Solar Photovoltaic Water Pumping System

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Abstract- *The objective of this study is to produce a Solar Water Pump which works on the principle of Linear Actuator which consumes less power compared to ordinary solar water pumps.The advantage of the system over the ordinary solar water pumps is that it consumes less power and construction cost also reduces comparatively. Agricultural technology is changing rapidly. Farm machinery, farm building and production facilities are constantly being improved. Agricultural applications suitable for photovoltaic (PV) solutions are numerous. These applications are a mix of individual installations and systems installed by utility companies when they have found that a PV solution is the best solution for remote agricultural need such as water pumping for crops or livestock.*

Keywords- Solar powered water pump, Linear actuator model, Solar Cell .

I. INTRODUCTION

Salt water accounts for 97.5% of all of the Earth's water Of the remaining 2.5% of fresh water, approximately 70% is frozen in the polar ice caps and the other 30% is mostly soil moisture or lies in underground aquifers. In all, less than 1% of the world's fresh water is readily accessible for direct use. While water is readily available in developed countries, in developing countries more than 1.2 billion people do not have access to a safe and adequate water supply. One billion people make a three-hour journey just to collect water and 14,000 people die every day from water related illnesses. As the world's population grows, pressure on the available water supply increases. Groundwater is an important source of water and the dominant source for domestic supply in many areas, especially in dry areas where surface water is scarce and seasonal. Water pumping has a long history and many methods have been developed. These have utilized a variety of power sources, human, animal, wind, hydro and solar power, and fossil fuels.

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II. OBJECTIVES& METHODOLOGY

OBJECTIVES

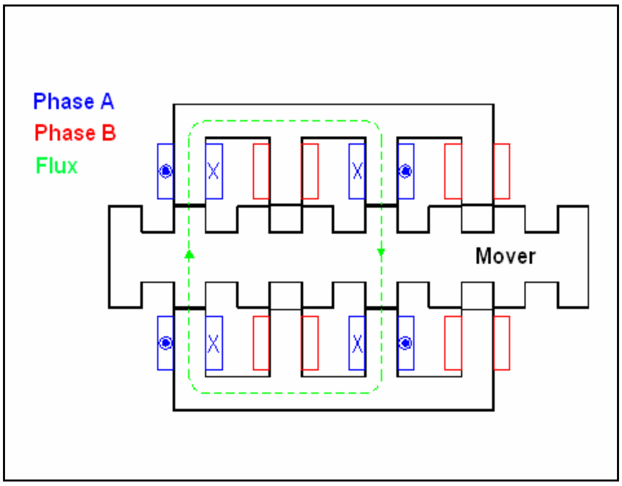
1. To study the uses and economic aspects of solar photovoltaic water pumping system.
2. To reduce maintenance and installation cost of solar photovoltaic water pumping system.
3. To introduce high efficient solar water pumps.
4. To educate farmers about advantages and troubleshooting methods of solar photovoltaic water pumping system.
5. To present the model which reduces the power consumption.

METHODOLOGY

A solar PV water pumping system using a newlinear actuator. A two-phase variable-reluctance linear stepper motor moves a piston-type water pump and is controlled by a simple electronic unit. The proposed system is suitable for rural communities in developing countries, because it is reliable, affordable and easy to use.

The linear actuator is coupled with the pump rod and is linked to a pulley and a counterweight. The counterweight equalizes load requirements during a complete cycle, i.e. the force generated by the linear actuator when it is moving upwards must be almost equal to the force generated when it is moving downwards. The upwards force required for producing suction pull of water from ground is obtained by downward movement of the counterweight.

Finally, adverse weather conditions or faults in the system must be taken into account when the reservoir's water capacity is designed. A reasonable choice would be to consider a capacity of at least five times the daily water flow forecast.

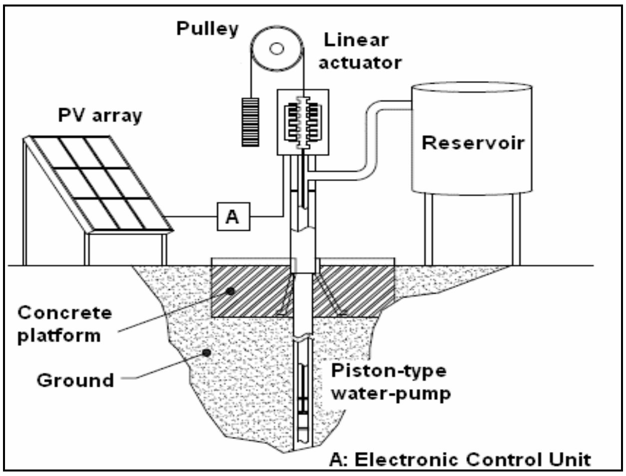


III. LONGITUDINAL CROSS-SECTION OF THE LINEAR ACTUATOR

Because of the salient nature of both the stator and mover poles, the inductance of each phase varies with the mover's position. The operating principle of the linear actuator is based on the minimum reluctance rule. The motor has four air gaps per phase. The stator pole width and the mover pole width are equal and are half the stator slot width.

The displacement of the mover equals the downward and upward strokes of the piston; therefore, a power converter must sequentially energize the phase windings of the motor and reverse the sequence each time the end positions of the mover are reached. Because simplicity was one of our main goals, we chose a unipolar power converter with only one switch per phase and a freewheeling diode

IV. DESIGN AND FABRICATION

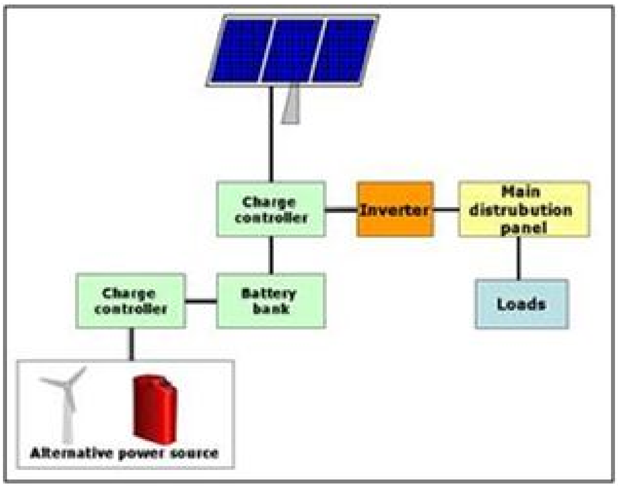


V. PROPOSED SOLAR PV WATER PUMPING SYSTEM

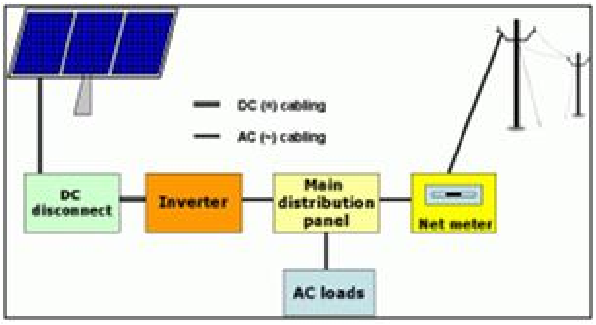
A solar PV water pumping system using a new linear actuator. A two-phase variable-reluctance linear stepper motor moves a piston-type water pump and is controlled by a simple electronic unit

In most cases, the water demand for irrigation is seasonal; however, the PV system generates electricity all year. The solar PV system should be able to supply the electricity required by the irrigation system in order to guarantee a uniform distribution of the volume flow rate of water required by all the crops. An adequate design of a PV system requires accurate data of solar resources. In this paper, the Solar Explorer (Explorador Solar), an online tool developed by the Chile Ministry of Energy [35], was used. The solar PV model available in the Solar Explorer is used in this study. It is based in the model developed by Sandia National Lab and. Also, the solar radiation data used in the solar PV model were obtained for each specific location from the Solar Explorer. The radiation database and its accuracy . Off-Grid PV System The off-grid systems may present some difficulties as they are designed to supply the majority of the electrical power required by the irrigation system. The electrical power peaks during the month with the highest water requirement. Therefore, this situation happens only one month per year. Consequently, this results in the off-grid PV system being oversized for the remainder of the year, and it is often not used at all due to a lack of irrigation. The power of the off-grid PV system (WPV) was sized .The off-grid system was designed to operate between 10:00 a.m. and 03:00 p.m., the period of higher solar radiation. However, as an additional safety factor, the irrigation system was available the remainder of the day if there existed the required solar radiation to drive it. 2.3.2. On-Grid PV System The on-grid PV system was sized so as to supply the required energy on an annual basis, using the electrical grid either as a source to complement the PV system, or as a drain for the excess electrical Energies 2018, 11, 1853 7 of 18 energy generated by the PV system. The main objective was to reduce the annual electricity bill to zero. The power of the on-grid PV system (WPV) was sized according to Equation (11): WPV = 1.2 EA /E1kW,PV ,

where EA is the annual electricity demanded for irrigation, and E1kW,PV was the annual electricity produced by a PV system with a nominal electrical power of 1 kW, evaluated in the selected location. A safety factor of 1.2, oversizing the PV system by 20%, was considered for off-grid and on-grid PV systems. E1kW,PV and W1kW,PV were obtained using information from the Solar Explorer . In addition, the slope of the PV modules was selected as 10◦ subtracted from the actual latitude and facing north. A loss factor of 14% for the PV modules and an inverter efficiency of 90% were also considered.



off grid system



on grid system

VI. CONCLUSIONS AND SCOPE FOR FUTURE

A) CONCLUSIONS

PV generator is the main and costly component of solar water pump therefore its efficiency improvement and cost reduction are important parameters for further promotion of PV pumping technology. Considerable advancements in the material and efficiency improvements of solar cells have taken place during recent years which have been discussed in this section. Solar cells are being used in satellite and space craft applications since 1950s but oil crisis and growth of PV industry in early 1970s resulted in remote area applications for electricity supplies and water pumping also. The mono-crystalline silicon and multi crystalline silicon wafer based solar cells are known as first generation technology. Mono-crystalline solar cells are made of silicon wafers cut from a single cylindrical ingot of silicon. The main advantage of these cells is high module efficiencies. Multi crystalline silicon solar cells are made by casting molten silicon into ingots, which crystallize into a solid block of inter-grown crystals. These cells are less expensive to produce than mono crystalline ones, due to the simpler manufacturing process and lower purity requirements for the starting material but with lower efficiencies than mono-crystalline. The crystalline silicon PV technology is now well established and shares about 90% of the world's PV installations and more than 80% of the world PV industry is based on crystalline silicon wafer based technologies.

B) SCOPE FOR FUTURE

PV water pumping technology, distinct from electrica l and diesel water pumps, is reliable and economically feasible for irrigating plants.

PV water pumping supplies and facilities for urban, r ural and community water is another prospective industry but i s not yet widely used.

Remote, inaccessible, gridfree places need unique att ention as well. These industries are still dependent on standard pumping systems based on electricity or diesel, leading in hig her recurring user expenses.

In perspective of the elevated assembly expenses of s olar water pumps, particularly for big irrigation and water sup ply, there is a need for more incentives from governments to make the technology an appealing alternative to diesel and ele ctric water pumping.

Factors influencing methods for enhancing output an d effectiveness, the use of extremely effective PV modules inc luding bifacial modules and the degradation of PV generators are fields for further studies

REFERENCES

[1] S.S. Chandel , M. Nagaraju Naik and Rahul Chandel-Review *of Solar PV water pumping system technology*-Renewable and sustainable energy reviews 49(2015) 1084-1099.

[2] B.Eker- *Solar powered water pumping systems*-Trakia Journal of Sciences, Vol. 3, No. 7, pp 7-11, 2005.

[3] Robert Foster, b Alma Cota- *Solar water pumping advances and comparitive economics*- Energy Procedia 57 (2014) 1431-1436.

[4] T A Binshad, K Vijayakumar, M Kaleeswari-*PV based water pumping system for agricultural irrigation*- Front. Energy 2016, 10(3): 319-328.

[5] Shaikh Abdullah Al Mamun Hossain, and Wang Lixue-*Solar Power Pumping in Agriculture*: a Review of Recent Research-Volume 4 Issue 3 - February 2017.

[6] Massachusetts Institute of Technology, Cambridge, Massachusetts-*Solar water pumps: Technical, Systems and Business model Approaches to Evaluation*.
[7] Pramod Kumar, S S Das-study the affect of *solar photo voltaic pump for*
[8] *enhancing economic condition of farmers*-Volume- 3, Issue-8, Aug.-2015.