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Development and Testing of Solar Power Water Pumping System for Domestic Purpose

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Abstract: ***Solar power is absolutely perfect for use with irrigation systems for gardens, allotments, greenhouses, and polytonal. When the sun is shining you need more water and so the solar power is there for the pump. By adding a suitable deep-cycle leisure/marine battery, power can be made available 24 hours per day enabling watering in the evening - the best time to water plants in the summer so that the water has a chance to soak into the ground. A solar-powered pump is a normal pump with an electric motor. Electricity for the motor is generated on-site through a solar panel which converts solar energy to direct-current (DC) electricity. Because the nature of the electrical output from a solar panel is DC, a solar-powered pump requires a DC motor if it is to operate without additional electrical components. If a pump has an alternating-current (AC) motor, an inverter would be required to convert the DC electricity produced by the solar panels to AC electricity. Due to the increased complexity and cost, and the reduced efficiency of an AC system, most solar-powered pumps have DC motors. DC motor has been used to drive 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. It has been observed that the power is generated above 48 watt which is required to drive pump.***

Keywords: ***Solar power, DC motor, solar energy, solar panel, pump.***

I. INTRODUCTION

Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar heating, solar photovoltaic, solar thermal electricity, solar architecture and artificial photosynthesis. Solar technologies are broadly characterized as either passive solar or active solar depending on the way they capture, convert and distribute solar energy. Active solar techniques include the use of photovoltaic panels and solar thermal collectors to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light dispersing properties, and designing spaces that naturally circulate air. In 2011, the International Energy Agency said that "the development of affordable, inexhaustible and clean solar energy technologies will have huge longer-term benefits. It will increase countries' energy security through reliance on an indigenous, inexhaustible and mostly import-independent resource, enhance sustainability, reduce pollution, lower the costs of mitigating climate change, and keep fossil fuel prices lower than otherwise. The Earth receives 174 peta watts (PW) of incoming solar radiation (insolation) at the upper atmosphere. Approximately 30% is reflected back to space while the rest is absorbed by clouds, oceans and land masses. The spectrum of solar light at the Earth's surface is mostly spread across the visible and near-infrared ranges with a small part in the near-ultraviolet.

Solar pumping system is a system of two main components: solar panel and solar pump. A solar panel is composed by a small electronic device called solar cells made in semiconductor materials which produce direct current (DC) when exposed to the solar radiation. The panel system collects the direct current and is then supplied to the pump directly or stored in the batteries for later use by the pump. Actually there are two types of solar pumping systems: direct coupled and indirect coupled,

Direct coupled: When there are no batteries in the system, this system is used when water is needed only during sun shine (day light) or when continuous water supply is not needed; in this case the storage tank is needed to ensure continuous water supply.

Battery coupled: When the system is having batteries to store DC currents, the direct current from solar panels during day light is stored in batteries then the batteries will supply the energy to the pump at any time when the water supply is needed.

Solar-powered pumping systems can be configured to meet a wide variety of demands. The amount of water a solar powered pump can deliver is a function of how far the water has to be lifted, the distance it has to travel through a delivery pipe (and the size of pipe), the efficiency of the pump being used, and how much power is available to the system. Power can be increased by adding more solar panels. One of the main advantages of a solar-powered pumping system is its simplicity and durability. The pump is the only part of the system having any moving parts, and it comprises a relatively small portion of the total system cost. Unless the

system is installed in an extremely dusty area, occasional inspection of the wiring and the general appearance of the panels will be all that is necessary. Panels can be cleaned with plain water and a soft cloth. The frequency of inspection should match the amount of storage available. For example, if the system incorporates a three-day supply of water and/or energy in storage, then it should be inspected at least every three days.

II. LITERATURE SURVEY

During the last two decades, a number of studies involving experimental Study of Solar power Water Pumping System for Domestic and irrigation Purpose were reported.

Deshmukh Priyanka et.al[1], they have been studied on PV Based Solar Water Pumping System. Due to the continuous decrease of the solar cells cost, photovoltaic energy is used in diverse applications. The most important one is the batteries-coupled water pumping system powered by photovoltaic generators. The use of batteries allows the system to deliver a constant water flow during the low light periods and night. The photovoltaic pumping system is composed of a PV generator, inverter, batteries, AC motor and centrifugal pump. The surplus energy produced by PV panels during light hours charges the batteries and the batteries in turn supply power to the pump during backup energy. A simulation study is presented under variable weather conditions and the results show the effectiveness of the studied method.

Brian D. Vick and R. Nolan Clark [2], Both have experimentally studied for Determining the Optimum Solar Water Pumping System for Domestic Use, Livestock Watering or Irrigation. In this review, several steps are given to select a solar-PV water pumping system. The steps for selection of stand-alone water pumping system were: deciding whether a wind or solar water pumping system would be best, determining the type of PV module, how controller can affect the decision, selecting pump type (diaphragm, piston, helical, or centrifugal), and analyzing the monthly water demand requirement. Three case studies are also included to demonstrate how to determine PV array size, motor/pump rated power, and type of pump.

AI Abdelkerim, A. Aibinu and M A Eusuf [3], They have been Development of Solar Powered Irrigation System. The system is powered by solar system as a renewable energy which uses solar panel module to convert Sunlight into electricity. The development and implementation of an automated SCADA controlled system that uses PLC as a controller is significant to agricultural, oil and gas monitoring and control purpose purposes. The system is equipped with four input sensors; two soil moisture sensors, two level detection sensors. Soil moisture sensor measures the humidity of the soil, whereas the level detection sensors detect the level of water in the tank. The output sides consist of two solenoid valves, which are controlled respectively by two moistures sensors.

S. Harishankar et.al[4], They have been discussed Solar Powered Smart Irrigation System Cost effective solar power can be the answer for all our energy needs. Solar powered smart irrigation systems are the answer to the Indian farmer. This system consists of solar powered water pump along with an automatic water flow control using a moisture sensor. It is the proposed solution for the present energy crisis for the Indian farmers. This system conserves electricity by reducing the usage of grid power and conserves water by reducing water losses.

Sagar Kande [5], he developed Solar based water pumping. In This research work through innovative ideas has tried to combine human power and solar pv hybrid system with pendulum mechanism. The mechanism developed helps store pendulum kinetic energy in fly wheels and converts oscillatory motion in to smooth reciprocating motion to lift water .A small push required to continue the oscillatory motion is given by a motor run on small solar pv panel. The pendulum based water pump can be useful in the areas where electricity is not available. A proto type of hybrid solar water pump designed and enveloped has lifted the 20 lpm water to 6 meters height with the solar panel of 10W to charge the12 V 20AH battery to run 84W DC volumetric efficiency achieved motor of 35 RPM. The volumetric efficiency achieved is 31,72% and is highest among solar pumps available in market having efficiency of 7 to 10%.

Mohit Bansal et.al[6], Experimentally, they studied Automatic Solar Powered Water Pumping Using Zigbee Technology. There has been a vast improvement and change in agriculture technologies used for irrigation purpose. Farm machineries, farm buildings and production facilities have been improved to a large extent. It has been found that PV system is the best solution for remote agriculture and for needs such as water pumping for crops or river life stock. Zigbee technology is renewable and is still a new concept. A Zigbee based water pumping system comprises of various components like, PV panels, pumps and Zigbee modules. In this Zigbee technology is used for wireless transmission and for enhancing the security of the system. In our system we have tried to automate the water pumping system to pump the water whenever the water level is increased beyond the prescribed level during rain or flood.

B. Kavitha et.al [7], The Designed of solar PV water pumping system using BLDC drive using sensorless method have been discussed. This review deals with the development of low cost PV pumping system using a PMBLDC (permanent magnet brushless

dc motor) drive coupled to a pump load. The controller has been designed and developed without current and position sensors therefore reducing to a large extent the overall cost of the drive system. DC-DC converters are used to maintain the required output in case of low solar insolation during the winter and also in case of reduced solar output due to increase in cell temperature. A simple filter circuit is introduced before inverter to reduce ripples which increases the efficiency of the system. The inverter drives PMBLDC to pump the water to the tank. The input from the water level sensors attached to the tank indicates the water level to the controller and thereby automates the pumping system.

K. B. Rohit, Prof. G. M. Karve & Prof. Khatri [8], experimentally, they studied the Solar Water Pumping System. PV array is increasingly employed for water pumping system. In this paper, the developed boost converter steps up the voltage produced by the PV array to a value which is suitable to run a single-phase induction motor. A design of directly coupled solar water pumping system powered from photovoltaic panels, DC to DC Boost converter, full bridge sinusoidal pulse width modulation (SPWM) inverter, LC filter, induction motor and centrifugal pump is presented. PID feedback controller is used to control the voltage. The model was implemented using MATLAB/Simulink with SPWM controlled inverter model. The detailed modeling of the components of proposed scheme has been taken up.

Athira Chandran G et.al[9], they discussed on Solar Water Pumping System with Improved Efficiency and Less Maintenance. Solar systems are becoming increasingly prevalent in distribution and generating system. This is because of its large availability. Even though there is a large availability, it is not commonly used because large area with huge installation cost as well as maintenance cost is required. One of the major field in which solar energy used is water pumping for small scale irrigation. This review is aimed to introduce Ćuk converter as well as impedance source inverter in pumping system along with photovoltaic cells (PV) in order to obtain a constant power output irrespective of the intensity of solar radiation with low installation and maintenance cost. The proposed model is developed with the help of MATLAB/Simulink.

Dipesh Patel et.al [10], they studied Development of Solar Powered Water Pumping System. Providing clean, environmentally safe water for livestock in sufficient quantities continues to be a major concern for farmers and ranchers.. Solar water pumping system operates on direct current. The output of solar power system varies throughout the day and with changes in weather conditions. Photovoltaic module, the power source for solar pumping, have no moving parts, requires no maintenance and last for decades. A properly designed solar pumping system will be efficient, simple and reliable. Solar powered pumping systems are used principally for three applications town and city water supply, livestock watering and irrigation.

Anish Saini et.al [11], experimentally, the studied the solar powered stirling engine driven water pump. Depletion of non-renewable resources has been a major problem that we face in today's world, thus taking this into consideration this paper we deal with the powering of water pump using solar energy, for this purpose we use the principle of sterling cycle to achieve the desired result. Parabolic mirror is used to concentrate the solar beams onto the area where enough energy is produced drive the stirling engine which works on the basic principal of the conversion of the heat energy to mechanical work depending on the heat difference being provided. A country like India, where energy crisis is a frequently observed problem, our system could be great use especially in the areas where water deficiency is high, where shortage of electricity is a known fact. Our system uses the only abundant renewable energy that is the sun light generate electric power, this method can act as an important tool.

Basava Sidramappa Dhanne, Sachin Kedare, Shiva Sidramapp Dhanne [12], they have been discussed on modern solar powered irrigation system by using arm. This review gives information related automatic supply of water to fields, automation of system is provided with modules and soil moisture sensor, the source to generate electricity through renewable resources, we prefer sunlight as the main source. The objective is to supply water for the fields through solar powered water pump and automate the system for better management of resources. The farmer (user) can water the fields from any place using GSM technique which provides an acknowledgement message about the situation. The main advantage of this project is optimizing the power usage through water resource management and also saving government's free subsidiary electricity. This proves an efficient and economy way of irrigation and this will automate the agriculture sector.

Dave Umang Y et.al [13], they studied Solar Powered Reciprocating Pump experimentally. In present days, people need more and more power for driving instruments. A solar based reciprocating pump is a pump, running on electricity on electricity generated by solar cell, available from collected sunlight as opposed to greed electricity or diesel run water pump. Nowadays many types of pump are available such as, positive displacement pump, impulse pump, velocity pump, gravity pump, steam pump, valve less pump. A reciprocating pump is class of positive displacement pump, is used for variety of purpose such as, car washing, irrigation, color spraying, extraction of oil from bottom of the earth, large fountain, garden water pump, etc. If 50% of the diesel pump were replaced with solar PV pump set, diesel consumption could be reduced to the turn of about 225 billion liter/year. This system consists of solar collector, battery, motor, crankshaft, reciprocating pump, valve, and tank.

M.Abu-Aligah [14], Design of Photovoltaic Water Pumping System and Compare it with Diesel Powered Pump has been studied. In locations where electricity is unavailable, other means are necessary to pump water for consumption. One option is a photovoltaic (PV) pumping system. Advantages of PV pumping systems include low operating cost, unattended operation, low maintenance, easy installation, and long life. These are all important in remote locations where electricity may be unavailable. So far, in the development of this research, the focus has been to estimate the available radiation at a particular location on the earth's surface and then analyzed the characteristics of a photovoltaic generator and a photovoltaic network. The purpose of this research is to examine all the necessary steps and key components needed to design and build a pump using photovoltaic system.

Balkeshwar Singh & Anil Kumar Mishra[15], Both have been discussed on Utilization of Solar Energy for Driving a Water Pumping System, Renewable energy sources in general, and Solar Energy source in particular, has the potential to provide energy services with zero or almost zero emission. The solar energy is abundant and no other source in renewable energy is like solar energy. The solar-powered pumping system can be used anywhere but it is appropriate for rural areas which is facing energy crisis. Due to geographical position, sultanate of oman and gulf region has ample sunshine throughout the year which makes it ideal location for utilization of solar energy. Small farms, villages, and animal herds in developing countries require hydraulic output power of less than a kilowatt. Many of these potential users are too far from an electrical grid to economically tap that source of power, and engine-driven pumping tends to be prohibitively expensive as well as unreliable due to the high cost of purchased fuel and insufficient maintenance and repair capabilities.

III.EXPERIMENTAL SET-UP

The aim of the present work is to investigate experimentally the Study of Solar Cell Water Pumping System for Domestic and irrigation Purpose. The details of the experimental set- up are as follows.

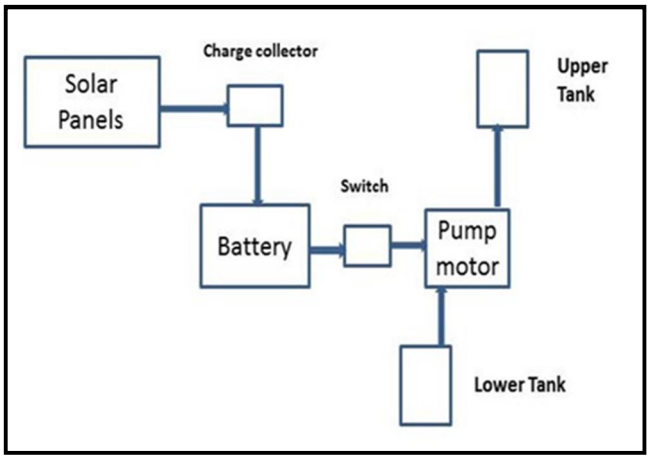

Fig.1: Schematic diagram of Solar Water Pumping System for Domestic Purpose.

Fig.2: Photographic view of Solar Water Pumping System for Domestic Purpose.

A. Component Specifications

TABLE I
COMPONENT DETAILS

Sr.no.	Components	Details
1	Solar Panels	60Watts
2	Battery	12Volts
3	Water Pump	12Volts DC Motor Pump
4	Supply Pipes	Half inch PVC pipes
5	Water Tanks	3*3 Metal Tank

IV. RESULTS AND DISCUSSION

A. Variation of day wise power generate by solar panel with respect to time

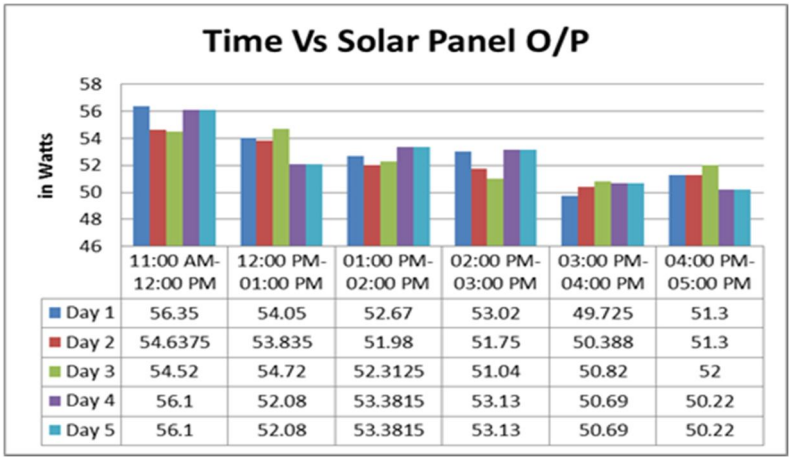

Fig.3: Variation of day wise power generated by solar panel with respect to time

Figure shows the Variation of day wise power generated by solar panel with respect to time. In this figure shows at 11.00 am to 12.00 pm power is generated is maximum as compared to the other time. The power is generated above 48 watts which is required to drive pump and remaining power stored in the battery.

V. CONCLUSIONS

In this paper, the research works on development and testing of solar power water pumping system for domestic purpose. The solar water pumping system has long lifetime and it is maintenance free. The system is powered by an intelligent solar system in which solar panel targets the radiation from the Sun. Other than that, the solar system has reduced energy cost as well as pollution. This system consists of solar panel, battery, water pump, supply pipes, water tanks and charge controller. This system conserves electricity by reducing the usage of grid power and conserves water by reducing water losses. It has been cleared that the power is generated above 48 watt which is required to drive pump.

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