S. GARDELLA, M. MARCHESONI, R. SALUTARI, AND G. SCIUTTO, "DESIGN AND ECONOMY OF RENEWABLE ENERGY SOURCES TO SUPPLY ISOLATED LOADS AT RURAL AND REMOTE AREAS OF EGYPT", ELECTRICITY DISTRIBUTION - PART 1, 2009. CIRED2009. 20TH INTERNATIONAL CONFERENCE AND EXHIBITION ON, PP. 1, 8-11 JUNE 2009.

Meteorological conditions in many sites of the world countries as well as in Egypt are well adapted to install more than one of renewable energy sources (RESs) to supply electrical loads. Solarandwind energies are the most convenient and economic types of RESs pertaining the Meteorological conditions of Egypt. Also, the main type of isolated loads at rural and remote areas of Egypt is pumping loads for irrigation purposes. So, three alternatives of solar photovoltaic andwind energy systems can be used to supply these loads. In this work, a proposed model has been introduced to evaluate the design and economy of these alternatives to supply isolated loads in a remote area. This model is used also for optimizing these alternatives of RESs from economical point of view. The proposed model depends on the Meteorological data at the installation site, the performance of solar photovoltaic andwind energy systems used, the type and capacity of energy storage facility employed, the economical parameters of these resources and load. The proposed model is applied numerically to design three alternative sources of solar photovoltaic andwind energy systems to supply an isolated load in a remote area of Egypt. The economy of these sources are determined and compared to develop the most economical one of these RESs.

III. BLOCK DIAGRAM

In our project we use solar photo voltaic cells for pumping water. The photo voltaic modules convert sunlight direct to electricity which is used to run a dc motor pump for bailing of water. It consists of solar photo voltaic modules, power conditioner to protect storage batteries from over charging during non-sun shine and a dc water pump.The solar tracking is used to maximize the energy production and that is stored in battery. The GSM switch is used to switch ON and OFF the DC motor of the centrifugal pump [5]. GSM modem can also give the information about the water level inside the tank and the amount of water pumped during the time when the motor is in switched on condition.The proposed method block diagram is given in fig.1.

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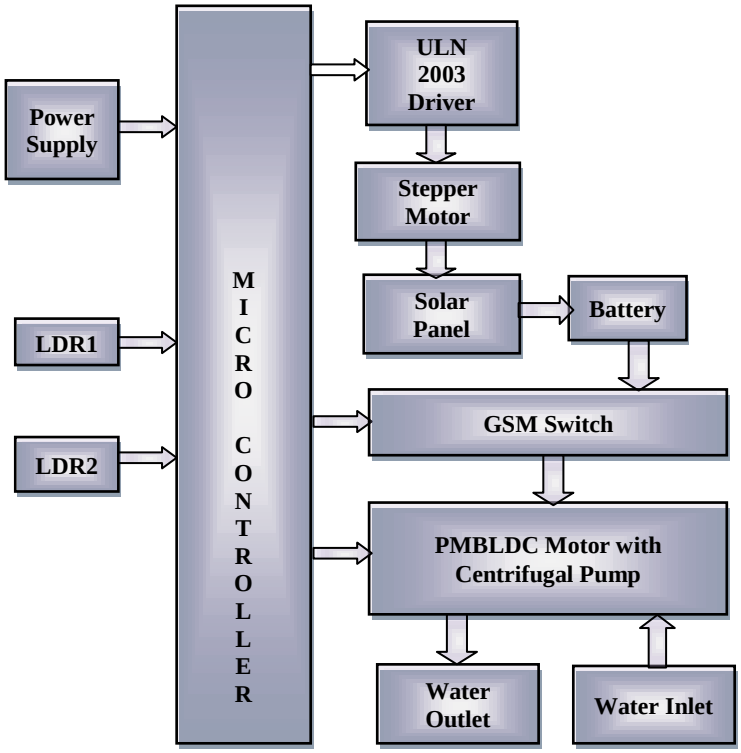

Fig.1Block diagram of dynamic irrigation based on solar tracking system with telemetry

IV.EXPLANATION

A.SOLAR PANEL

The Basic of Photovoltaic: The density of power radiated from the sun (referred to as the "solar energy constant") at the outer atmosphere is 1.373 kW/m^2. Part of this energy is absorbed and scattered by the earth's atmosphere. The final solar energy that reaches the earth's surface has the peak density of 1 kW/m2 at noon in the tropics. The technology of photovoltaic PV) is essentially concerned with the conversion of the solar energy into suitable electrical energy. The basic element of PV system is a solar cell. By settling solar cells under the sunlight, they can convert solar energy directly to electricity. This electricity can be modified to any consumer applications such as lighting, water pumping, refrigeration, telecommunications, and so on. Solar cells rely on a quantum-mechanical process known as the "photovoltaic effect" to produce electricity. A typical solar cell consists of a p-n junction formed in a semiconductor material similar to a diode. Solar cells are semiconductor devices that are designed to generate electric power when exposed to electromagnetic radiation. The spectrum of light given off by the sun is shown in Fig.2.

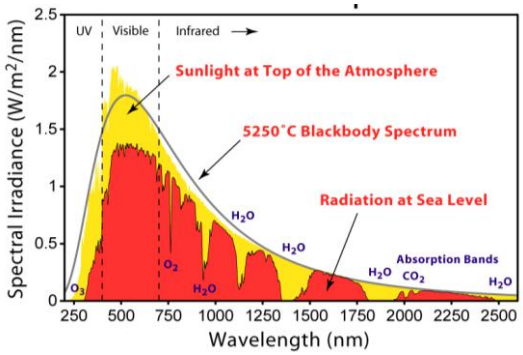

Fig. 2 Spectrum of Solar Radiation in Space and on Earth

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The distribution of light in outer space resembles the theoretical radiation provided by a black body. As the light passes through the atmosphere, some of the light is absorbed or reflected by gasses such as water vapour and the ozone. The typical distribution of light on the surface of the earth is different than the distribution of light in space. Engineers must consider the spectrum of incident light when designing solar cells [6].Solar cells consist of one or more p-n junctions. Light enters the semiconductor material through the n region and generates an electron-hole pair (EHP) in the material due to the photoelectric effect. The n region is designed to be thin while the depletion region is thick. If the EHP is generated in the depletion region, the built-in electric field drifts the electron and hole apart. The result is a current through the device called the photocurrent. If the EHP is generated in the n or p regions, the electron and hole drift in random directions and may or may not become part of the photocurrent.

Performance of a Solar Cell: The following terms deal with the performance of a solar cell.
Short-circuit current, J_{sc}: The current of a solar cell when the top and bottom (negative and positive leads) are connected with a short circuit. This is the horizontal intercept on the I-V curve shown in Fig. 2.
Open-circuit voltage, V_{oc}: The voltage between the top and bottom of a solar cell. This is the vertical intercept on the I-V curve shown in Fig. 3.

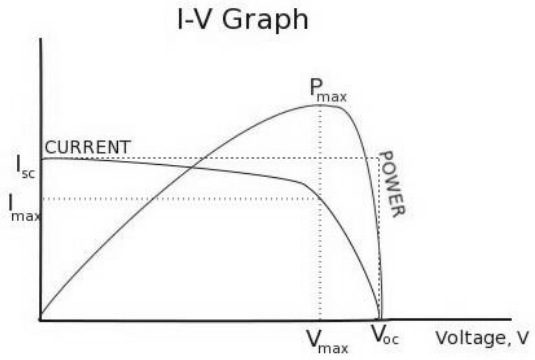

Fig. 3 Current Versus Voltage Curve (I-V curve) For a Typical Solar Cell

Power point: The point on the I-V curve of a solar cell at (J_{PP}, V_{PP}) that generates the maximum amount of power for the device. This is the point that encloses the most amount of area in the first quadrant when vertical and horizontal lines are drawn from the point. This represents power since the area is equivalent to the current times voltage of the cell.
Fill factor, FF: A percentage given by Equation.1 that describes how close the I-V curve of a solar cell resembles a perfect rectangle, which represents the ideal solar cell.

$$\text{Fill Factor} = \frac{V_{PP} * J_{PP}}{V_{OC} * J_{SC}}$$

Quantum efficiency: The number of EHPs that are created and collected divided by the number of incident photons. This is a percentage since each photon can produce at most one EHP.

Overall efficiency: The precent of incident electromagnetic radiation that is converted to electrical power. Often the overall efficiency for a given solar cell depends on many factors including the temperature and amount of incident radiation.

Materials used to make cells: The original and still the most common semi-conducting material used in PV cells is single crystal silicon. Single crystal silicon cells have are generally the most efficient type of PV cells, converting up to 23% of incoming solar energy into electricity. These cells are also very durable and have proved their long life in many space related applications. The main problem with single crystal silicon cells is their production costs. Growing large crystals of silicon and then cutting them into thin (0.1-0.3 mm) wafers is slow and expensive. For this reason, researchers have developed several alternatives to single crystal silicon cells, with hopes of reducing manufacturing costs.

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A solar cell is a PV cell designed to convert sunlight to electricity [5]. The simplest cells consist of a circular silicon wafer with a*pn*-junction sandwiched in the middle, a metallic bottom contact (e.g. aluminium) and a transparent top contact (either a transparent conducting oxide or a grid-like metal structure). Solar panels with cells like this have played a vital role in space technology since the late '50s, powering space satellites. They are expensive to produce because silicon wafers are expensive to produce (mainly because they are high-purity single crystals) but their cost was unimportant in the space race [5] [6].

B. SOLAR TRACKING SYSTEM

A Solar tracker is a device for orienting a solar photovoltaic panel towards the sun. In solar tracking systems the surface of the module tracks the sun automatically throughout the day. Tracking system [5] increases the efficiency of the system considerably there by reducing the cost per unit of output energy.

Why to Use Solar Tracking System: From many centuries, sun has been the primary source of energy for the globe. Technically, solar energy can be defined as Electromagnetic energy transmitted from the sun (solar radiation).The amount of energy that reaches the earth is equal to one billionth of total solar energy generated. But is that small? No. The amount of energy which strikes the surface of the earth in one day exceeds daily consumption by 10,000 to 15,000 times. In other words, the amount of solar energy intercepted by the earth every minute is greater than the amount of energy the world uses in fossil fuels each year. Moreover, of all the renewable energy sources available, solar energy has the smallest environmental impacts. Electricity produced from photovoltaic cells does not result in air or water pollution, deplete natural resources, or endanger animal or human health [3].

In spite of these benefits, man is not able to use this energy completely and economically. Two billion people in the world still have no access to electricity. For most of them, solar energy would be their cheapest electricity source, but they cannot afford it. This is because the price of electricity produced from solar cells is still significantly more expensive than it is from fossil fuels like coal and oil. This is because of cost involved in converting the solar energy into required form of electrical energy and low efficiency of solar system i.e., the output from the solar system is not completely sufficient for our needs. The problem here is that the sun's position is not constant throughout the day. The output from the solar system depends on the intensity of sunlight and the angle at which radiation is being incident. Hence there is a need to track the sun in order to produce maximum output throughout the day.

Analization of Solar Tracking System: A Solar tracker is a device for orienting a solar photovoltaic panel towards the sun. In solar tracking systems the surface of the module tracks the sun automatically throughout the day. Tracking system increases the efficiency of the system considerably there by reducing the cost per unit of output energy.Concentrators, especially in solar cell applications require a high degree of accuracy to ensure that the concentrated sunlight is directed precisely to the powered device, which is at the focal point of the reflector or lens. The output greatly depends on the angle of incidence, Zenith angle and azimuth angle. Some solar trackers may operate most effectively with seasonal position adjustment and most will need inspection and lubrication on an annual basis.

Stepper Motor: A stepper motor is an electromechanical device which converts electrical pulses into discrete mechanical movements. The stepper motor is used for position control in applications like disk drives and robotics. The name stepper is used because this motor rotates through a fixed angular step in response to each input current pulse received by its controller. In recent years, there has been wide-spread demand of stepper motors because of the explosive growth of computer industry. Their popularity is due to the fact that they can be controlled directly by computers, microprocessors and programmable controllers. Stepper motors are ideally suited for situations where precise position and precise speed control are required without the use of closed-loop feedback. When a definite number of pulses are supplied, the shaft turns through a definite known angle. This fact makes the motor well suited for open-loop position control because no feedback need be taken from the output shaft. Every stepper motor has a permanent magnet rotor also known as shaft surrounded by a stator poles. The most common stepper motor s has four stator windings that are paired with a center-tapped. This type of stepper motor is commonly referred to as a four-phase stepper motor. The center tap allows a change of current direction in each of two coils when a winding is grounded, there by resulting in a polarity change of the stator.

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Steps per complete revolution = Number of phases (coils) x Number of teeth on rotor

Smaller the step angle, greater the number of steps per revolution and higher the resolution or the accuracy of positioning obtained. The step angles can be as small as 0.72˚ or as large as 90˚. The motor speed is measured in steps per second.

Steps per second = (Revolution per minute x steps per Revolution)/ 60

Stepping motors has the extraordinary ability to operate at very high speeds (up to 20,000 steps per second) and yet to remain fully in synchronism with the command pulses, when the pulse rate is high, the shaft rotation seems continuous. If the stepping rate is increased too quickly, the motor loses synchronism and stops. Stepper motors are designed to operate for long periods with the rotor held in a fixed position and with rated current flowing in the stator windings whereas for most of the other motors, this results in collapse of back emf and a very high current which can lead to a quick burn out.A stepper motor is a special kind of motor that moves in individual steps which are usually .9 degrees each. Each step is controlled by energizing coils inside the motor causing the shaft to move to the next position. Turning these coils on and off in sequence will cause the motor to rotate forward or reverse. The time delay between each step determines the motor's speed. Steppers can be moved to any desired position reliably by sending them the proper number of step pulses.

V. SOLAR WATER PUMPING

As we know that mankind will be never lacking in energy. Today, it is liquid fluid, tomorrow it may be uranium with an element of risk. Risk exists where ever there is human activity and production of energy. Just as the supply of fossil fuel is finite thus there will be the supply of uranium. Perhaps, uranium would be exhausted quickly if it is used on a large scale. It is therefore, harnessing the gigantic inexhaustible solar energy source reduces the dependence on fossil fuels [5].

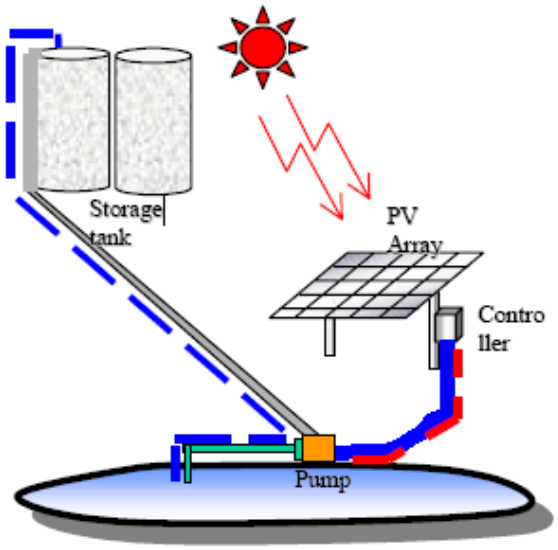

Fig. 4 Solar water pumping system

A. WORKING PRINCIPLE

The panel is kept under the sun for radiation. The photon energy from the sun lights that incident on the top metallic grid causes the electrons in the P-layer and holes in the N-layer to diffuse towards the junction. In this process the electrons collected on the N-side and holes collected on the P-side charge these two sides oppositely. This develops an open circuit voltage across the two terminals. The energy conversion process continues as long as light is incident on the active top surface of the cell. The power developed by these cells are collected and stored in a battery. The power from the battery is sent to the DC motor. It runs the pump coupled to it. The suction head is connected to the well and

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discharge head is directed towards the field. The water from the well is pumped out and it is used for the domestic or agricultural purpose.

B. PUMPS: TYPES, CHARACTERISTICS, OPERATING CURVES

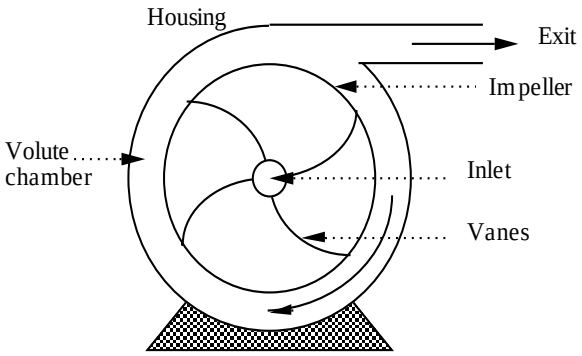

Fig. 5 A simple centrifugal pump

Centrifugal pumps are widely used for transferring liquids of all types. These pumps are available in capacities from 2 GPM to 10^5 GPM,and for discharge pressures from a few feet to approximately 7000 psi. A centrifugal pump typically consists of an impeller rotating within a stationary housing. The impeller usually consists of two flat disks, separated by a number of curved vanes (blades), and mounted on a shaft that project outside the housing [5]. Power from an outside source is applied to the shaft, rotating the impeller within the stationary housing. The revolving vanes of the impeller produce a reduction in pressure at the inlet hole or eye of the impeller. Fluid then flows to the eye. From the eye the fluid is flung outwards by centrifugal force into the periphery of the housing and from there to the volute chamber and finally to the pump exit. The overall pressure increase across the pump at low flow rates is approximately.

$$\Delta p = \rho u_2^2 = \rho \pi^2 D^2 N^2$$

Where, ρ= density of the fluid
u_2 = tangential impeller velocity
D = diameter of impeller
N = rotational speed of the impeller

We have a centrifugal pump testing unit in the transport laboratory. This consists of the pump, the DC motor, a dynamometer, meters for D.C. volts and amps, various pressure gauges; water feed tank and a weigh tank for mass measurement during a measured time interval [5]. Make a sketch of the pump testing unit, showing all relevant information. This does not have to be exactly to scale, but it should resemble the physical unit.

VI. GSM MODEM

A GSM modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone [5]. From the mobile operator perspective, a GSM modem looks just like a mobile phone.For the purpose of this document, the term GSM modem is used as a generic term to refer to any modem that supports one or more of the protocols in the GSM evolutionary family, including the 2.5G technologies GPRS and EDGE, as well as the 3G technologies WCDMA, UMTS, HSDPA and HSUPA.

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Fig.6 GSM Modem

A GSM modem exposes an interface that allows applications such as Now SMS to send and receive messages over the modem interface. The mobile operator charges for this message sending and receiving as if it was performed directly on a mobile phone. To perform these tasks, a GSM modem must support an "extended AT command set" for sending/receiving SMS messages, as defined in the ETSI GSM 07.05 and 3GPP TS 27.005 specifications. GSM modems can be a quick and efficient way to get started with SMS, because a special subscription to an SMS service provider is not required. In most parts of the world, GSM modems are a cost effective solution for receiving SMS messages, because the sender is paying for the message delivery.

VII. RESULT AND DISCUSSION

The solar tracking system is mainly implemented to track the solar radiations. The solar array moves according to the direction of the sun and utilizes maximum amount of solar radiation to convert to electrical energy. The tracking system allows maximum conversions of solar radiation than that possible by the normal fixed array voltage are given in table.1.

S.No.	Time	Tracking Array in Volts	Fixed Array in Volts
1.	07.15 Am	08.70	2.40
2.	08.30 Am	09.50	6.50
3.	10.45 am	10.60	9.10
4.	12.15 Noon	10.80	9.30
5.	13.45 Pm	11.40	9.60
6.	15.30 Pm	10.50	9.50
7.	17.50 Pm	09.40	2.40

Table.1 Compression of Tracking and Fixed array voltage Vs Time

The graph is recorded between voltage and time on a day to analyze the performance of the solar tracking array with respect to a fixed array.

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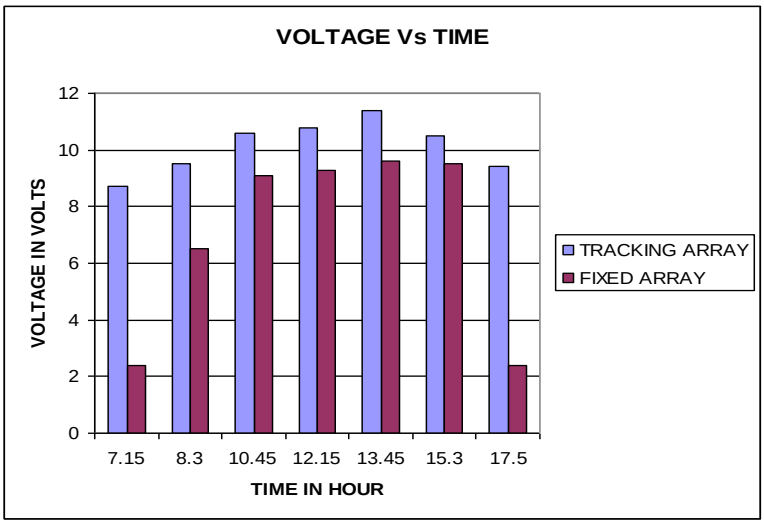

Graph.1 Time Vs Voltage Graph

It is analyzed that the utilization of solar energy is better by the solar tracking system than that of the fixed array. The output voltage is increased by 33.46 % than that of the fixed plate. The above readings are taken at various intervals of time on a hot sunny day.
The readings give a very good data analysis of the energy production by utilizing solar energy.

Rate of Flow = 12 litres / min
Duration = 18 Hours

VIII. CONCLUSION

This project is one time installation cost and is having very low maintenance cost. As this project is simple in construction and can be easily implemented in rural side .It is not dependent on Non Renewable energy sources and also ecofriendly. Not only that it will reduce the farming cost which will ultimately beneficial to the common people as well as the government in controlling the inflation on the food products and will also save non-renewable energy like coal and petroleum of our country.

IX. FUTURE SCOPE

We are using DC Motor coupled to the centrifugal pump for pumping water runned by the battery which is charged by solar or wind energy. Now the maintenance cost of the DC motor is very low because of non-use of brush and commutator. The input voltage increases according to the increase in the H.P of the motor. Its input voltage ranges from12v to 300v dc and has very high rpm up to 30000 rpm. This input can easily be achieved by solar and wind power. This is one of the simple and eco-friendlyprojects the installation of the solar and wind power cost one time installation and free power for ever with very less maintenance. Consideration of the government on the installation of the solar panel and wind mills can bring electricity to each and every village and rural areas which they can use in irrigation of their farm land, pumping drinking water from the well and underground borings.

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