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# Photovoltaic Water Pumping System for the Development of Rural Irrigation

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***Abstract-*** *This paper presents design and economic analysis of efficient solar PV water pumping system for irrigation. Photovoltaic water pumping system is a cost-effective application in rural areas. The design of rural photovoltaic water pumping system, this paper suggests that if the use of solar energy in rural areas through photovoltaic systems is a best solution for water pumping systems. The photovoltaic system has many advantages along with a lot of challenges in its operation and maintenance. This paper proposes that if we use this PVWP system it can be helpful to meet the demand water in rural area for irrigation. Also, the life cycle cost (LCC) analysis was conducted to assess the economic viability of the system. The results of the study inspiredthe utilization of the PV systems for water pumping application to irrigate orchards.*

***Keywords:*** *PV pumping irrigation system, Photovoltaic system, Water demand*

## 1. INTRODUCTION

A majority of people near about 87% in worldwide, get safe drinking water, however in many rural areas access of safe drinking water is still a big task. In these regions near about 60% of people only get safe drinking water. Lack of safe drinking water causes many direct health problems; due to the unhealthy water 1.5 million deaths occur each year. In water stressed regions such as rural, finding and transporting safe water is a big task. In these regions, most people live apart from a reliable electric grid on a latest estimate only 12% of rural region gets electricity. Without the possibility for electrical pumping, carry and storage water becomes a manual task that is a big burden to the women and girls. Regions where water level is low the solar radiations are high. Therefore, using solar photovoltaic (PV) power to pump water is quiet easy. In 1985, Kenna and Gillett developed a handbook focused on providing design guidelines for solar PV-based water pumping systems for rural communities. More recent many books have also focused on solar PV systems for water pumping for small scale. In 2012, the US Department of Energy reported that PV module cost has decreased 74% from 1998. The decreasing cost of PV technology is helpful to make this technology more attractive for rural electrification and water projects gives an accessible and brief overview of the different technologies to pump water, including manual power, animal power, wind, solar PV, and
diesel. Proper design of a solar PV pumping system is important to avoid over-sizing or under-sizing the system resulting in either excessive capital costs or in sufficient water supply.

## 2. METHODOLOGY

A simple model is chosen for the MA TLAB modeling and simulation. A simple PV cell is represented by a light dependent current source (lsc) in antiparallel with a diodedriven by current Id and a series resistance in the current path through semiconductor material, the metal grid, contacts and current collecting bus. A simple power calculation is given below for designing a solar DC Pump for a required capacity.
Step 1: Amount of water required per day is 25,000 liters/day.
Step 2: Total Dynamic Head (TDH). It depends on two factors.

- Total Vertical Lift.
- Total frictional losses.

TDH= Vertical lift + Frictional losses.
Vertical lift = Elevation+ standing water level+ Draw down.
Frictional losses = 0.5% of Total vertical lift for the given specifications, Vertical lift= 16 m.
Frictional losses= 16*0.051100= 0.008m
Then TDH=16 m+0.008 m =16.008m.

Step 3: Hydraulic energy required to raise the water level per day is;
= Mass* g*TDH.
= (Density*volume)*g*TDH.
(1 000kg/m3*25m3 /day)*9 .8m/s2* 16.008m.

1089.43 watt-hour/days

Step 4: Solar radiation data 6hours/day. (Peak
= 1000wattim 2).
Step 5: Size and number of solar PV modules required are;
Total wattage of PV panel = Total hydraulic energy/no. of hours.
= 1089.43/6 =18l.57 watt.
System losses = Total PV panel wattage/ (pump efficiency *mismatch factor).
=181.57 watt/ (0.3*0.85) = 712.03
Considering operating factor = Total PV panel wattage after losses/operating factor.
PV panel capacity = 712.03/0.75 =949.38watt.
Number of PV panels required = 949.38/240 □ 4.
1 HP DC motor can be run with a solar capacity of 960Wp with the available 240Wp model solar panel

## 3. SIMULATION OF MODEL

A simple modeling is chosen for MATLAB modeling and simulation. A simple PV cell is represented by a light dependent current source (lsc) in antiparallel with a diode driven by current Id and a series resistance in the current path through semiconductor material, the metal grid, contacts and current collecting bus. The presence of diode determines the output V -I characteristics of solar cell. The parallel resistance associated with a small leakage of current through a resistive path in parallel with an intrinsic device is very large, so its effect is very less and is neglected. The equations which govern the characteristics of solar cell are:Solar cell now is a direct element of simelectronics library part of MATLAB 2012's Simulink environment.
Boost converter is an Electronic DC to Dc converter which allows us to implement the MPPT algorithm by varying the duty cycle of PWM which is given to IGBT, PWM is generated by Microcontroller, through MPPT algorithm implemented in microcontroller.
Dc used in this system is DC series motor which runs on full load PV array through boost converter circuit to extract the maximum power from the source.Several types of motors are currently available in the market, such as AC, DC, permanent magnet, brushed, brushless, synchronous and asynchronous, variable reluctance, and many more. The PV array could be directly connected to the motor, if the application needs a DC motor. There are several types of pumps according to their pumping principle: Centrifugal pumps, where liquid is sucked by the centrifugal force created by the impeller and the casing directs the liquid to the outlet as the impeller rotates. The liquid leaves with a higher velocity and pressure than it had when it entered. Screw pumps, where a screw traps the liquid in the suction side of the pump casing and forces it to the outlet. Piston pumps, where motion of the piston draws water into a chamber using the inlet valve, and expels it to the outlet using the outlet valve.

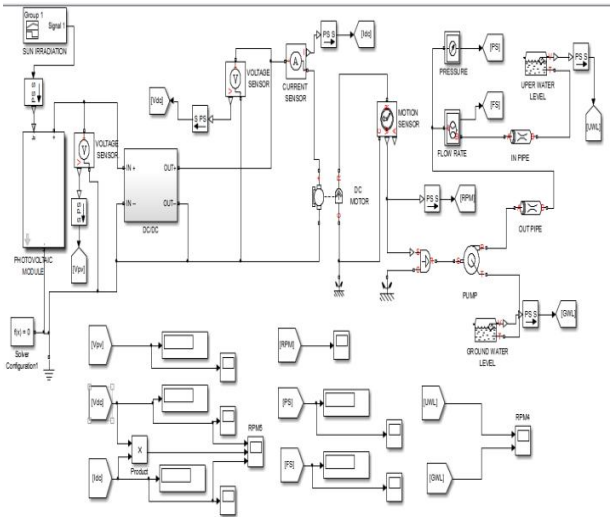


Fig 1. Solar DC Pump model in Simulink

In the simulation model photovoltaic water pumping system 36 solar cell are connected giving rising voltage with respect to the solar radiance change at the day time this solar voltage is given to the DC/DC converter which convert the fluctuating dc into then constant dc is faded to DC motor runs its full load speed

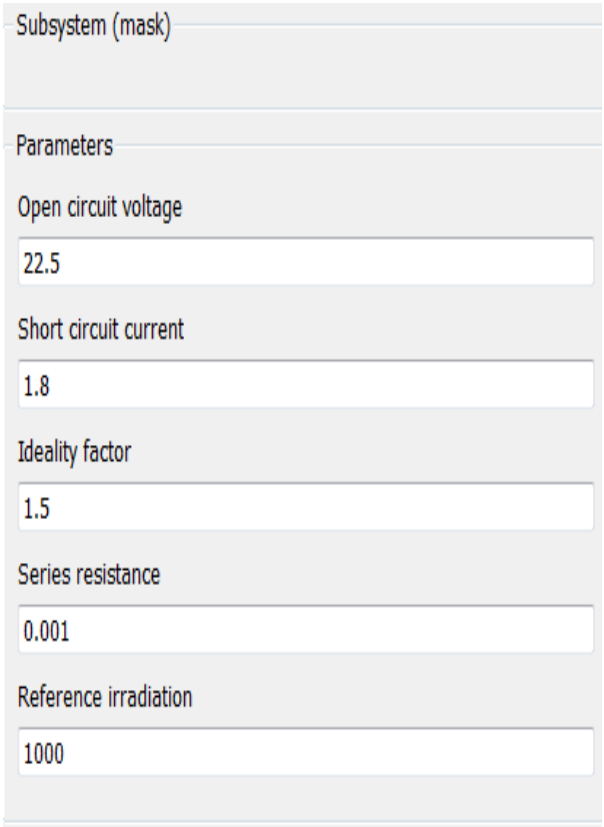


Fig2. Parameters of solar cell

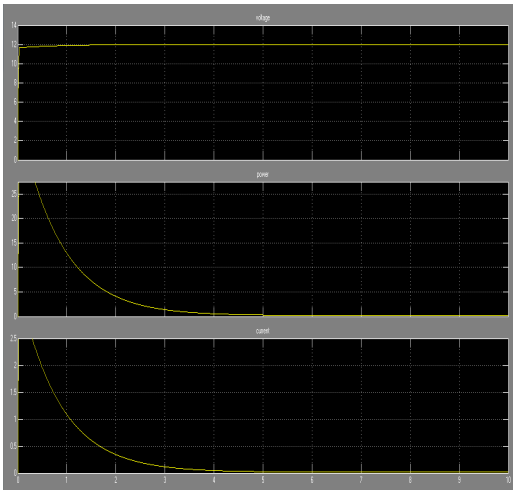

Fig3. Wave form of DC/DC converter

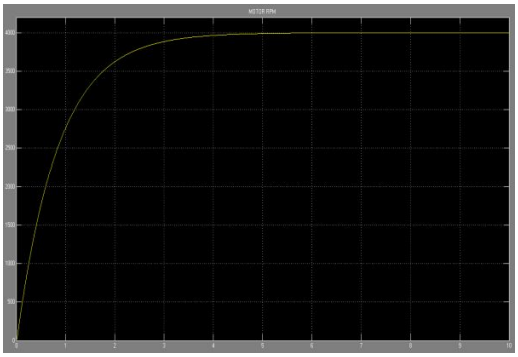

Fig4. Motor RPM

## 4. CONCLUSIONS

Photovoltaic water pumping system gain very popularity because of its ecofriendly nature and can easily installed in the nearby user end. Solar water pumping system installed for the rural agricultural applications. Solar photovoltaic water pumping is installed with solar panel controller and DC submersible motor. The solar PV water pumping system has excellent performance in terms of productivity, reliability, and cost effectiveness. Solar photovoltaic water pumping system improves the water supply to livestock in remote locations. The Successful demonstration of these systems is encouraging other ranchers to try this Relatively new technology as another viable water supply option Photovoltaic water pumping system is a cost effective and environmental friendly way to pump water in unavailability for light or bad lighting system Solar DC pumps are gaining popularity as they are easy to install for rural agricultural applications. Solar DC Pump is an Integral product of Solar PV Panels, Controller and Submersible DC pump.

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