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Design and economic analysis of a solar PV water pumping system for irrigation of banana

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ABSTRACT : This paper presents design and economic analysis of efficient solar PV water pumping system for irrigation of banana. The system was designed and installed in solar farm of Jain Irrigation System Limited (JISL), at Jalgaon (Maharashtra). The study area falls at 21^0 05' N – latitude, 75^0 40'E–longitude and at an altitude of 209 m above mean sea level. The PV system sizing was made in such a way that it was capable of irrigating 0.41 acre of banana plot with a daily water requirement of 9.72m^3/day and total head of 26m. Also, the life cycle cost (LCC) analysis was conducted to assess the economic viability of the system. The results of the study encouraged the use of the PV systems for water pumping application to irrigate orchards.

KEY WORDS : Latitude, Life cycle cost, PV, Water pumping

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Recently the water demand has been increased due to the increase in the population and the availability of water has become more crucial than ever before. A source of energy to pump water is also a big problem in developing countries like India. Developing a grid system is often too expensive because rural villages are frequently located too far away from existing grid lines. Even if fuel is available within the country, transporting that fuel to remote, rural villages can be difficult. There are no roads or supporting infrastructure in many remote villages. The use of renewable energy is attractive for water pumping applications in remote areas of many developing countries. Transportation of renewable energy systems, such as photovoltaic (PV) pumps, is much easier than the other types because they can be transported in pieces and reassembled on site (Khatib, 2010). Photovoltaic (PV) energy production is recognized as an important part of the future energy generation. Because it is non-polluting, free in its availability, and is of high reliability. Therefore, these facts make the PV energy resource attractive for many applications, especially in rural and remote areas of most of the developing countries like India. Solar photovoltaic (PV) water pumping has been recognized as suitable for grid-isolated rural locations in poor countries where there are high levels of solar radiation. Solar photovoltaic water pumping systems can provide water for irrigation without the need for any kind of fuel or the extensive maintenance required by diesel pumps. They are easy to install and operate, highly reliable, durable and modular, which enables future expansion. They can be installed at the site of use, rendering long pipelines unnecessary (Andrada and Castro, 2008). Therefore, an attempt has been made to design and develop efficient solar water pumping system for irrigating banana at Jain irrigation system limited (JISL), Jalgaon (Maharashtra).

METHODOLOGY

Design of solar PV system for water pumping (Fig. A-C) :

Water requirement of the plant :

The water requirement of plants varies with time and depends on the season and growth of plants. It is essential to irrigate optimally during the stage of flowering to fruit maturity. The type of soil and the climatic parameters are other factors that need to be considered. However, in the present study the peak water requirement of the plant was evaluated to design the system and for that the following equation was used :

$$W_r = \frac{\text{Crop area} \times PE \times P_c \times K_c \times W_a}{E_u} \qquad \text{...... (1)}$$

where,

W_r = peak water requirement, (lit /day/plant)

Crop area= row to row spacing (m) × plant to plant spacing