

Possibility of Using a Solar Water Pumping Systems for Rural Villages in Sudan

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Abstract:

The solar photovoltaic (SPV) water pumping system is one of the best technologies that use solar energy to pump water from deep groundwater sources and to provide clean drinking water throughout Sudan. The availability of abundant solar radiation and enough underground water sources in Sudan can be combined together to make clean drinking water available to rural communities. The aim of this article is to explain how a solar water pumping system works and to encourage the community to use renewable energy sources.

A review was given of the use of solar energy for water pumping to improve the living conditions of the population in rural areas and to develop techniques for utilization of solar energy in a tropical environment condition. The results of this study encourage suggests that, solar powered water pumping must be encouraged, promoted, invested, implemented, and demonstrated general of rural area in Sudan.

Keywords —Solar energy, Solar photovoltaic, Solar radiation, Water pumping.

1- Introduction:

According to the forecasts, it is expected that by 2050 global demand for energy grows up to 3 times. At least 15 to 20 percent of global energy demand will be met directly by new and renewable energy sources; solar energy is considered one of these sources. The use of solar energy is on the rise because it is clean, but the truth about solar power is that solar energy is expensive and for economic use, it is necessary to minimize the occurrence of errors in it. Production of nuclear and fossil power and other energies which are harmful to the environment, peace and human welfare, must be replaced with better methods, it means that they should turn into the form of available renewable energy in the environment various types of renewable energy sources contributing to currently energy demand consist of water, wind, solar energy and biomass.

A solar energy-powered water pump is a water pump running on the electricity that is generated by solar photovoltaic modules. Solar photovoltaic (PV) systems can be an attractive complementary energy source deployed alongside diesel pumps in areas with plenty of sunshine and where the cost to run power lines is high. Photovoltaic systems have the benefit of being scalable, with capacity ranging from a few watts for applications such as automated farm gates or timers, to hundreds of kilowatts for the homestead and farm sheds. Rather than having one large centralized system, a number of distributed PV systems can be deployed at pump sites ^{{1}{2}}.

In some areas of the country the traditional water pumping systems powered by diesel or gasoline engines have been used for longtime, but fuel cost, transportation problem, lack of skilled personnel makes the conventional water pumping system unreliable and expensive for rural communities.

In developing countries like Sudan, generally composed of several villages sparsely located and with different topography, it is very difficult to extend the electric grid to every location where it is required. Also, the lack of safe drinking water is still an issue to be solved in many developing countries, especially in rural areas. The trend of increasing fossil fuel price and its high contribution to environmental problems makes fossil energy sources unpromising. Different researches have been carried out and their results show that, the renewable energy are the best alternative energy sources to replace the fossil energy ^[3].

The Republic of Sudan in Eastern Africa has one of the fastest growing economies in Africa. However, its remotely isolated rural areas pose problems to rural energy management and development because of poor road links with urban centres, and remoteness from the national electrical transmission grid. Development of renewable energy sources, therefore, has a vast potential in Sudan. Solar energy, with excellent sunshine of over 3000 h per year, it is of paramount importance, applications of which are already quite significant and are growing at constant rate.

Most areas in Sudan have climates suitable for solar pumping ^[4].

This technology systems are best suited for transfer operations (to pump water out of bore, for instance, or transfer it from well to storage tank) in which pumps run continuously for most of the day.

Another relatively new technology harnesses solar energy. This technology, referred to as photovoltaic(PV), converts the sun's energy into electricity through electromagnetic means when the PV module is exposed to sunlight. The solar radiation energy is converted into DC power and requires an inverter to convert it into AC power.

This technology has uses similar to electrical wind turbines, and has become the power supply for such applications as operating lighting and refrigerating vaccines in health clinics. PV has also been used to power rural communications. This technology is ideal for water pumping applications because energy storage is not required for night pumping as the energy is stored in the form of water in elevate tank ^[3].

A Solar water pumping system is an easy and affordable solution to solve the water shortage problem in Raul area, especially in villages where the land is plane and then the low head solar pumps are needed for water supply.

The technical potential for renewable energy in Sudan, at both a centralized and a distributed level, is very high. The annual average solar radiation exceeds 2000 kWh/m², which is considered to be among the highest globally. Figure 1 shows the potential for electricity generation from solar PV throughout Sudan as estimated in the World Bank's Solar Atlas ^[5].

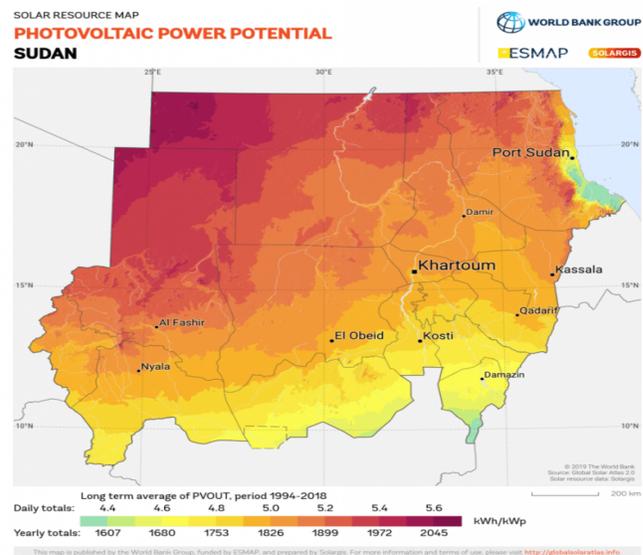


Figure 1: Sudan's technical potential for solar PV technology (image credits: © 2019 The World Bank, Source: Global Solar Atlas 2.0, Solar resource data: Solargis)

2- System Overview

Photovoltaic water pumping system is comprised of various segments. There is a photovoltaic array which changes over solar energy straight forwardly into electricity as DC. The pump will have an electric motor to drive it. The attributes of these segments should be coordinated to get the best performance. The pump motor unit will have its own particular ideal speed and stack contingent upon the sort and size of the pump. Motor can be DC or AC. On the off chance that an AC motor is utilized then an inverter is likewise required. AC motors are all the more broadly accessible. Inverters have gotten to be modest and proficient and solar pumping system use exceptional electronically controlled variable-frequency inverters which will improve coordinating between the panel and the pump. The most effective kind of DC motor is a permanent magnet motor, These are getting to be mainstream in solar pumping system. All present day, commercial PV devices use silicon as the base material, basically as mono crystalline or multi-crystalline cells, however all the more as of late additionally in amorphous structure. Different materials, for example, copper indium diselenide and cadmium telluride are being produced with the point of decreasing expenses and enhancing efficiencies. An array can change from maybe a couple modules with a yield of low or less, to an immeasurable bank of a few kilowatts or even megawatts⁽⁶⁾.

3- Problem statement:

Water is the source of life, and the availability of water has become more crucial than ever before. The demand for water grows along with the world's population. The need for water to irrigate land, which will then produce more food, as well as clean water for drinking purposes, is crucial in coping with the world's population growth. A source of energy to pump water is also a big problem in many remote areas in Sudan. Developing a grid system is often too expensive because rural villages are frequently located too far away from existing grid

lines. Depending on an imported fuel supply is difficult and risky; foreign exchange rates fluctuate and economy of Sudan can then plummet. Even if fuel is available within the country, transporting that fuel to remote, rural villages can be difficult. There are no roads or supporting infrastructure in many remote villages where transportation by animals is still common. Diesel generators, for example, may be impossible to bring to such locations.

The use of renewable energy is attractive for water pumping applications in rural areas in Sudan. Transportation of renewable energy systems such as Solar cells, wind machines and photovoltaic (PV) pumps, is much easier than other types because they can be transported in pieces and reassembled on the site. With the increasing acuity of these problems especially in rural area, solar pumping systems are taking great importance, which will still increase in the next years. The challenges of design are revolving for how to choose specific water flow rate and head.

4- Working:

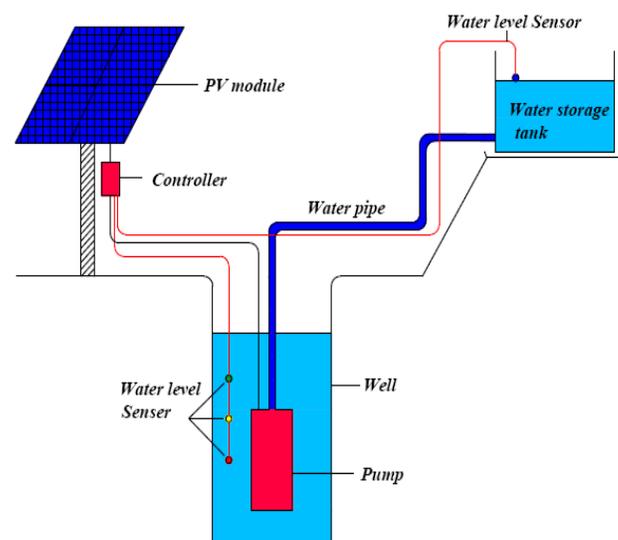


Fig-2: Solar water pumping by using PV system.

The figure shows the simplified diagram of a solar water pumping system. The energy from the sun is converted into the electrical energy in the form of DC voltage which fed to the battery and inverter at sametime Battery store this energy and inverter convert this DC voltage into AC voltage, which is input to the AC pump. Inverter is required between the PV panel and submersible to convert from the direct current generated by the solar panel to the alternate current required by the electric pump motor^[8].

5- System Components:

Solar pumping system is a system of two main components:

- I. Solar panel.
- II. 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 sunshine 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 sunshine is stored in batteries then the batteries will supply the energy to the pump at any time when the water supply is needed^[8].

6- CONCLUSION:

From above discussion it has been cleared that conventional energy sources degraded day by day, so it's mandatory to move to renewable energy

sources like solar, wind, tidal, etc. For that purpose we used solar energy to produce electricity to run submersible pump.

Solar energy is suitable for small-scale water pumping in rural areas where the demand is regular, such as for drinking water, but it may also be used for irrigation. Most areas in Sudan have climates suitable for solar pumping. A review is given of the use of solar energy for water pumping to improve the living conditions of the population in rural areas and to develop techniques for utilization of solar energy in a tropical environment condition.

References:

- 1- Esdras Nshimyumuremyi, "Solar Water Pumping System in Isolated Area to Electricity: The Case of Mibirizi Village (Rwanda),"Scientific Research Publishing Inc., February 2015.
- 2- Shaikh Abdullah Al Mamun Hossain, and Wang Lixue, "Solar Power Pumping in Agriculture: a Review of Recent Research,"AgriculturalResearch and Technology Open Access Journal , Volume 4 Issue 3 - February 2017.
- 3- Misrak Girma , Ababayehu Assefa and Marta Molinas " Feasibility study of a solar photovoltaic water pumping system for rural village " AIMS Environmental Science Volume 2, Issue 3, 697-717. 30 , June 2015.
- 4- Omer, Abdeen Mustafa, "Solar water pumping clean water for Sudan rural areas," Renewable Energy, Elsevier, vol. 24, 2001.
- 5- Dr. Mohamed Alhaj "Status and Potential of Renewable Energy in Sudan" Clean Energy for Africa, Renewablesinafrica.com, January 10, 2020.
- 6- Mr. Bhong Sagar, Mr. Kale Madhav, Mr. Shinde Kishor, Mr. Bobade Rameshwar. "Solar Water Pumping System", International Research Journal of Engineering and Technology (IRJET), ISSN: 2395-0056, Volume: 05 Issue: 02 | Feb-2018.

- 7- Suhagiya Falcon, Dave Siddharth,*
“Development of Solar Powered Water Pumping System ,” *IJIRST –International Journal for Innovative Research in Science & Technology*, Volume 1 , Issue 12 , April 2015.
- 8- Neway Argaw Denver, Colorado,
“Renewable Energy Water Pumping Systems Handbook,” *National Renewable Energy Laboratory, NREL/SR-500-30481*, July 2004.
- 9- Wikipedia.

Author Profile



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received the B.Sc. degree in mechanical engineering from university of Nyala, Nyala, Sudan, in 2013.

In 2015 he joined the University of Nyala, mechanical engineering department, as technical assistance. Currently he is working at African Humanitarian Action organization {INGOs} in Sudan as project engineer. He has authored one academic paper in referred international journal. His research interests in Renewable energy include, photovoltaic (PV) system, Wind energy, Biogas, Water pumping systems.