# Solar Power Reciprocating Water Pumping

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**Abstract—** The soul of India lives in the villages, and the backbone of that soul is the agricultural sector. Improvement in irrigation is necessary to strengthen the economic background in agriculture. In present times, more power is required for people to use new equipment. Solar energy must be used optimally to achieve the expected results that it is environmentally friendly and can be run with less power consumption than central pumps and fuel-based pumps. Its ultimate objective is to lift water from the level of discharge through water resources. Therefore, electric energy is powered by the help of PV panels and batteries charged by the Sun's rays, and electric power is obtained to drive the DC motor, which provides power to the reciprocating pump with mechanical power to the connecting rod. The system consists of a single solar panel, battery, motor, crankshaft, exchange pump, valve, and tank.

**Keywords**— Power consumption, Reciprocating, crankshaft, exchange pump, valve, and tank.

## 1. Introduction

A pump is a device that moves fluids by mechanical action. One sort of pump once common worldwide was a hand-powered water pump, or 'pitcher pump'. It was commonly installed over community water wells in the days before piped water supplies. The pendulum-based hybrid water pump works on the principle of Simple Harmonic Motion. The Simple Harmonic Motion is the motion in which the restoring force is directly proportional to the displacement. When the system is displaced from its equilibrium position, a restoring force that resembles Hooke's law tends to restore the system to equilibrium. In this project, the oscillatory motion of a pendulum is converted into reciprocating motion. The main components of this project are the pendulum, the pump, counterweights, the wiper motor, the battery, & solar panel. At first, an initial oscillatory motion is given to the pendulum. So the pendulum will start oscillating, so in order to keep the pendulum in continuous oscillatory motion, a small amount of swing is required to give the pendulum, during each oscillation. Hence, that swing is given to the pendulum by using a 12V, 3A DC wiper motor. At the same time, counterweights or flywheels are also rotated simultaneously. The counterweights are arranged in such a way that, when one weight comes up at the second will go down. Also, vice versa, so some torque will also be generated by these counterweights. Now, the combined power produced by the pendulum, the electric motor & counterweights is given to the pump through the transmitting mechanism used in the system. It will transmit this combined power to a reciprocating single-acting type water pump. So, by using this power, the pump will pump the water from the desired head &produce a particular discharge. By using this hybrid pendulum-based water pump. We can continuously pump the water up to 3 hours & 30 minutes, because the battery will get discharged at the same time. In order to charge this 12V, 7A battery, on 10W solar panel is used. It can fully charge the battery in four hours.

Usually in rural areas, i.e, mostly in villages, people use the suction plunger pump to pump the water, and it is very difficult to pump the water by using this pump because is lot of muscle energy is required, and also the flow of water is not continuous. Especially in India, there are still many places where electricity and drinking water systems are not as they are in other developed countries. As we all know the India is an agricultural country the economic development of the country also depends on the agricultural sector. For the progress of this field, the supply of proper electricity is needed, but the load shading creates a problem in front of farmers in irrigating their crops.

**2025.** In Haipeng Liu et al. (eds), Proceedings of First International Conference on Engineering and Technology for a Sustainable Future ICETSF-2025, 2025, pp. 1-7.
https://doi.org/10.32622/978-81-931579-1-6-126

## 2. Literature Review

### *2.1 D. Subramanyam and D. R. Srinivasan (2022),*

D. Subramanyam and D. R. Srinivasan (2022) they presented that the use of fossil fuels for industrial and domestic application over the last few centuries has resulted in over explanation of natural resources leading to deforestation and alarming rise in the rate of global warming. This has given impetus to explore alternative sources of energy with prime objective of harnessing the renewable energy resources as these are abundantly available, environment friendly nonpolluting with lowest running and operating costs like solar energy, wind energy, tidal energy is some of the examples. The solar energy is the harnessed b using solar photovoltaic cells and this energy is used to power the water pumping system. As the intensity of solar radiation varies from time to time, month of the season from maximizing the generation of solar power two axis orientation of solar panels is proposed and he generated electricity is stored in a lead acid battery and use of this power from battery source has inherent advantage of constant is in interrupted power supply these by ensuring continuous pumping of water taking place. Multiple sensors shall be used to orient the solar photovoltaic panel to desire direction and appropriate inclination so at ensure maximum power is generated from them, also to prevent over charging of battery and disconnecting the power source to mechanical water pump to ensure the energy stored in battery is maintained at a minimum level. The use of this system has advantage of zero carbon emissions, independent of conventional power source as it can be operated at any location provided sunlight is available and lowest maintenance and operating system.

### *2.2 Mukesh Kumar Yadav, and et al., (2021)*

Mukesh Kumar Yadav, and et al., (2021), they presented the consists of a water pumping system to supply potable water to an orphanage located in the Chuluchosemacommunity of Malawi, Africa. The water will be pumped from a nearby well up to a water tower located in the orphanage center. The pump will be powered by a solar panel that with Mercer's University's Master's Program for Environmental Engineering and Mercer on a Mission. The water pump system will be built on Mercer's campus and will then be sent to the pumping system will be built by materials that are sustainable enough to allow the system to function properly long after the student has installed the system and has left. The intent of this p a student by working with various professors and manufacturers, as well as different contacts from the developing country. The goal of this project is to supply potable water to an orphanage without a Solar Water Pump.

### *2.3 Ashish, Jitesh, and et al., (2020)*

Ashish, Jitesh, and et al., (2020) they presented the people need more power for driving instruments. A solar based reciprocating pump is a pump, running on electricity generated by solar cell, available from collected sunlight as opposed to grid 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 tune of about 225 billion liter/year.

### *2.4 Ibrahim Alkhubaizi, (2017)*

Ibrahim Alkhubaizi, (2017) they presented the solar powered water pumping systems have become the interest of many people in the recent years. Acknowledge-edging that nature has provided a bounty of energy which can be converted into electrical energy has created innovative ways of discovering materials that can be used to make a system that supports turning heat into electricity. In this regard, the paper presented different concepts that relate to how the whole energy creation process is done and discusses useful ways of turning heat into useful energy. Furthermore, the recommendations dictate that while advancements in the technology are given attention, the issue of the investment cost and how it will thrive in the market is still a question. Nevertheless, many developing and developed countries continue to express interest in this area, and most are actively using and exploring how solar power can be used in other ways. Photovoltaic systems which are used to pump water for people, livestock and plants are an important move for technology and use of solar energy. Pumping water system using this PV technology has shown that is simple and that it does not require a lot of maintenance. In this regard, the idea gained the interest of farmers whose main concern is providing sufficient water not only for themselves but also for their plants and crops and livestock. The only major difference to this is that the system relies on solar energy as a power source for the pumps.

*2.5 Sagar Kande, (2015)*

Sagar Kande, (2015), they presented the Today's world there are many areas where drinking water is problem. In most of thecase hand pumps are used at villages and remote places to solve the problem. These are operatedwith hands .It is difficult to operate it for children and women as it consumes human power.Solar power is one of the alternatives but is costly and unaffordable.This research work through innovative ideas have tried to combine human power andsolar pv hybrid system with pendulum mechanism. The mechanism developed helps storependulum kinetic energy in fly wheels and converts oscillatory motion in to smoothreciprocating motion to lift water .A small push required to continue the oscillatory motion isgiven by a motor run on small solar pv panel. The pendulum based water pump can be useful inthe areas where electricity is not available. Especially in India there are still many places whereelectricity and drinking water systems are not as they are in other developed countries. Thispump can solve their problem of drinking water as they can use this mechanism to pump thewater under the earth's surface.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 84WDC volumetric efficiency achieved motor of 35 RPM. The volumetric efficiency achieved is31 to72% and is highest among solar pumps available in market having efficiency of 7 to 10% .

## 3. Objectives

The main objective of this project is to provide an alternative power solution for remote locations such as research areas and small villages.

i. To develop continuous pumping system without use of electricity.
ii. To analyse the system techno economically with solar PV pumping system
iii. To achieve the least cost
iv. To develop mechanism with least friction and wastage of energy

*3.1 ADVANTAGES*

i. It is multipurpose machine
ii. No electric power required.
iii. Easy to operate.
iv. It is pollution free
v. It is profitable.
vi. Unit cost is very cheap one.
vii. Maintenances cost is low.
viii. Easy to assemble.
ix. It is ideal for exercise.

*3.2 DISADVANTAGES*

i. Speed is not constant
ii. More space is required.
iii. Manually operation so it is difficult to run continuously
iv. It is not self-prime.

## 4. Design consideration and Drawing

*4.1 Design consideration*

To develop this system & to investigate performance, modeling and mathematical calculations have to develop. Different models of hybrid system have covered in literature. Following are the components from review of literatures:-

*4.2 Meteorological data*

Meteorological analysis of the location has to be made for optimization process. It is important for total utilization of PV/Water sources. Measuring solar and Water resources data is main input of the system. That all data should be measured hourly, daily and as per weather or climate change.

*4.3 Load Demand*

It is necessary part of system to design & analyze. To find out the exact load demand it is very complicated and difficult to decide. Load variation for different seasons is not predictable, so system have to design for nearer or more than load demand to full fill requirements

*4.4 System Configuration*

By studying all data like solar radiation, wind speed and load demand proper selection of equipment have to be made. But sizing of system will be according to the environmental conditions. Because producing power from solar-wind is depend upon the location which is to be selected.

*4.5 Design Drawing*

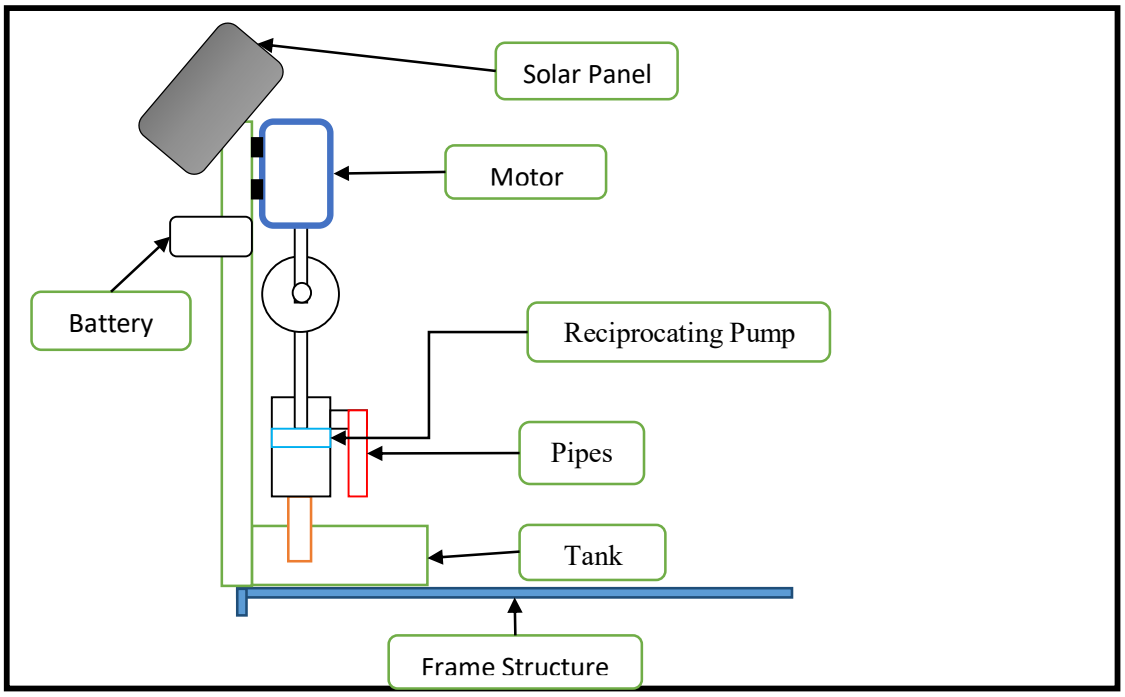


Fig. 1. Proposed design

## 5. Manufacturing Processes

*5.1 Diagram of the project*

Measurement is the foundation of scientific inquiry. In order to test our hypotheses, wemust observe our theoretical concepts at the operational level. In simple words, wemust measure what we have defined. But there are different levels of measurement, which provide differing amounts of information about the theoretical construct. There are also some basicissues about the adequacy of measurement which we must address.

*5.2 Cutting operation as per dimension*

Cutting processes work by causing fracture of the material that is processed. Usually, the portion that is fractured away is in small sized pieces, called chips. Common cutting processes include sawing, shaping (or planning), broaching, drilling, grinding, turning and milling. Although the actual machines, tools and processes for cutting look very different from each other, the basic mechanism for causing the fracture can be understood by just a simple model called for orthogonal cutting.

*5.3 Machining operation on required parts*

Turning is a cutting operation in which the part is rotated as the tool is held against it on a machine called a lathe. The raw stock that is used on a lathe is usually cylindrical, and the parts that are machined on it are rotational parts – mathematically, each surface machined on a lathe is a surface of revolution. Machining is an essential process of finishing by which work pieces are produced to the desired dimensions.

*5.4 Drilling and tapping the material as per dimension*

These four methods all produce holes of different types. Drilling produces round holes of different types; reaming is used to improve the dimensional tolerance on a drilled hole; boring uses a special machine operating like a lathe, to cut high precision holes; and tapping creates screw-threads in drilled holes. Drilling: The geometry

of the common twist drill tool (called drill bit) is complex; it has straight cutting teeth at the bottom – these teeth do most of the metal cutting, and it has curved cutting teeth along its cylindrical surface

*5.5 Welding the material as per dimension*

Welding is a process for joining two similar or dissimilar metals by fusion. It joins different metals/alloys, with or without the application of pressure and with or without the use of filler metal. The fusion of metal takes place by means of heat. The heat may be generated either from combustion of gases, electric arc, electric resistance or by chemical reaction. During some type of welding processes, pressure may also be employed, but this is not an essential requirement for all welding processes. Welding provides a permanent joint but it normally affects the metallurgy of the components. It is therefore usually accompanied by post weld heat treatment for most of the critical components. The welding is widely used as a fabrication and repairing process in industries. Some of the typical applications of welding include the fabrication of ships, pressure vessels, automobile bodies, off-shore platform, bridges, welded pipes, sealing of nuclear fuel and explosives, etc. Most of the metals and alloys can be welded by one type of welding process or the other.

*5.6 Grinding the project welding joints:*

There are several types of grinding machines. The main ones are surface grinders, grinding wheels, cylindrical grinders and center less grinders. The figure below shows examples of a few of these. Surface grinders produce flat surfaces. To improve dimension control on cylindrical parts, center less grinders, which use long cylindrical wheels, are employed. The axis of the regulating wheel and grinding wheel are slightly misaligned, causing the part to travel slowly in the axial direction, and after some time, the part automatically moves beyond the length of the wheel. Controlling the angle of misalignment can control the time that the part is subjected to grinding. If a turned part of complex shape (e.g. stepped shafts) are to be ground, then cylindrical grinding is used, which employs specially made grinding wheels, whose profile fits the profile of the part to be ground

## 6. Experimental Setup


Fig. 2. Experimental Setup


Fig. 3. Experimental Setup

## 7. Future Scope

Solar Power Reciprocating Water Pumping also has some future challenges, which can be listed below:

i. As the system is purely mechanical. Hence, power losses are more. They are in the form of frictional or wear losses
ii. Volumetric efficiency of this pump is less
iii. As battery charging takes place using solar energy. Hence it is less effective during rainy season.
iv. Oscillations of pendulum is needed to maintain.
v. Size of the system is too large.

## 8. Conclusion

The method used here to build solar powered water pumping system is cost effective comparatively to an electrically operated hydraulic pump. Since here non-conventional energy is used to achieve the required head. Discharge obtained from the observations is 2.7liters per minute. The reciprocating pump built by us is built with the help of simple and easily available materials still we have successful to demonstrate the worth of a reciprocating pump. This device serves its purpose to some extent, but with proper course of actions, it can perform still better.

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