Solar Pump Technology for Water Management

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Abstract **-** *Solar photovoltaic technology is described with a view to providing power for the management of water. The status of the technology, the futuristic approaches and some case studies are discussed in this article.*

Keywords — *solar, pump, renewable, technology, water, harvesting*

I. INTRODUCTION

In arid region, while water is one of the limiting factors for increasing agricultural production, the non-availability of power supply adds to the problems for using it optimally. The fossil fuel resources are depleting fast and therefore, it is essential to provide an alternative source of power to make best use of scarcely available water. Solar energy is plentiful in this region and can be used to generate electricity right at the place of utility and therefore minimizing the losses as much as possible. It is free, abundant and non-polluting source of energy. Technologically it can be harnessed either in the form of thermal energy by using flat plate collector and concentrators or generating electricity using photovoltaic cells. The latter approach finds more use particularly in places where the possibility of electric grid extending is bleak in near future. In solar insolation the potential use of solar powered pumps for irrigation is obvious. There is tremendous scope of solar pumps for supplying drinking water in remote rural areas. The status of these technologies will be discussed in this article.

II. LITERATURE

Solar Photovoltaic Technology

Photovoltaic cells are devices made of few selected semi-conductors which convert part of solar energy to electricity. These devices have been used for providing power to satellites in space programme since 1950s. In view of the recent interest in utilizing PV cells for terrestrial purposes, reducing their cost has become the primary aim. To achieve this, efforts have been made to improve the efficiency of the devices and to enhance the scale of production. Efficiencies above 23% in case of single crystal silicon solar cells have been achieved and modules of 16% efficiency are commercially available. The total production of solar cells increased from 3 MW in 1980 to 69.4 MW in 1994 which reduced the cost from $30 in 1970s to $4 per WP in 1995. Simultaneously much attention has been given to more promising thin film solar cells which require much less material and energy for fabrication. Solar cells based on amorphous silicon, Cd Te and Copper Indium Di Selenide have potential to reduce the cost to one fifth of the present cost.

Solar Pumps

The application of photovoltaic cells is enormous in operating pump for supply of drinking water and irrigating crops. The shortage of drinking water in remote rural areas in India and other developing countries is well known. A system of solar pump with storage tanks can be installed at such places where the availability of solar radiation is ensured, the population is around 500-1000 and no other source like electricity is available. Generally in solar pump a SPV array is coupled to high efficiency centrifugal pump set. The produced electricity runs electric motor which in turn actuates pump coupled to the motor. Different models are available depending on suction head and water requirement.

For irrigation purposes there is no need of storage tank because the solar radiation availability, pump output and water requirement are inter-related. In India, there are two main season of crops, rabi and kharif. While during kharif season there are over cast conditions, the water requirement is low due to less evapotranspiration. On the other hand during rabi season, there is clear sky conditions and so the pump output matches to the requirements. The potential of solar pump in India has been evaluated with a very simplified model considering and ideal 10% of the system and 10 m head. As the evapotranspiration ratio during rabi season vary from 2 to 3 mm per day in north India compared to 3 to 4 mm per day in South India, it was reduced that the solar pump of 1 m square panel area can irrigate about 1 hectare in northern parts and about 0.6 to 0.7 hectare in southern India. However, during summer season the evapotranspiration rates vary from 6 to 8 mm per day in many part of the country and therefore the pump can provide 0.25 ha cm water and so it can irrigate 0.3 to 0.4 ha only. During kharif season, the pump can supply 0.2 ha cm water and as protective irrigation can cover about 1 ha area. Depending on the system's efficiency, head and

requirements of water, PV panel array and water pump capacity need to be matched accordingly.

Earlier solar pumps based on thermodynamic conversion were used. The efficiency of such pumps have been low and there require maintenance. In eighties the use of photovoltaic pumps increased with the more production of PV panels and their reduction in cost. The main advantages of solar PV pump have been that it is easy to install, it does not require continuous attention for its operation, the requirement of maintenance is less and it has long life. Under UNDP Project GLO/787/004 Sir William Halcrow & Partners in association with intermediate Technology Power Limited assessed the solar pumping technology in developing countries like Bangladesh, Brazil, Egypt, Kenya, Mexico, Pakistan, Sudan and Thailand (UNDP Project, 1983).

Their major findings have been that the system had efficiency range for 3.4% to 3.8% compared to 2.2% of the phase I of the programme. There has been no specific body or institute to look after the solar technology deployment for the solar resource rich countries that lie between Tropic of Cancer and Tropic of Capricorn. Absence of universal energy access and gaps in potential solar energy manufacturing eco-system has proven to be an obstruction in development. Recently, International Solar Alliance has been conceived to provide a dedicated platform for cooperation among solar rich countries. ISA has been conceived as a coalition amongst the solar rich nations which will help them address their specific energy needs and also to provide collaboration in addressing the identified gaps through a common agreed approach.

In India in eighties more than 1000 pumps were distributed by DNES. CEL Sahibabad, BHEL, Tata BP etc have been engaged with the development of solar pump. Typically a pump run by a 360 WP panel can deliver 30,000 to 40,000 litre water against a head of 5 m. The other model of 600 and 900 WP can deliver 50,000 to 80,000 litre of water against a head of 10m. There are mechanical arrangements to tilt the panel once in a month and track the array towards sun three times a day to capture more solar energy. For deep well pumping solar submersible pumps are also available. The system comprises SPV array, submersible motor pump set, inverter and electronic control. Under a special scheme, Ministry of Non-Conventional Energy Sources is providing a subsidy of Rs. 150 WP in these solar pumps. Further a soft loan of Rs. 80,000 can be obtained through IREDA, New Delhi which can be paid back in ten years with an interest rate of 5%. During 1991–2014, around 11,600 pumps were installed and as of current statistics, 1.1 Lacs Pumps have been installed till 2017 under various schemes.

A solar pump has been installed at CAZRI, Jodhpur to carry out simulation studies in order to develop suitable solar drip system for growing orchard along IGNP Canal using limited water. There were problems of high salinity in canal's Phase I due to over use of water. Suitable LPC drippers have been identified for attaching to the system for growing a 5 ha orchard along IGNP canal and has revealed a cost benefit ratio for pomegranate to be 2.07.

Conclusion

Some advanced concepts for increasing the efficiency are being explored (Schroer, 1994). It is expected that with the efficiency 16% of PV panels and with motor and pump efficiency of 0.9 and 0.8, the system's efficiency can approach 10%. In that case solar pump would be very useful. Nations along with technologically advanced Industries have been collaborating in forms of various institutes to tackle the problem of energy deficit. More research towards development of even more efficient and lowering the production costs of solar energy capturing devices will boost in the demand for Solar Pumps and will be an environment friendly source.

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