JUST AGRICULTURE
multidisciplinary e-Newsletter

Solar Irrigation System

Pravidhi Sharma[1] and Gagan Mehta[2]
[1]Department of Environmental Sciences, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan-H.P
[2]Department of Social Sciences, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan-H.P
Corresponding author: **vidhusharma461@gmail.com**
ARTICLE ID: 050

Introduction

Almost 70% of India's population depends on agriculture directly or indirectly, thereby making it one of the primary source of livelihood in rural areas and one of the major driver's in shaping economy of a country. Also irrigated agriculture is an important factor for local economic development in most developing countries. While about 44% of the 140 million sown hectares area relies on irrigation, the rest depends on the monsoons. But rain-fed agriculture can be a high-risk venture, particularly with changing rainfall patterns and high value crops such as fruits and vegetables. Reliable and affordable access to irrigation water is hence key to food security and poverty reduction. Most water pumps utilised for irrigation purposes worldwide are powered by engines running on fossil fuels (diesel, petrol, gas) or on electricity supplied from the grid (and thus produced by fossil fuel based generators). Fossil energy sources are limited in availability and the emissions from their use have severe impacts on the global climate.

At the same time, electricity supply especially in developing countries tends to be insufficient and unreliable, if not largely absent in rural areas. In the absence of reliable electricity supply due to intermittent service or even a complete lack of grid connection, farmers in developing countries often must rely on fossil fuel driven pumps for water abstraction and conveyance. This technology has low initial investment costs but incurs high operation costs and is prone to outages due to an insufficient fuel supply and frequent maintenance and repair. A reliable and cost-effective supply of irrigation water is therefore a limiting production factor in many rural areas of the developing world. This context presents a significant potential to introduce PV (Photovoltaic) technology in irrigated agriculture to a

JUST AGRICULTURE
multidisciplinary e-Newsletter

much larger extent. Solar energy as we know is one of the most abundant source of energy in the world. We can say that Solar power is not only an answer to today's energy crisis but also an environment friendly form of energy, hence photovoltaic power generation is an efficient approach for using the solar energy. PV-based water abstraction and conveyance has a number of positive ecological effects, notably due to the low carbon footprint of the technology, the avoidance of emissions and the reduction of groundwater contamination risks. With regard to the sustainable utilisation of water resources, PV-based pumping solutions can have a widespread positive effect if planned in a meaningful way. The daily operational window of a solar-powered pump is up to 60 per cent narrower than that of a pump driven by conventional energy sources, which suggests introducing modern, water-saving micro-irrigation approaches to counter this limitation.

Major components of Solar Irrigation System

A. **Photovoltaic Array:** An array of photovoltaic modules connected in series and possibly strings of modules connected in parallel.
B. **Controller:** An electronic device which matches the PV power to the motor and regulates the operating, starting and stopping of the PVP. The controller is mostly installed on the surface although some PVPs have the controller integrated in the submersible motor pump set.
C. **Array Voltage:** Some of the pumping systems have array voltages. This has the advantage that the array may be further from the borehole without significant voltage drop (dependent on cable size and current). Array positioning may be important where there is potential for theft.
D. **DC Motors:** DC motors reach efficiencies of up to 80 per cent and are therefore significantly more efficient than sub-kW three phase motors which have efficiencies in region of 60 per cent to 65 per cent.
E. **Brushless DC Motors:** This combine the high efficiency of DC motors with low maintenance as opposed to brushed DC motors which require regular brush replacement (approximately every one to two years – head and quality dependent).
F. **Three phase permanent magnet motors**: This similarly combines the efficiency of permanent magnet motors with low maintenance.

JUST AGRICULTURE
multidisciplinary e-Newsletter

G. **Surface Centrifugal Pump**: Surface pumps are suitable for areas where the water level is within 7m below ground level. A surface or centrifugal pump is normally placed at ground level. The pump is suitable for pumping from shallow bore wells, open wells, reservoirs, lakes and canals. The solar pump driven by permanent DC motor is connected directly to an array of solar panels. The pumping has total dynamic head (suction plus delivery) of 14m. The maximum suction head is 7m or 22 feet. The pump will not work if the water table is below 7m in depth. It is possible to increase the delivery head if the suction head is less than 7m. This enables one to pump water even from deep wells by installing the pump inside the well called 'cut-down'

H. **Submersible Pump**: A submersible pump is one that is immersed in water. It pumps water by displacement. Submersible pumps are suited both to deep well and to surface water sources. Moat deep wells are submersible pumps. These pumps are costlier but have a longer life and greater reliability than surface pumps.

I. Moisture Sensor Module: A moisture sensor is used to sense the level of moisture content present in the irrigation field. It has a level detection module in which we can set a reference value. This circuit can be used with analog probes that produce a voltage proportional to soil moisture such as VG400 probe shown in Fig. 1. The moisture content of the soil is found by using the soil moisture sensor such as VG400 which produces an equivalent output voltage proportional to the conductivity between the two probes.

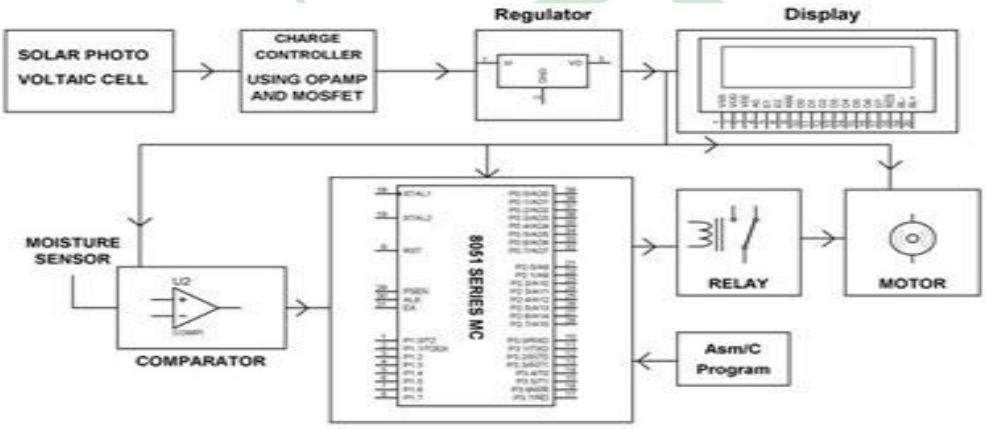

Fig:1 Block Diagram

Advantages

Photovoltaic systems are especially designed to supply water and irrigation in areas where there is no main electricity supply. Their main advantages over hand pumps or internal

JUST AGRICULTURE
multidisciplinary e-Newsletter

combustion engine pumps are their practically zero maintenance, their long useful life, that they do not require fuel, that they do not contaminate, and finally that they are straightforward to install. Another important characteristic is that, as they use the sun as their energy source, the periods of maximum demand for water coincide with the periods of maximum solar radiation. When compared to diesel powered pumping systems, the cost of solar PV water pumping system without any subsidy works out to be 64.2 per cent of the cost of the diesel pump, over a life cycle of ten years. Solar pumps are available to pump from anywhere in the range of up to 200 m head and with outputs of up to 250 m^3 per day. In general photovoltaic pumps are economic compared to diesel pumps up to approximately 3 kWp (Kilowatts peak) for village water supply and to around 1 kWp for irrigation. Solar photovoltaic (SPV) sets represent an environment friendly, low-maintenance and cost effective alternative to irrigation pump sets which run on grid electricity or diesel. It is estimated that India's potential for Solar PV water pumping for irrigation is 9 to 70 million solar PV pump sets, that is, at least 255 billion litres per year of diesel savings.

Limitations

1) **Low yield:** Solar pumping is not suitable where the water requirement is very high as the maximum capacity available with solar pumping is very low. However, the output of the solar DC pump is more than a normal pump.
2) **Variable yield:** The water yield of the solar pump changes according to the sunlight. It is highest around noon and least in the early morning and evening. So it should be operated during noon time.
3) **Theft:** Theft of solar panels can be a problem in some areas which could be avoided by keeping fencing around it. Ideally, the solar system should be insured against theft as well as natural hazards like lightning.

Conclusion

By implementing the proposed system there are various benefits for the government and the farmers. For the government a solution for energy crisis is proposed. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduce the human intervention for farmers. The excess energy produced using solar panels can also be given to the grid with small modifications in the system circuit, which can be a source of the revenue of the farmer, thus encouraging farming in India and same time giving a solution for energy

JUST AGRICULTURE
multidisciplinary e-Newsletter

crisis. Proposed system is easy to implement and environment friendly solution for irrigating fields. The system was found to be successful when implemented for bore holes as they pump over the whole day. Solar pumps also offer clean solutions with no danger of borehole contamination. Even though there is a high capital investment required for this system to be implemented, the overall benefits are high and in long run this system is economical.