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REVIEW ON PHOTOVOLTAIC (PV) SOLAR WATER PUMPING SYSTEM

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ABSTRACT

In Today's world there are many areas where drinking water is problem. In most of the case hand pumps are used at villages and remote places to solve the problem. Solar water pumping system is one of the alternatives. Solar power for water pumping is natural and symbiotic choice. and it gives good match between seasonal solar resource and seasonal water needs. Photovoltaic water pumping (PVWP) systems can meet a wide range of needs and are relatively simple, reliable, cost competitive, and low maintenance. Photovoltaic energy has many applications in agriculture and electrical energy providing in various cases like drinking water supply. The generation of electrical power from photovoltaic cell is mainly dependent on solar irradiations at respective times. The performance of solar powered water pump was as equal as pump powered by conventional one. The efficiency of solar based water pump is much higher than conventional power based water pump. Solar energy is the alternative of grid electricity used by farmers. It is best prevention method for Global warming which is a biggest challenge for humanity in the 21st century. This paper includes Utilization of solar energy for driving a solar water pump system.

Keywords: Solar energy, water pump, PV Cell, SWP system, drinking water supply system.

I. INTRODUCTION

Solar energy is one of the most applicable renewable energy sources. Solar energy consumption is the 10,000 times the current annual energy consumption in all over world. Now days for powering water heater, for running street lights and to meet domestic loads solar panels are extensively used. This solar energy system is the less expensive but high output efficiency system. The solar power pumping system can be used anywhere but is appropriate in Rural areas where they facing energy crisis and suitable for grid-isolated rural locations in poor countries where there are high levels of solar radiation. A solar energy service is the almost zero emission process [1]. Now days for future of county prevention of fuel is very important, solar energy pumping system help to prevent non renewable energy. Solar energy is the alternative of grid electricity used by farmers. They are easy to install and operate, highly reliable, durable and modular, which enables future expansion. PV pumping systems have, as a minimum, a PV array, a motor, a pump and normally a water storage tank. For

steady pumping needs such as community water supply or livestock watering PVWP is most cost effective system. The system requires minimal maintenance and attention as they are self-starting.

II. PRINCIPLE OF OPERATION OF SOLAR ENERGY[2]

Solar energy is available in abundance in most parts of the world. Sun gives 1.373 kW/m2 density of power radiated. Solar cell is a device which converts photons in Solar rays to direct-current (DC) and voltage. The technology is called Solar Photovoltaic (SPV). Near the top surface of the cell an electrical field is created where these two materials are in contact (the P-N junction). Electron springs up when the sunlight hits the semiconductor surface, an and is attracted towards the N-type semiconductor material. This will cause more positives in the P-type semiconductors and more negatives in the n-type, generating a higher flow of electricity this is called as Photovoltaic effect. On its efficiency, its size (surface area) and the intensity of sunlight striking the surface the amount of current generated by a PV cell depends. For example, under peak sunlight surface area of about 25 square inches a typical commercial PV cell will produce about 2 watts peak power.

III. COMPONENTS OF THE SYSTEM:

3.1 Photovoltaic Cells:

Photovoltaic cells are devices which 'collect the light and convert it into electricity. The cells are wired in series, sealed between sheets of glass or plastic, and supported inside a metal frame. These frames are called solar modules or panels. Photovoltaic cells are used in variety of applications for powering ranging from calculators and wrist-watches to complete home systems and large power plants. PV cells are made of thin silicon wafers; a semi-conducting material similar to that used in computer chips. When sunlight is absorbed by these materials, solar energy releases the electrons from their atoms, allowing electrons to flow into the material for the production of electricity. This process of converting light (photons)to electricity (voltage) is called the “photovoltaic effect”.

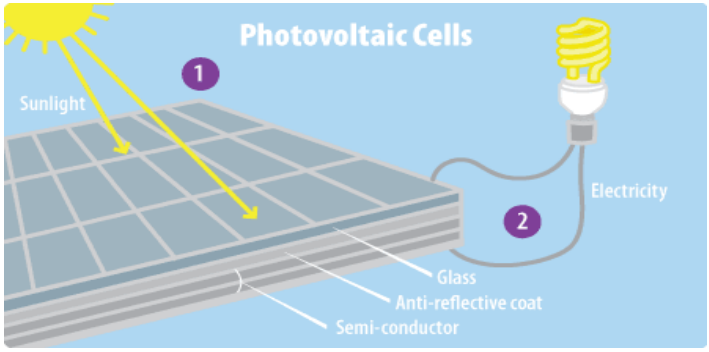

Fig.1 – Photovoltaic cell

3.2 Pumps:

DC water pumps typically use between one third and one half of the energy of conventional AC pumps. DC pumps are classified as displacement or centrifugal type and can be classified as submersible or surface types. Positive displacement pumps use diaphragms, vanes or pistons to seal the water in a chamber and force it through a discharge outlet. Like a water wheel, centrifugal pumps use a rotating wheel that adds energy to the water and pushes it into the system. It is very reliable to place submersible pumps in a well or sump, because they are not exposed to subzero temperatures, do not require special protection of the elements and do not require priming. Surface pumps, located on or near the surface of the water, are mainly used to transport water through a pipeline. Some surface pumps can develop high heads and are suitable for carrying water over long distances or at high altitudes.

3.3Pump Controller:

The main role of a pump controller in a battery-coupled pumping system is boosting the voltage of the battery to match the output. Without a pump controller, the operating voltage of the photovoltaic panels is dictated by the battery bank and is reduced from the levels, which are achieved by operating the pump directly from the solar panels.

IV. DESIGNING AND INSTALLING SYSTEMS:

Every pumping and stock-watering situation is unique. It is likely that the average consumer is intimidated by the possibility of sizing and designing a solar pumping system, and most people need the assistance of a qualified solar retailer. In general dealers are eager to help.Many will provide a no-cost proposal based on a few simple questions that can be askedover the phone.

In order to size and design a system correctly, the dealer will want to know:

• How much water you need;
• When you need the water;
• Whether your water source is a stream, pond, spring, or well;
• Water available in gallons per minute (gpm);
• Well depth;
• At what distance water need to be pumped and with what elevation gain.
• Water quality problems (e.g., high mineral content or salt) that may damage the pump;
• How much volume is available in storage tanks and how the tanks are arranged.

Installing a solar pump is a complex task. Combining elements of electrical work, plumbing and heavy construction include in the task (often including earthmoving, pouring concrete, and welding).Written instructions are not always as complete as they should be. A backhoe or tractor with a front-end loader is almost a necessity for some larger projects.

V. SOLAR-POWERED WATER PUMPING SYSTEM CONFIGURATIONS:[3]

There are two basic types of solar-powered water pumping systems, battery-coupled and direct-coupled. A variety of factors must be considered in determining the optimum system for a particular application.

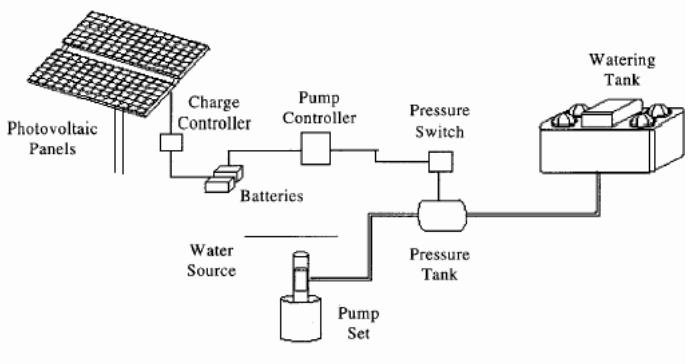

Fig.2 - Battery-coupled solar water pumping system

5.1 Battery-powered water pumping systems include photovoltaic (PV) panels, a charge controller, batteries, a pump controller, a pressure switch and a tank and a DC water pump (figure 2). The electric current produced by PV panels during daylight hours charges the batteries, and anytime water is needed the batteries in turn supply power to the pump. The use of batteries spreads the pumping over a longer period of time by providing a steady operating voltage to the DC motor of the pump. Thus, during the night and low light periods, the system can still deliver a constant source of water for drinking water supply and livestock. The use of batteries has its disadvantages. First, batteries can reduce the efficiency of the system in general. During maximum sunlight conditions depending on its temperature and battery charge, the voltage provided by the batteries may be one to four volts less than the voltage produced by the panels.

5.2 The electricity from the photovoltaic modules is sent directly to the pump, which in turn pumps the water through a pipe where it is needed (Fig. 3) to the direct coupling pumping systems. This system working at day time as is designed to pump water only during the day. About the amount of sunlight that reaches the photovoltaic panels and the type of pump, the amount of water pumped depends completely. Because the intensity of the sun and the angle of impact of the photovoltaic panels change throughout the day, the amount of water pumped by this system also changes throughout the day. For example, during optimal periods of sunlight (from morning to afternoon on sunny days), the pump runs 100% or close to it with a maximum water flow. However, early in the morning and in the afternoon, the efficiency of the pump can drop 25% or more in these low light conditions. The efficiency of the pump will decrease even more during cloudy days. To compensate for these variable flows, a good match between the pump and the PV module (s) is necessary to ensure an efficient operation of the system. For the availability of water during the cloudy days and during the night, the direct coupling pumping systems are sized to store extra water on sunny days. Water can be stored in a larger water tank than necessary or in a separate storage tank, and then fed by gravity to smaller water tanks. The

storage capacity of water is important in this pumping system. Depending on the weather and how you use the water, it may be necessary to store two to five days. Storing water in tanks has its disadvantages. Considerable losses of evaporation can occur if water is stored in open tanks, while closed tanks large enough to store several days of water supply can be expensive. Also, the water in the storage tank can freeze in cold weather.

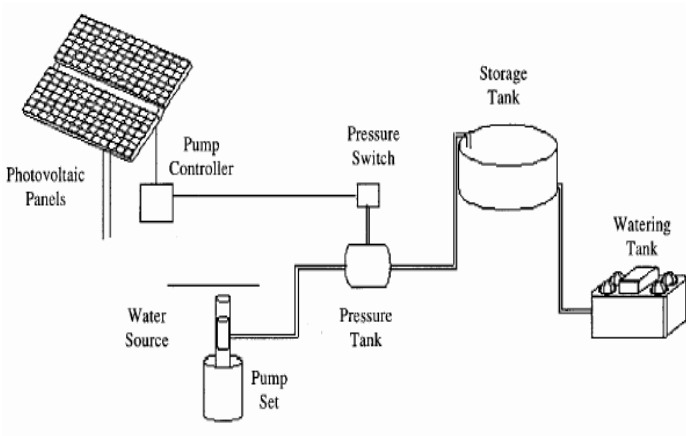

Fig.3 - Direct coupled solar pumping system

VI. APPLICATIONS

- Drinking water supply :-

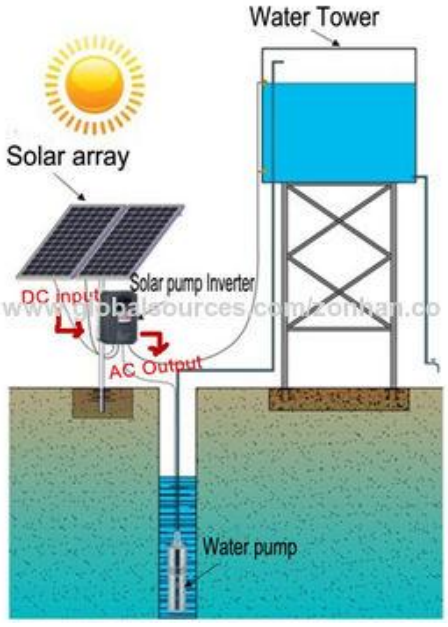

Fig.4 - Drinking water supply flow diagram

- Village water supply

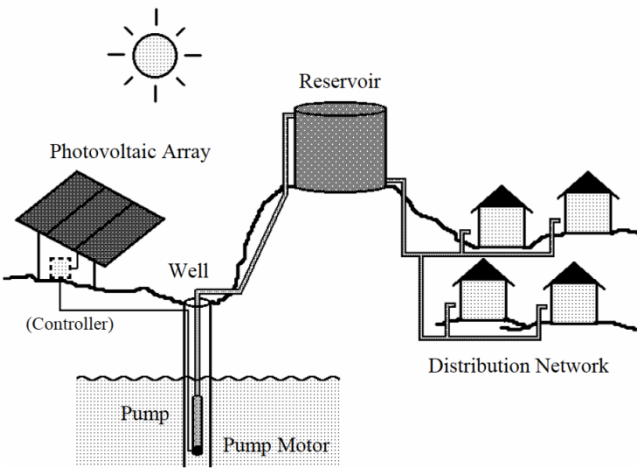

Fig.5 - Village water supply flow diagram

- Livestock watering

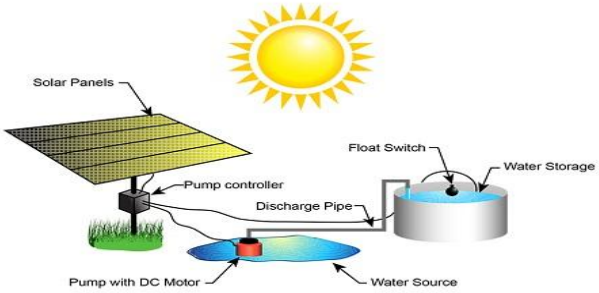

Fig.6 - Livestock watering flow diagram

- Irrigation

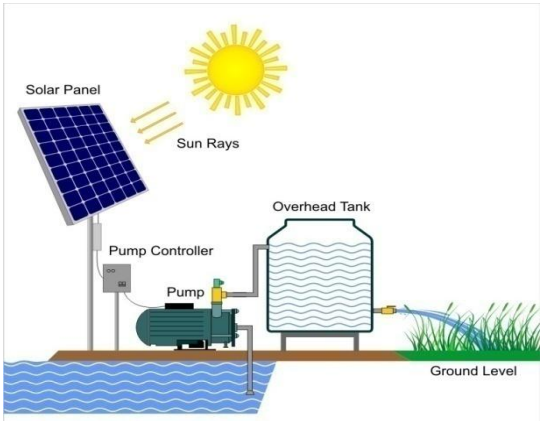

Fig.7 - Surface pump

VII. ADVANTAGES OF PV PUMPING SYSTEM

The PV pumping system has many advantages that are summarized below:

(i) Low operating cost: No fuel required for the pump like electricity or diesel hence it reduces the operating cost.

(ii) Low maintenance: This technology requires Low-maintenance because of lack of moving parts

(iii) Harmonious with nature: Another important advantage is that it gives maximum water output when it is most needed i.e. in hot and dry months.

(iv) Flexibility: The panels need not be right beside the well. They can be anywhere up to 20 meters away from the well, or anywhere you need the water. These pumps can also be turned on and off as per the requirement, provided the period between two operations is more than 30 seconds.

(v) Most important advantage is that technology is noiseless.

(vi) It is a Non-polluting technology, which means that it does not release greenhouse gases

VIII. LIMITATIONS OF PV PUMPING SYSTEM

PV pumping system has its various limitations which are as following:

(i) Low yield:Solar pumping is not suitable for very high demand. It gives very low availabilityof maximum capacity.74

(ii) Cost: The initial investment cost of this system is high.

(iii) Theft: Theft of solar panels can be a problem in some areas. So the farmers need to take necessary precautions.

(iv)Area/ space: As the efficiency levels are low, the space required is relatively high.

(v) Solar energy is heavily dependent on atmospheric conditions.

IX. CONCLUSION

Solar water pump play significant role in under the circumstances of inadequate supply of electrical energy. Solar photovoltaic pumping offers an alternate means to meet the electricity demand for irrigation and livestock watering. Here, PV pumping system has been analyzed with its scope and limitations. The proposed PV solar water pumping system has long lifetime and it is maintenance free. Together with decreasing PV module costs and increasing efficiency, PV is getting more pervasive than ever. In the 21st century for humanity issues like energy and global warming are some of the biggest challenges. Expenditure on energy increases day by day as maximum use of non- renewable energy. Therefore utilization of renewable energy becomes a crying need for today. It helps to ensuring energy resources and minimizes the global warming along with saving of expenditure on money. Among different types of renewable resources, solar energy has great prospect for utilization in electricity generation.

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