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A Solar Powered Water Pumping Systems in Agriculture

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Abstract: Agricultural era is converting swiftly. Farm machinery, farm building and production centers are constantly being progressed. Agricultural applications appropriate for photovoltaic (PV) solutions are numerous. Those programs are a combination of person installations and systems hooked up by utility businesses once they have observed that a PV solution is the nice solution for remote agricultural want along with water pumping for crops or farm animals. A sun powered water pumping system is made from primary components. These are PV panels and pumps. The smallest detail of a PV panel is the sun mobile. every sun cell has two or more in particular prepared layers of semiconductor cloth that produce direct modern-day (DC) electricity whilst uncovered to light. This DC current is accrued by using the wiring in the panel. Its miles then supplied both to a DC pump, which in flip pumps water each time the sun shines, or stored in batteries for later use by using the pump. The goal of this article is to explain how solar powered water pumping machine works and what the variations with the other energy assets are.

Keywords: Agriculture, water, solar cell, pump

I. INTRODUCTION

It's far not unusual to use diesel to power mills in agricultural operations. at the same time as those structures can provide power where needed there are some full-size drawbacks, including:

- 1) Gas must be transported to the generator's region, which may be pretty a distance over some hard roads and landscape.
- 2) Their noise and fumes can disturb farm animals.
- 3) Gas costs upload up, and spills can contaminate the land.
- 4) Generators require a sizable amount of maintenance and, like every mechanical systems, they damage down and need substitute components that aren't constantly available.

There also are essential disadvantages in the usage of propane or bottled fuel to heat water for pen cleansing or in crop processing packages, or To warmness air for crop drying, together with transportation to the place in which you need the warmth, charges of fuel and protection troubles. For many agricultural desires, the opportunity is solar energy. Contemporary, properly-designed, easy-to-maintain sun structures can provide the strength that is wanted wherein it is wished, and whilst it's far wanted. Those are systems that have been examined and demonstrated around the sector to be cost-effective and dependable, and they are already raising tiers of agricultural productiveness worldwide (**Figure1**).



Figure 1. A range and solar system are side by side [1]

In general, there are two types of solar systems—those that convert solar energy to D.C. power and those that convert solar energy to warmth. Each sort has many applications in agricultural settings, making life less complicated and supporting to boom the operation's productivity. First is solar-generated strength, called photovoltaic (or PV). Photovoltaic are solar cells that convert sunlight to D.C. electricity.

The solar cells in a PV module are made from semiconductor materials. Whilst light energy moves the cellular, electrons are knocked unfastened from the material's atoms. Electric conductors connected to the advantageous and poor sides of the fabric allow the electrons to be captured in the form of a D.C. modern-day. This electricity can then be used to strength a load, which includes a water pump, or it can be stored in a battery [2]

It's an easy reality that PV modules produce power handiest while the sun is shining, so a few shape of energy garage is vital to operate structures at night. You may store the energy as water through pumping it right into a tank while the sun is shining and distributing it by way of gravity when it's needed after darkish. For electrical programs at night time, you may need a battery to save the strength generated all through the day (Figure2).



Figure 2. A typical assembly of solar cells[3]

Photovoltaic is a well-mounted, verified generation with a giant worldwide industry network. And PV is an increasing number of fee-effective in comparison with both extending the electric grid and using turbines in remote locations. The value in keeping with height watt of nowadays PV electricity is about \$7. Neighborhood supply situations, which include transport charges and import responsibilities, range and might add to the value.

PV systems are very low-budget in presenting strength at far flung locations on farms, ranches, orchards and different agricultural operations. A "faraway" location can be as little as 15 meters from a current energy supply. PV systems can be an awful lot inexpensive than putting in energy strains and step-down transformers in programs along with electric fencing, area or building lighting, and water pumping—either for live stock watering or crop irrigation.

II. WATERPUMPING

Water pumping is one of the simplest and most appropriate makes use of for photovoltaic. From crop irrigation to stock watering to domestic uses, photovoltaic-powered pumping structures meet a huge variety of water desires. Most of these structures have the brought gain of storing water for use when the sun isn't always shining, disposing of the want for batteries, improving simplicity and lowering usual device prices.

Many human beings considering installing a solar water pumping device are put off by means of the rate. Viewing the price over a period of 10 years, however, gives a better idea of the actual price. Via evaluating installation prices (such as labour), gas charges, and preservation charges over 10 years, you can discover that sun is an economical desire.

Solar-powered pumping devices are commonly in the equal rate variety as a new windmill however tends to be greater dependable and require much less preservation. A sun-powered pumping machine normally fees extra initially than a fuel, diesel, or propane-powered generator however again requires a long way less preservation and labour [4]. The fee of sun- pumped water in line with cow ranged from \$zero.03 to

\$zero.15 in line with day. The value according to gallon of water pumped ranged from \$0.002 to \$zero.007 in line with gallon.

A. Solar-Powered Water Pumping System Configurations

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 [1].

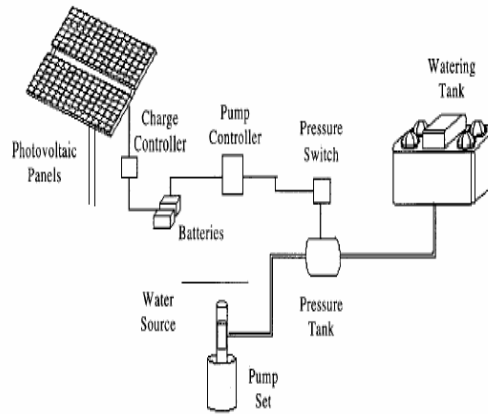


Figure 3. Battery-coupled solar water pumping system [5]

Battery-coupled water pumping systems include photovoltaic (PV) panels, charge manage regulator, batteries, pump controller, stress switch and tank and DC water pump (discern three). The electric present day produced by means of PV panels all through daylight charges the batteries and the batteries in flip supply electricity to the pump anytime water is wanted. The use of batteries spreads the pumping over a longer time frame by using supplying a constant working voltage to the DC motor of the pump. Accordingly, throughout the night and occasional mild periods, the machine can nevertheless supply a regular source of water for livestock. The usage of batteries has its drawbacks. First, batteries can lessen the performance of the overall gadget because the running voltage is dictated by way of the batteries and now not the PV panels. Depending on their temperature and the way nicely the batteries are charged, the voltage provided through the batteries may be one to 4 volts decrease than the voltage produced by using the panels in the course of maximum sunlight conditions. This decreased efficiency may be minimized with the usage of the proper pump controller that boosts the battery voltage furnished to the pump.

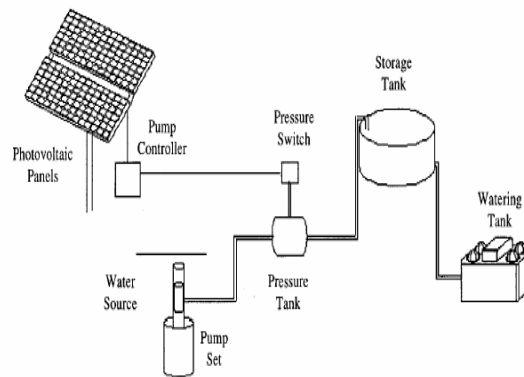


Figure 4. Direct coupled solar pumping system [5]

In direct-coupled pumping structures, strength from the PV modules is sent without delay to the pump, which in turn pumps water thru a pipe to wherein it is needed (discern 4). This machine is designed to pump water simplest in the course of the day. the amount of water pumped is totally depending on the quantity of sunlight hitting the PV panels and the form of pump. due to the fact the intensity of the solar and the perspective at which it strikes the PV panel changes at some stage in the day, the amount of water pumped with the aid of this device additionally changes for the duration of the day. For instance, throughout most excellent daylight durations (overdue morning to past due afternoon on bright sunny days) the pump operates at or close to a hundred percent performance with most water float. but, in the course of early morning and overdue afternoon, pump performance may drop by as much as 25 percent or more under these low-light conditions. During cloudy days, pump efficiency will drop off even more. To compensate for these variable flow rates, a good match between the pump and PV module (s) is necessary to achieve efficient operation of the system.

Direct-coupled pumping systems are sized to store extra water on sunny days so it is available on cloudy days and at night. Water can be stored in a larger-than-needed watering tank or in a separate storage tank and then gravity-fed to smaller

watering tanks. Water-storage capacity is important in this pumping system. Two to five days' storage may be required, depending on climate and pattern of water usage. Storing water in tanks has its drawbacks. Considerable evaporation losses can occur if the water is stored in open tanks, while closed tanks big enough to store several days water supply can be expensive. Also, water in the storage tank may freeze during cold weather.

B. Main Solar Powered Stock Watering System Components

Atypical solar-powered stock watering system includes a solar array, pump, storage tank and controller [6], (Figure 5).

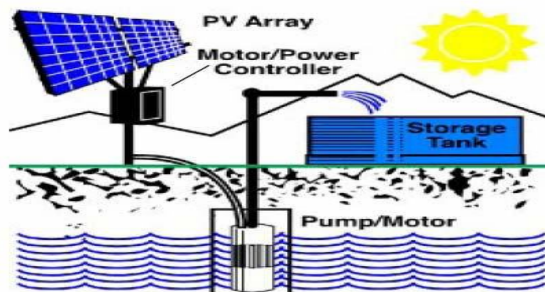


Figure 5. A typical solar-powered stock watering system[1]

- 1) *Solar Modules:* Solar electric systems are sometimes called photo voltaic systems. The word “photovoltaic” is often abbreviated PV. Most solar panels, or modules, generate direct current (DC) electricity. A group of modules is called an array.
- 2) *Mounting Structures:* There are two ways to mount solar modules: either on a fixed structure or on a tracking structure. Fixed mounts are less expensive and tolerate higher wind loading but have to be Carefully oriented so they face true south(not magnetic south).

An array can easily be mounted on a trailer to make it portable. A tracking array follows the sun across the sky. A tracker will add at least \$400 to \$800 to the cost of a system, but can increase water volume by 25 percent or more in the summer time, compared to a fixed array.

C. Pumps

DC water pumps in widespread use one-1/3 to at least one-half the electricity of conventional AC (alternating present day) pumps. DC pumps are classed as either displacement or centrifugal, and may be both submersible and floor types. Displacement pumps use diaphragms, vanes or pistons to seal water in a chamber and pressure it through a discharge outlet. Centrifugal pumps use a spinning impeller that provides strength to the water and pushes into the gadget, much like a water wheel. Submersible pumps, positioned down a properly or sump, are distinctly reliable because they may be no longer uncovered to freezing temperatures, do now not want unique safety from the elements, and do now not require priming. Surface pumps, located at or near the water surface, are used by and large for moving water through a pipeline. Some surface pumps can expand high heads and are appropriate for shifting water long distances or to excessive elevations.

D. Storage

Batteries are usually not recommended for solar-powered live stock watering systems because they reduce the overall efficiency of the system and add to the maintenance and cost. Instead of storing electricity in batteries, it is generally simpler and more economical to install 3 to10 days' worth of water storage.

E. Controller or Inverter

The pump controller protects the pump from high-or low-voltage conditions and maximizes the amount of water pumped in less than ideal light conditions. An AC pump requires an inverter, an electronic component that converts DC electricity from the solar panels into AC electricity to operate the pump.

F. Other Equipment

A float switch turns a pump on and off when filling the stock tank. It's similar to the float in a toilet tank but is wired to the pump controller. Low water cut-off electrodes protect the pump from low water conditions in the well.

G. Designing and Installing Systems

Every pumping and stock-watering situation is unique. The average consumer is likely to be intimidated by the prospect of sizing and designing a solar pumping system, and most people need the assistance of a qualified solar dealer. In general dealers are eager to help. Many will provide a no-cost proposal based on a few simple questions that can be asked over the phone. If the price seems too high, you can easily get bids from other dealers.

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

- 1) How much water you need;
- 2) When you need the water;
- 3) whether your water source is a stream, pond, spring, or well;
- 4) water available in gallons per minute (gpm);
- 5) well depth;
- 6) how far the water needs to be pumped, and with what elevation gain;
- 7) water quality problems (e.g., silt or high mineral content) that may damage the pump;
- 8) 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 (often including earth moving, pouring concrete, and welding). Written instructions are not always as complete as they should be. A back hoe or tractor with a front-end loader is most a necessity for some larger projects.

III. CONCLUSION

For the reason that increase in rate according to boom in unit energy output of a photovoltaic device is more than that for a diesel, fuel, or electric powered machine, photovoltaic power is extra cost aggressive whilst the irrigation machine with which it operates has a low total dynamic head. Because of this, photovoltaic strength is more fee-aggressive whilst used to energy a micro irrigation gadget in comparison to an overhead sprinkler device. Photovoltaic strength for irrigation is fee-aggressive with conventional strength sources for small, remote applications, if the total machine design and utilization timing is cautiously considered and organized to use the solar power as effectively as possible. In the future, when the prices of Fossil fuels rise and the economic advantages of mass production reduce the peak watt cost of the photo voltaic cell, photo voltaic power will become more cost-competitive and more common.

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