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Indonesian Journal of Educational Research and Technology

IJERT Indonesian Journal of Educational Research and Technology

Journal homepage: http://ejournal.upi.edu/index.php/IJERT/

Development of a Solar-Powered Submersible Pump System Without the Use of Batteries in Agriculture

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ABSTRACT

The purpose of this study was to describe the development of a solar-powered submersible pump system without the use of batteries in agriculture. The submersible pump system used a solar drive to run it. The implementation uses a combination of solar trackers, water storage tanks, power converters, and stabilizers. The results of the study explained that solar trackers increased the efficiency of solar units that track the sun throughout the day and convert solar energy into DC electrical power.

ARTICLE INFO

Article History:
Submitted/Received 15 Apr 2021
First revised 21 Aug 2021
Accepted 22 Aug 2021
First available online 22 Aug 2021
Publication date 01 Mar 2022

Keyword:
Agriculture,
Farming,
Irrigation system,
Submersible pumps.

1. INTRODUCTION

Agriculture is the largest employer in India, the Indian agriculture sector is not much developed, but last some years demand for food increasing continuously, which automatically promotes the agriculture activities (Rasul & Thapa, 2004). Various conventional methods are carried out in actual activates practices on the farm, which results overall production and growth per hector is low as compared to devolved agricultural countries. Irrigation is among the measures that can improve yields, reduce vulnerability to changing rainfall patterns and enable multiple cropping practices (Nisa *et al*., 2019). As such, irrigation is often seen as the engine that helps to ensure food security, generates incomes, provides jobs, and drives rural development

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 heat (Mekhilef *et al*., 2011). Both types have many applications in agricultural settings, making life easier and helping to increase the operation's productivity. First is solar-generated electricity, called photovoltaic (or PV). Photovoltaic are solar cells that convert sunlight to D.C. electricity (Sharma & Chandel, 2013). The solar cells in a PV module are made from semiconductor materials (Bagher *et al*., 2015). When light energy strikes the cell, electrons are knocked loose from the material's atoms. Electrical conductors attached to the positive and negative sides of the material allow the electrons to be captured in the form of a D.C. current. This electricity can then be used to power a load, such as a water pump, or it can be stored in a battery. It's a simple fact that PV modules produce electricity only when the sun is shining, so some form of energy storage is necessary to operate systems at night. You can store the energy as water by pumping it into a tank while the sun is shining and distributing it by gravity when it's needed after dark. For electrical applications at night, you will need a battery to store the energy generated during the day.

Many problems occur during Existing pumps using in the farmland are not able to deliver at full potential because of the discontinuity of the electric power supply, presently available solar water pumps usually run with DC power and are different from the common submersible pumps. Also, bad weather, battery storage, maintenance and controlling units, and expensive components that is why the overall cost of the system is more. Three types of solar water pumping systems are available including (Meah *et al*., 2008; Eker, 2005):

1. Borehole/well (submersible) pumps- In these systems, the solar water pump is located within the borehole or well. These pumps are generally available for 100 mm (4 inches) and 150 mm (6 inches) boreholes. The solar array is typically located near the top of the borehole/well and the water is generally pumped to a storage tank. The pump controller is typically located at the solar array. The pump and pump controller are interconnected using waterproof cables.
2. Surface pumps- These systems are typically used in shallow wells or boreholes and also lakes, rivers, and any open water source that is near or on the surface. The solar water pump is located above the water level and a suction pipe is used for drawing the water from the water source as is shown in Figure 5. In the Pacific, they could be installed beside rivers and streams, though flooding may be a serious problem. It is not anticipated that there will be many sites associated with dams built specifically for the pumping system though that may be the case for some larger irrigation water supplies.
3. Floating pumps- If the water source is a large dam or large open well, then a floating pump may be installed. In these systems, the water pump component is mounted within a floating device such that the pump inlet is located within the water source. These systems

DOI: https://doi.org/10.17509/ijert.v2i1.37956
p- ISSN 2775-8419 e- ISSN 2775-8427

remove any requirement for a suction pipe and the problems that can be associated with them, though a floating pump does usually.

It is assumed that the first two will be the most common in the Pacific and this guideline will detail how to determine the dynamic head for these types of systems that have purposed: 1) To the selection of components like solar panels, submersible pump, inverter, cables, pipes, and storage tank. 2)To design a single-axis solar tracker system. With fixed mounting and panel holding frame 3) To develop a controlling panel. This study aimed to describe the development of a solar-powered submersible pump system without using batteries in agriculture. Solar power was used to run the submersible pump system. The implementation uses a combination of a solar tracker, water storage tank, power converter, and stabilizer. The results of the study explain that the solar tracker increases the efficiency of a solar unit that tracks the sun throughout the day and converts solar energy into DC electric power.

2. METHOD

Solar water pumping system is considered a promising solution to solve those challenging issues. It presents a clean source of supplying water for irrigation with a low-cost system with minimum maintenance. This proposed solution consists of a combination of a solar tracker, water storage tank and power converters, and stabilizers. A solar tracker increases the efficiency of the solar unit which tracks the sun in the complete day and converts the solar energy into electrical DC power. This energy is stabilized through stabilizers and provide to a submersible pump. The system water is drawn from bore wells or other sources. a solar water pump is pumped to supply water as required. It can be stored in tanks from where it is later channeled to fields or the supply from the pump may be coupled with an irrigation system. The synchronizing of a solar tracker and storage tank floats sensors, which maintains the maximum water level in the storage tank. This solution is effective and efficient which gives a continuous supply of water and increasing the overall capacity of the system. This solution is unique due to its applicability to make sure of precision and its effective working. In solution suitable designed for existing submersible pump without batteries. Also simple in working with minimum maintenance cost.

2.1. Material Components

Table 1 shows the material components to make the development of a solar-powered submersible pump system without using batteries in agriculture, consisting of several types of components, specifications for each component, and the estimated funds used.

Tabel 1. material components to make the development of a solar-powered submersible pump system without using batteries.

Sr.No	Component name	Specification for	Budget
1	Submersible pump	3 hp AC	-
2	Invertor	3Kwatt (considered 20-30%) DC to AC	5,500/-
3	Solar panel	300watt 10 solar panels	72,000/-
4	Slew drive	150square ft required for 10 panels	9000/-
5	AC cable	7 inch	350/-
6	DC cable	10 ft	500/-
7	Storage tank	10 ft	10,000/-
8	Frame	5000 lit	500/-
9	PVC pipes	10 by 15 ft	3000/-
10	Small components	25 ft	1000/-
			Total: 101,850/-

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2.2. Research Procedures

The steps in designing and selecting a solar water pumping system are summarized as follows:

(i) During a site visit:

a. Determine the water source and based on the characteristics of the water source and the water's end usage, select the appropriate solar water pumping system to be installed.

b. Determine the daily or weekly water requirement and verify that the water resource availability over the long term can meet the requirements.

c. Determine where the solar array will be located.

d. Determine where the water pump will be located.

e. Determine the length of cables required between the solar array, pump controller, and water pump.

f. Determine where and how the water will be stored.

g. Measure the static head for the site.

h. Measure the total distance from the water source to the final location of the water.

i. Determine and measure any land irregularities (hills, ditches, etc.) that the piping system must traverse.

(ii) Determine the solar irradiation for the selected site on an annual and a monthly basis.

(iii) Select the size and type of the water pipe to be used to transfer the water from the source to its storage tank or its final destination if there is no storage tank.

(iv) Estimate the expected dynamic head and select a possible solar water pumping system using either manufacturers' tables or an appropriate computer program, accounting for available solar irradiation. This will then provide information on the maximum flow rate.

(v) Use the estimated maximum flow rate and calculate the frictional losses (flow friction head) and determine the dynamic head. Design, Selection, and Installation of Solar Water Pumping Systems 7

(vi) Choose a type of pump consistent with the quality of the water being pumped and the overall characteristics of the site (especially the particulate content of the water such as mud or coral sand),

(vii) With the final calculated dynamic head finalize the selection of the solar water pumping system from either manufacturer's tables or a computer program.

2.3. How The Tools Works

The procedure on how the tools work is

(i) Solar panels are installed on the frame, and complete assembly of the solar set is mounted on the solar tracker.

(ii) With piping connection storage tank installed on top of the platform

(iii) Outlet pipe of ac pump is connected to inlet of storage tank pipeline.

(iv) Solar plate connected with the junction of the solar controlling unit, this solar dc generated supply is connected with the inverter, which converts the dc supply into the ac power

(v) This generated ac power is not stable, for this stabilizer is installed n between load and invertor

(vi) Invertor supply is connected with the pump starter at a location of the starter feedback loop sensors from the storage tank are connected with the automation unit.

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(vii) When the sun is shining the solar tracker is made perpendicular angle between the solar panel and the sun, which converted sun energy into electrical DC energy.
(viii) This generated energy is converted into AC form from the invertor, because of the existing pump having AC operated.
(ix) At a sun shining continually pump is working and store the water in the storage tank. When solar energy is not available that time stored water we can use.
(x) When the storage tank is full, automatically pump is stopped, by sensing through water level float sensors.
(xi) At a No working of the pump, the water is consumed by the farmer the level goes decrease, that time automatically pump is stared.

Figure 1 shows how the process of a solar-powered submersible pump system without using batteries in agriculture, starting from how solar panels absorb solar energy, proceeding to process controllers, DC pumps, and Float Sensors, to storage tanks.

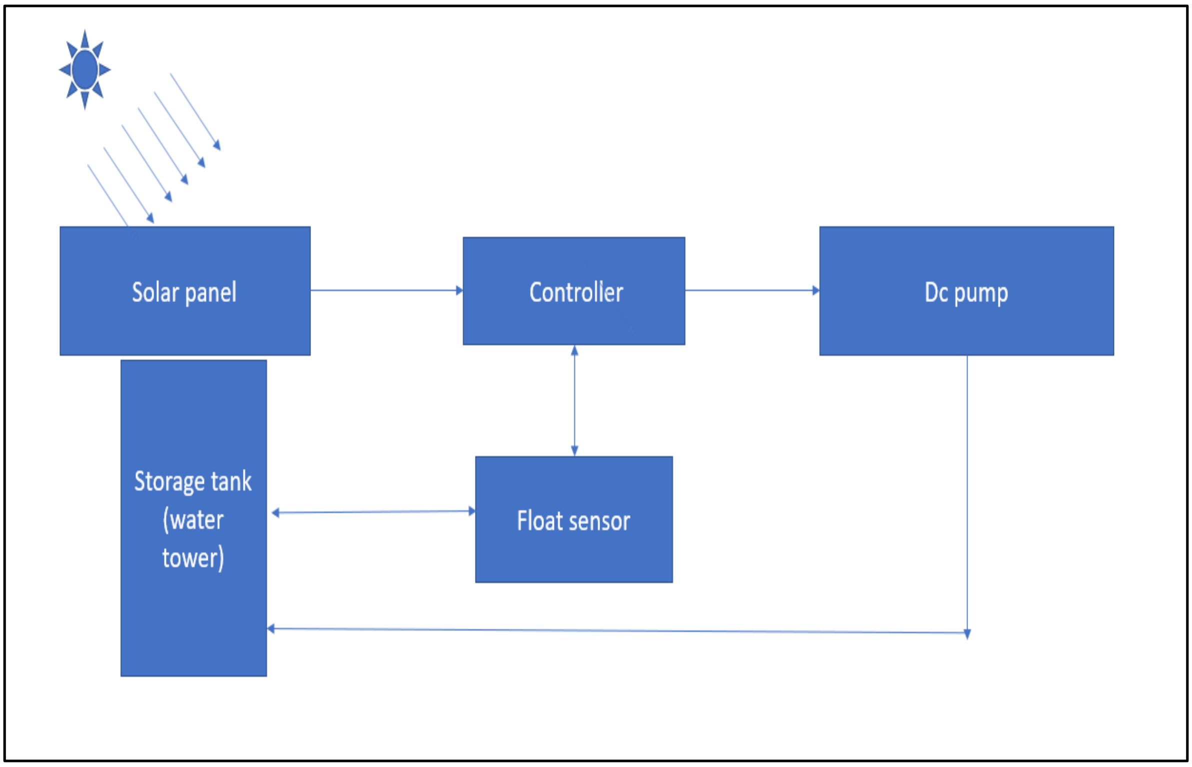

Figure 1. process of a solar-powered submersible pump system.

3. RESULTS AND DISCUSSION

3.1. Condition Problems

India is an agricultural country where more than 70% of the people depend on Agriculture. Due to the steady increase in the consumption of electricity for the past few years, there is low grid power coverage in the country, therefore grid-powered pumps cannot be used in most of the parts of the country. To overcome the inconvenience, there is a need to design and construct a solar-powered water pumping system. Existing pumps in the farmland are not able to deliver at full potential because of the discontinuity of the electric power supply, presently available solar water pumps usually run with DC power and are different from the

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common submersible pumps. Also, bad weather, battery storage, maintenance and controlling units, and expensive components that is why the overall cost of the system is more. is needed to develop an adaptive system, the solar drive that can run existing submersible pumps with solar energy without batteries.

This developed solution is overcoming the problems of existing pumps, the water storage tank, inverter, and solar tracker increase the efficiency of solar operated pumps.

(i) the total system runs on real-time energy generated which is based on the feedback system. Solar trackers track the sun path automatically which generate continues energy whole day, that's why solar panel increases efficiency.
(ii) The storage tank and its level monitoring sensors store the water which is available at the time of off electrical supply.
(iii) Invertor is converting the DC generated energy into the AC supply for AC operated pump. invertor and stabilizer unit make suitable from of stable and continuous supply which will be used for the existing pump.

3.2. Calculation About Material

About 67 % of Indian farmland is holding below I hector are 1 hector = 10,000 m^2 = 2.471 acres

(i) Assume 1-acre area for irrigation at a one, for 1-inch irrigation required 5,000 L of water at one time. Using Existing pump = 3 HP, the discharge of 3-HP pump = 100 L/min.
(ii) Time required for irrigation (T) = total required water / discharge of pump = 5000 L/ 100 = 50 min.
(iii) Approximating 1 hour to run the pump for demand water fulfillment, the motor is loaded. Thus, the output power of 3 HP is = 3 HP. 0.746 = 2.24 kW.
(iv) Pump efficiency is 90%, then input power is = (output power) / (efficiency /100). Thus, Input power = 2.49 KW.
(v) For safety, 20 to 30% of the bigger size of the inverter is profred, that is why 3 kW of input power is considered.
(vi) In India as per geographical region with 7 to 8 hours of solar energy is available at max time of the year.
(vii) Consider, 300-W rating modules are selected. Thus, we can calculate number of panels required = total energy required / 300-W rating module = 3000 W/ 300 W =10 panels. Thus it is required 10 panels.

Using this system has many advantages, including

(i) Require minimal Attention as they are self-starting through automation;
(ii) The solar power unit is designed for submersible pump runs the whole day;
(iii) Weak boreholes can be used effectively with a low volume pump due to pumping 8 to 10 hours per day;
(iv) High-accuracy Solar Tracking arrays can be used to increase daily water pumping rates;
(v) Water storage tanks and solar tracking mechanisms are interconnected with each other; they are working through automation. And maximum water level;
(vi) Solar pumps offer clean solutions with no danger of borehole contamination;
(vii) The solar pumping unit is without a battery, which results in system costs is low

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In addition to the advantages, there are several disadvantages in using this system, namely:

(i) Initial installation cost is automatically increased due to the addition of a solar tracker, and

(ii) Space required is relatively high, due to the movement of the tracker.

This system can be applied in several fields, including agriculture water supply –irrigation; Village water supply process industry; Drinking water supply station; Livestock watering; and Food process industry.

4. CONCLUSION

A renewable energy system offers an alternative way for the sustainable development of a country. This project indicates that the solar water pumping system can be integrated into irrigation systems. in as no battery bank is considered in designing the system to minimize the capital cost of the Solar Water Pumping System. An individual farmer can afford such a low-price pumping system in a developing country like India. The designed system is economically feasible to meet the irrigation challenges faced during the dry season.

5. DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. The authors confirmed that the paper was free of plagiarism.

7. REFERENCES

Bagher, A. M., Vahid, M. M. A., and Mohsen, M. (2015). Types of solar cells and application. *American Journal of Optics and Photonics*, *3*(5), 94-113.

Eker, B. (2005). Solar powered water pumping systems. *Trakia Journal of Sciences*, *3*(7), 7-11.

Meah, K., Fletcher, S., and Ula, S. (2008). Solar photovoltaic water pumping for remote locations. *Renewable and Sustainable Energy Reviews*, *12*(2), 472-487.

Mekhilef, S., Saidur, R., and Safari, A. (2011). A review on solar energy use in industries. *Renewable and Sustainable Energy Reviews*, *15*(4), 1777-1790.

Nisa, N. A. B., Priyadharshini, K., Priyadharshini, K., and Devi, R. N. (2019). Agriculture irrigation water demand forecasting using lora technology. *International Research Journal of Engineering and Technology*, *6*(3), 3050-3052.

Rasul, G., and Thapa, G. B. (2004). Sustainability of ecological and conventional agricultural systems in Bangladesh: an assessment based on environmental, economic and social perspectives. *Agricultural Systems*, *79*(3), 327-351.

Sharma, V., and Chandel, S. S. (2013). Performance and degradation analysis for long term reliability of solar photovoltaic systems: A review. *Renewable and Sustainable Energy Reviews*, *27*(2013), 753-767.

DOI: https://doi.org/10.17509/ijert.v2i1.37956
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