Research Paper Engineering

Management of Crop Quality & Productivity Using Solar Power Irrigation System

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ABSTRACT

Energy is a key resource for the overall development of an economy. India receives 5000 Trillion kWh/year amount of solar energy 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. The demand for electrical energy is far outstripping supply, especially in the agricultural sector. It is also becoming increasingly difficult to meet the exponential growth in demand of Agricultural productivity which is closely associated to direct and indirect energy inputs. Necessary policies are required to consolidate this relationship for the benefit of farmers. 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.

KEYWORDS | Solar energy, Irrigation, Automation system.

I. Introduction

Agriculture & irrigation is hampered by erratic electric supply in rural India. Farmers get 7-8 hours supply a day. They had to pump only when supply is available rather than crop need. This leads to water wastage and have adverse impact on crops. Also irregular monsoon creates problem for farmers. Diesel pumps have high operating cost due to increasing oil prices. So, Solar Pumps are best proposed solution for the present energy crisis for the Indian farmers. India has huge potential of Solar as its location is around tropic of cancer & equator regions. This is a green way for energy production which provides free energy once an initial investment is made. Also operating cost of solar powered pumps is free. Solar pumps are useful even where grid electricity is unavailable. Solar pumps system conserves electricity by reducing the usage of grid power and conserves water by reducing water losses. According to a survey conducted by the Bureau of Energy Efficiency (BEE) in India in 2011,there are around 18 million agricultural pump sets and around 0.5 million new connections per year is installed with average capacity 5 HP. Total annual consumption in agriculture sector is 131.96 billion KWh 19% total electricity consumption. We can clearly save this amount of electricity by shifting our present irrigation pumps to solar pumps. The solar panels make up most (up to 80%) of the solar pump set systems cost. The cost of solar panels is constantly decreasing which encourages its usage in various sectors. The size of the PV-system is directly dependent on the size of the pump. A battery may be connected in order to operate the pump during night & no sun condition. The MNRE under JNNSM programme provides subsidy for off grid solar water pumping at the rate 30% of capital cost. Additional could be provided by State Govt. Bank may provide finance taking a margin of 10% on the cost to be paid by beneficiary. Among solar technologies useful in irrigation sector are pumping and water lifting. 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. The daily variation in solar power generation necessitates the surplus of water pumped on sunny days and shortage 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 complementarities 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.

II. Literature Survey and Background Study

According to the survey conducted by the Bureau of Electrical Energy in India in 2011 there are around 18 million agricultural pump sets and around 0.5 million new connections per year is installed with average capacity 5HP. Total annual consumption in agriculture sector is 131.96 billion KWh (19% of total electricity consumption). B.Ramesh, A.Ramesh has discussed in their paper about Autonomous Solar Powered Irrigation System which is automated off grid solar application in irrigation by optimizing the power usage through better water resource management.

S. Harishankar, R. Sathish Kumarhas discussed in their paper about Solar Powered Smart Irrigation System which is solar water pump along with an automatic water flow control using a moisture sensor. This system conserves electricity by reducing the usage of grid power and conserves water by reducing water losses.

Swami Prakash Srivastava, Surat Prakash Srivastava has discussed in their paper about solar energy and its future role in Indian economy. Solar energy could be made financially viable with government tax incentives and rebates. The National Solar Mission is a major initiative of the Government of India and State Governments to promote ecologically sustainable growth while addressing India's energy security.

Binoy Seal, Omkar Shirke, Siddhesh Shewale, Abhilash Sirsikar, Prof.Priya Hankarehas discussed in their paper about Solar based automatic irrigation System which deals with design of solar tracking system to harness maximum solar energy that is converted into electrical energy which in turn is used to power the irrigation system. The irrigation pump can be controlled automatically in which the water pump is switched on and off automatically based on moisture sensor value.

III. Solar Energy Condition of Different States

Maharashtra- The Shri Sai Baba Sansthan Trust has the world's largest solar steam system. It was constructed at the Shirdi shrine at an estimated cost of Rs.1.33 crore, Rs.58.4 lakh of which was paid as a subsidy by the renewable energy ministry. The system is used to cook 50,000 meals per day for pilgrims visiting the shrine, resulting in annual savings of 100,000 kg of cooking gas and has been designed to generate steam for cooking even in the absence of electricity to run the feed

water pump for circulating water in the system. The project to install and commission the system was completed in seven months and the system has a design life of 25 years. Osmanabad region in Maharashtra has been blessed with abundance of sunlight and is ranked the third best region in India in terms of solar insolation. A 10 MW solar power plant in Osmanabad, Maharashtra by relay on solar, generates approximately 18 Lac units per MW which is the highest generation in Maharashtra by any other solar power plant. The Maharashtra State Power Generation Company (Mahagenco) has made plans for setting up more power plants in the state to take up total generation up to 200 MW.

Punjab: - The northern state of Punjab, currently ruled by a party that is also an ally to the central government, has announced plans to set up 2,000 MW of solar power capacity, and asked the central government to help it achieve the target. The need to add 2,000 MW capacity stems from the fact that the state has power demand of 8,600 MW, and has an installed capacity of 2,600 MW. The state utility faced severe power shortage during the summers due to high temperatures and low rainfall.

Table1. Comparisons b/w different States

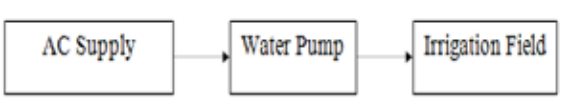
State	Total MNRE project MW	States policy MW	REC Scheme MW	Total Commissioned Capacity MW
U.P.	12	59.26	0	71.26
Punjab	10.5	177.25	7.52	195.27
Maharashtra	57	185.38	121.32	363.7
Rajasthan	789.1	65	193	1047.1

Table2. Comparisons b/w different States

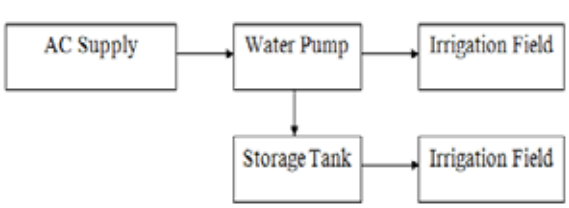
State	Avg. Rainfall	Irrigated area	Agri. Land	Total Land
Punjab	658.6 mm	4.019 million hectare	4.20 million hectare	5.036 million hectare
U.P.	990 mm	12814 million hectare	17612 million hectare	24.3286 million hectare
Maharashtra	1005.7 mm	3 2.60 lakh hectare	225.56 lakh hectare	307.58 lakh hectare

IV. Solar based Irrigation System

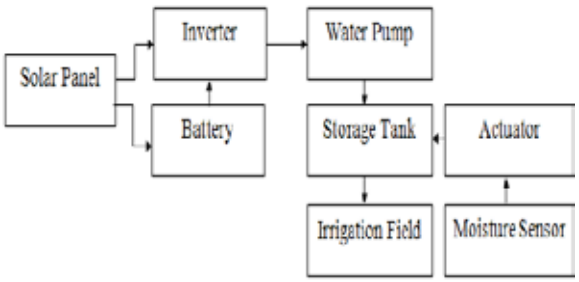
In past few decades irrigation is revolutionized by introduction of an Electric Pumps.



This pump uses AC supply from distribution feeder to pump out water for irrigation. As shown in block diagram the existing system can be arranged in such a way to save electricity and improve irrigation technique.



In this type of arrangement a storage tank is added to irrigation system. Another way of ac supply is firstly we install solar panel and store energy in batteries. As we know solar Photovoltaic provides DC output, to convert this DC into AC we use inverter.



We can use inverter output to run the water pump. Due to pumping storage tank is filled with water. A moisture sensor and actuator is also added to storage tank. This will increase our agricultural output and also it prevent from wastage of water.

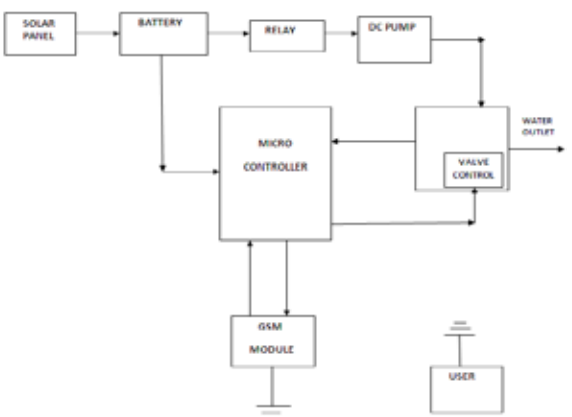


Figure 1:- Architecture of Solar power Irrigation System

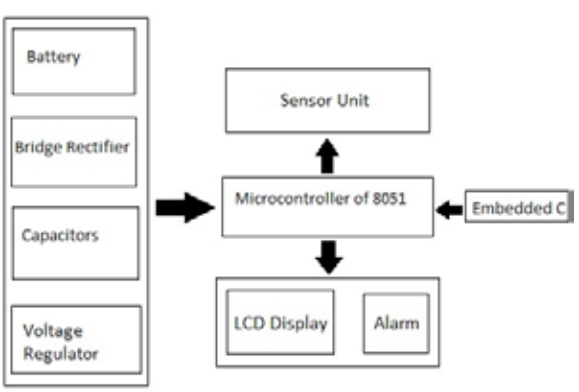


Figure 2:- Block Diagram of Automatic Solar irrigation System

Working: - On the input side there are three sensors as shown the architecture. Soil moisture sensor will check the moisture of the soil as per the crop which is to be cultivated. When the moisture level of the soil goes above or below the set value, it will direct the microcontroller whether it should pump the water or not. Humidity sensor will check the temperature of the surrounding. If the temperature goes above or below the set value which is needed for a crop to grow, the microcontroller will direct the shedding to shed the entire field thereby maintaining the temperature needed by the crop for its healthy growth. The water level sensor will check whether the water in the reservoir or tank is empty or not. Alarms/buzzers are connected at the output side to get rid of birds, animals, and mosquitoes. LCD display is used to notify what actions is

been taken by the microcontroller. If we add GSM module to the system, entire system can be monitored, it will be just like a close loop system, which will help in providing feedback to the farmer on what actions is been taken by the microcontroller.

V. Role of ISRO in Irrigation

Availability of adequate and timely irrigation is a crucial factor of agricultural productivity. Over the past 50 years around Rs.42,500 crores have been invested by the government in various works- about Rs. 28,000 crores of it in major and medium irrigation works (including Command Area Development); Rs. 14,500 crores in minor irrigation.

Towards Ensuring Water Security- Water is a crucial input required to enhance agricultural production, as most of the small farmers living in arid and semi arid regions are deprived of irrigation facilities. With the increasing concern of global warming and climate change, rainfall is expected to be erratic and the water requirement for crops is likely to increase due to a significant increase in evaporation and transpiration losses. Therefore, concrete efforts are necessary towards - sustainable use of all the available water sources, efficient harvesting and storage of rain water, improving the irrigation use efficiency, restoration of reservoir storage capacity etc.

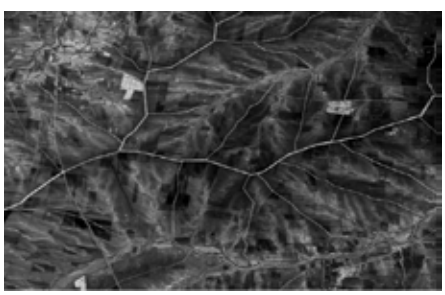


Figure 3:- Monitoring Irrigation Infrastructure

Command Area Development- In India, 60% of total food grain production comes from the irrigated area, which is about 40% of net sown area. Management of water supplies for irrigation in command areas requires information on total demand and its distribution. In India, there is a gap of 9 million hectares between the irrigation potential created and its utilization at the ground level. In this regard, high-resolution satellite data has been utilized to map the irrigation infrastructure in the command area and monitor its progress under the "Accelerated Irrigation Benefit Programme (AIBP)", at the behest of Central Water Commission.

Figure 4:- *Satellite derived Canal Network* **(Part of Malaprabha, Karnataka)**

Ground Water Information:- In the last two decades, significant changes have taken place in India in the use of groundwater for irrigation, and currently about 60% of irrigated agriculture depends on groundwater source. Depletion of water tables, contamination (by fluoride and nitrates) and over-extraction of groundwater have become critical issues in several regions of India. In addition, close to 90% of rural domestic water supply is from groundwater and due to rapid development and increase in population the demand on groundwater for water supply has grown considerably during the last decade.

Conclusion

The history of agriculture dates back thousands of years, and the development has been driven and defined by greatly different climates, cultures and technologies. The main contribution of this paper is to give a overview of project model which will greatly develop the irrigation system in India. The solar power irrigation system will help to reduce the gap between required and consumed energy and further conserves the resources thereby reducing the wastage of resource. .This system can be improved by adding temperature sensors and dissolved solid sensors. By implementing the proposed system there are various benefits for the government and the farmers. For the government a solution for energy crisis is proposed. By using the automatic irrigation system it optimizes the usage of water by reducing wastage and reduces the human intervention for farmers. The excess energy produced using solar panels can also be given to the grid with small modifications in the system circuit, which can be a source of the revenue of the farmer, thus encouraging farming in India and same time giving a solution for energy crisis. Proposed system is easy to implement and environment friendly solution for irrigating fields.

References

1. SatyaPrasanthYalla, B.Ramesh, A.Ramesh, "Autonomous Solar Powered Irrigation System", International Journal of Engineering Research and Applications (IJERA) ISSN: 2248-9622
2. Mahir DURSUN and Semih OZDEN, "Application of Solar Powered Automatic Water Pumping in Turkey", International Journal of Computer and Electrical Engineering, Vol.4, No.2, April 2012
3. Material availavle on website www.isro.gov.org
4. Binoy Seal, Omkar Shirke, Siddhesh Shewale, Abhilash Sirsikar,Prof.Priya Hankare, "Solar Based Automatic Irrigation System", International Journal of Research in Advent Technology, Vol.2, No.4, April 2014 E-ISSN: 2321-9637
5. Swami Prakash Srivastava, Surat Prakash Srivastava, "Solar energy and its future role in Indian economy", International Journal of Environmental Science: Development and Monitoring, ISSN No. 2231-1289, Volume 4 No. 3 (2013)
6. Basava Sidramappa Dhanne, Sachin Kedare, Shiva Sidramapp Dhanne, " Modern solar powered irrigation system by using ARM", International Journal of Research in Engineering and Technology.
7. M. Dursun, "Education purpose switched reluctance motor driver for photovoltaic array irrigation system", in *Proc. I. International* Vocational *and Technologies Congress*, İstanbul, pp.595-601. 2005.
8. M. Dursun and A. Saygin, "System Analysis of switched reluctance motor driver with boost converter for a photovoltaic array irrigation system", in *3rd Renewable Energy Sources Symposium*, Mersin, pp. 57–62. 2005.
9. M. Kolhe, J. C. Joshi, and D. P. Kothari, "Performance analysis of a directly coupled photovoltaic water-pumping system", *IEEE Trans. On Energy Conv.*, vol. 19, pp. 613-618, 2004.
10. S. Singer and J. Appelbaum, "Starting characteristics of direct current motors powered by solar cells", *IEEE Trans. Energy Conversion*, vol. 8, pp. 47–53, 1993.
11. M. Kolhe, S. Kolhe, and J. C. Joshi, "Determination of magnetic field constant of DC permanent magnet motor powered by photovoltaic for maximum mechanical energy output", *Renewable Energy*, vol. 21, pp. 563–571, 2000.