FABRICATION OF SOLAR POWERED WATER PUMP

ABSTRACT:

Scarcity of electricity coupled with the increasing unreliability of monsoon rains and prevalent costly diesel pumping systems pose an economic risk to small and marginal farmers. A complex set of factors including global warming, competitive land use and lack of basic infrastructure is creating new challenges for India's vast agrarian population. The ever increasing mismatch between demand and supply of energy, and electricity in particular, is posing challenges especially to farmers in remote areas. This coupled with the increasing unreliability of monsoon rains is forcing farmers to look at alternate fuels such as diesel for running irrigation pump sets. Currently, India uses 12 million grid based (electric) and 9 million diesel irrigation pump sets (C-STEP 2010). However, the high operational cost of diesel pump sets forces farmers to practice deficit irrigation of crops, considerably reducing their yield and income.

Solar water pumping systems constitute a cost-effective alternative to irrigation pump sets that run on grid electricity or diesel.

The performance of a solar water pumping system is discussed in this paper; the system consists of a photovoltaic (PV) array, a permanent magnet (PM) DC motor and a helical rotor pump. Coupling with solar wind energy is added advantage for electricity generation. Simulation and field test results are presented.

INTRODUCTION

Energy is a key ingredient for the overall development of an economy. India has been endowed with abundant renewable solar energy resource. India is large country and the rate of electrification has not kept pace with the expanding population, urbanization and industrialization and has resulted in the increasing deficit between demand and supply of electricity. This has not only resulted in under electrification but also put heavy pressure on the governments to keep pace with demand for electricity. People not served by the power grid have to rely on fossil fuels like kerosene and diesel for their energy needs and also incur heavy recurring expenditure for the poor people in rural areas. Wherever the rural areas have been brought under power grid the erratic and unreliable power supply has not helped the farmers and the need for an uninterrupted power supply especially during the critical farming period has been has been a major area of concern. India receives a solar energy equivalent of 5,000 trillion kWh/year with a daily average solar energy incidence of 4-7 kWh/m^2. This is considerably more than the total energy consumption of the country. Further, most parts of the country experience 250-300 sunny days in a year, which makes solar energy a viable option in these areas.

Among the solar technologies useful in agriculture are water lifting and pumping with solar photovoltaic systems. Water pumping by solar power is a concept which has won widespread interest since the early seventies. Solar energy can be utilized to operate pumps, utilizing either the thermal or light part of solar radiation. With a solar pump, energy is not available on demand, and the daily variation in solar power generation necessitates the storage of a surplus of water pumped on sunny days for use on cloudy days. In view of the fluctuating water demand of any irrigation scheme, solar energy needs to be reserved in the form of either electricity in batteries or lifted water in a storage tank. The suitability of solar power for lifting water to irrigate plants is undeniable because of the complementarity between solar irradiance and water requirements of crops. The more intensively the sun is shining the higher is the power to supply irrigation water while on the other hand on rainy days irrigation is neither possible nor needed.

Small scale irrigation is one of the most potential applications of solar power. The main advantage is that solar radiation is intense when the need for irrigation is high. Further, solar power is available at the point of use, making the farmer independent of fuel supplies or electrical transmission lines. The solar pumps have the potential to revolutionize small scale irrigation in the developing countries in the near future. The technical feasibility of solar (photo voltaic) pumps have been established.The major limiting factor has been the high cost and the lack of familiarity of the technology which require concerted effort in training of technicians and large scale introduction in a region with adequate technical support. However with the incentives and initiatives undertaken by MNES/State Govt the scheme may be propagated in rural areas for small irrigation system in far flung rural areas where electrification is a costly proposition.

The model scheme is to introduce solar water pumping and support irrigation schemes to provide a sustainable economic activity to farmers in non-electrified or under electrified rural areas .Various agencies and financial institutions are in place to assist in developing credit scheme targeted for non-electrified rural area.

Faster Installation

- Large surface area requires fewer interconnects and structural members
- All module-to-module wiring is built right into the module
- Multi-Contact Plug-n-Play connectors mean source-circuit wiring takes just minutes
- Unique mounting systems available for commercial roofs eliminate need for traditional mounting rails, heavy ballast, and roof penetrations

More Reliability

- Bypass diode protection for every 18 solar cells in series, thus minimizing power loss, and mitigating overheating/safety problems
- Advanced encapsulation system ensures steady long-term module performance by eliminating degradation associated with traditional EVA-encapsulated modules
- Moisture impermeable glass on both sides of the module protects against tears, perforations, fire, electrical conductivity, delamination and moisture
- Patented no-lead, high-reliability soldering system guarantees long life and ensures against environmental harm should the module break or be discarded

Higher Quality

- Each of the module's 216 individual semi-crystalline silicon cells is inspected and power matched to ensure consistent performance between modules
- Every module is tested utilizing a calibrated solar simulator to ensure that the electrical ratings are within the specified tolerance for power, voltage, and current
- Module-to-module wiring loss is factored into the module's labeled electrical ratings by testing through the module's cable/connector assemblies

ADVANTAGES

Cost effective: The life cycle and the cost to ultimate beneficiary make the SPV systems cost effective as compared to conventional systems. IN addition the farmer is saved from the capital investment he has to make for drawing lines from the grid to his field/farms. The govt. may save huge resources which otherwise may be uneconomical to network every agriculture field under the state electricity grid.

Reliable: The SPV is more reliable, consistent and predictable power option as compared to conventional power system in rural areas.

Free fuel: Sunlight, the fuel source of SPV system is a widely available, inexhaustible, and reliable and free energy source. Hence the SPV system has no monthly fuel bills.

Low maintenance: The system operates on little servicing and no refueling, making them popular for remote rural areas, hence the operation and maintenance is very low. The suppliers provide maintenance at a very low annual maintenance contract rates.

Local generation of power: The SPV system make use of local resource-sunlight. This provides greater energy security and control of access to energy.

Easy transportation: As SPV systems are modular in nature they can easily be transported in pieces/components and are easily expandable to enhance the capacity

Energy Conservation: Solar energy is clearly one of the most effective energy conservation programs and provides a means for decentralized PV-generated power in rural areas. Solar pump is energy efficient and a decentralized system avoids any unnecessary expenditure on T & D networks

Water conservation: The SPV sets are highly economical when combined with water conservation techniques such as drip irrigation & night time distribution of (day time pumped & stored) water. The SPV system leads to optimum exploitation of scarce ground water.

Environmental friendly: The use of sunlight as a source of fuel leads to clean, eco-friendly and decentralized generation of energy which saves the fossil fuel, controls deforestation and prevents environmental pollution.

Economic availability

In order to know the economic availability of the compared pumping systems the net present value (NPV) and the internal rate of return (IRR) have been computed. For economic analysis it is assumed that the PV pump is installed at open wells with maximum depths of 7 to 8 meters. The PV pump can irrigate between 1.5 to 2 ha, depending on the cultivated crop and the seasonal conditions. The PV system generates an average incremental income of more than Rs.18, 000/-. According to higher water discharge, Rabi crops can be cultivated on plots varying between 1 to 1.5 ha. Therefore major parts of the annual income originates from irrigated Rabi crops. For the farm model with the photovoltaic system annual cost for maintenance and repairs are expected to be Rs. 1950/- .

- IRR > 22% justifying financial assistance up to Rs. 72,000.
- Benefit cost ratio(BCR) : 1.38
- Loans of Rs.50000/- to Rs.65,000/- at normal rate of interest is viable and could be supported
- Saves more than Rs. 18000/- / year for Diesel
- In rural areas waiting period of 3-5 years for power supply is avoided.
- Saving in operating cost by using SPV pumps.
- Saving on transmission & distribution networks and associated problems.
- Increase in agriculture productivity and the most benefitted are the small/marginal farmers

- **Benefits to Farmers**

Farmer gets a high value, high discharge pumping system for a one time amount that is less than a third of the actual price and may be maintained at nominal cost annually.

- No fuel costs & minimal maintenance costs.
- More economical than diesel pump sets in the long run.
- Where no pumping system exists at present SPV based pumping system,
    - Enables cultivation of an extra crop
    - Helps in providing the critical protective irrigation in water scarce areas.
    - Saves time and labour
    - Improves agriculture productivity
    - Improves general quality of life with higher levels of income
    - Incremental income enables easy repayment loan taken for installing system

Incentives from Central/State Government

The Ministry of non-conventional energy sources and the state govt. agencies provide a variety of incentives. MNES SPV programme provides subsidy on solar water pumping system @ Rs. 135/- per watt, subject to a maximum of Rs. 250000/-.

Maintenance of Spy System

The supplier provides annual maintenance contract to the beneficiary at Rs. 1950/- after initial guarantee period of 1 1/2 years. The solar panel is expected to provide about 20 years of satisfactory service under normal conditions, even though the cell itself may last much longer. The only maintenance requirement is occasional washing of the surface to maintain maximum optical transmission through the glass. The panel has to be protected from breakage by external agencies. Some manufacturers cover the cell/array with

unbreakable glass. The motor and the pump require the usual periodic maintenance like cleaning, lubrication and replacement of worn parts.

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