SOLAR WATER PUMP: ENERGY SOLUTION FOR FARM IRRIGATION

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Abstract

The scarcity of non-renewable energy sources and the environmental problems they cause have emphasized the need for new renewable energy supply alternatives. Clean energy sources are those that use renewable technologies. Based on present and projected economic and societal needs, their ideal use has the least negative effects on the environment, produces the fewest secondary wastes, and is sustainable. Among all available renewable energy sources, solar energy is the least pollutive to the environment, cost-effective, and reproducible at the house level. It makes solar energy most attractive to the general masses and for production. As the world moves towards environmental protection, it would appear to be the ideal time to adopt green-friendly solar energy alternatives. It will not only prevent the depletion of energy sources but also make the world green and clean. The solar energy market in India is expanding rapidly. As on 31 January 2023, the country's solar installed capacity was 63.89 GW, whereas the total electricity produced is 411.64 GW which reflects a smaller and improvable proportion.

Pumping water is regarded as a common necessity throughout the world. Irrigation is a well-established method on many farms and is cultivated globally at various levels. It permits crop diversification while increasing crop yields. In India, for farm irrigation, conventional energy sources are being used, which include mainly electric motors and generators that run on fuel or power supply from electrical grids. Such dependency is a major hindrance to the growth of the agriculture industry; thus, the paper explores the suitability of Solar Photovoltaic (SPV) powered options to pump water for farming purposes. Recent advances in solar photovoltaic technology are paving the way for such alternate solutions. The exploratory analysis of literature has indicated that SPV pumps are also the best way to get water to remote areas that aren't connected to the power grid. This kind of energy also eliminates the irregular supply problems too. Such a solar-powered automated irrigation system offers an environmentally friendly method of increasing the effectiveness of water use in agricultural fields by using a system of renewable energy that does not require canal irrigation. This is the proposed answer to the energy problems faced by Indian farmers. This kind of field irrigation is simple to set up and gentle on the environment, that conserves energy by decreasing grid power consumption.

Keywords: *Energy, Renewable, Solar, Farm irrigation, SPVWPS*

INTRODUCTION

The Indian economy is one of the largest in the world, which is a well-known fact. The agriculture sector makes the most contribution to the development of the country out of all the other economic sectors in India. Both industrialised and developing nations are seeing an increase in energy-land integration. Demands for food, water, and energy have increased as a result of societal challenges like the effects of climate change, the need to expand clean energy production and reduce emissions, as well as fast population growth and economic expansion. These issues are being addressed by the general increase in renewable energy sources (wind, sun, geothermal, biomass, and hydropower), as well as their developing potential for application in agriculture (Al-

Saidi & Lahham, 2019; Chel & Kaushik, 2011; Xue, 2017). At the same time, the competitive advantages of renewables in agriculture and state efforts to improve water, energy, or food security make it easier to combine energy use and land use (Al-Saidi & Lahham, 2019; Renewable Energy Agency, 2015). Renewable energy development has been stimulated by international agreements such as the Paris Agreement of 2015, as well as by the need to decarbonize economies and reduce global CO2 emissions. These sources are replacing existing energy sources and supplying power to vital economic sectors in developing nations. For example, the renewable electricity capacity in India will treble between 2016 and 2022 (Kanna et al., 2020b; IEA, 2017).

There are many different types of energy in the universe, but solar energy is one of the most abundant. Solar power not only helps with our current energy crisis but also helps reduce pollution. One efficient use of solar energy is in photovoltaic generation (Kanna et al., 2020b; Raja Singh et al., 2020). Farmers in India have the option of employing solar-powered irrigation systems to handle their agricultural activities in order to address the country's present energy crisis. After making an initial investment, it is the best method to create energy in an environmentally responsible way (Keerthi Vardhan et al., n.d.)The use of solar energy for irrigation is a potential alternative to conventional water pumping systems reliant on grid power and diesel because the pumping requirements of urban water supply and agriculture are influenced by electricity shortages and high diesel costs. The vast majority of nations' goals in the environmental and economic sectors have recently focused on clean and renewable energies. The agricultural industry is the foundation of the Indian economy, and as the population grows, so does the demand for water. Water extraction and transportation for drinking and agriculture result in substantial energy consumption. Utilizing solar energy, which is abundant and virtually free, to give electricity to all sectors, particularly the irrigation industry, is one of the finest choices. There is a considerable amount of solar radiation from the sun during the growing season of crops, when water pumping is frequently necessary (Kanna et al., 2020a).

SCOPE OF RENEWABLE ENERGY IN FARMING SECTOR

According to estimations, India has a potential for 900 GW of economically viable renewable energy. There is about 800 MW of solar power potential, 104 GW of wind power potential at 80-meter tower height, 25 GW of biofuel potential, and the rest of the potential is for other renewable energies (Mamta Shukla et al., 2022a). Solar energy has the potential to be a game changer for the farming sector, adding value in a variety of ways, including conserving valuable water supply, minimizing grid dependence and electricity expenses over time, and perhaps even generating some supplementary revenue. Despite the fact that solar energy has been used in the farming sector since the dawn of civilization, there is an increase in demand for its use in broader applications across several sectors.

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State-wise installed capacity of Renewable Power as on 31.12.2022.														
S. No.	STATES / Uts	Small Hydro Power	Wind Power	Bio-Power										Total Capacity
				BM Power/Bagasse Cogen.	BM Cogen. (Non-Bagasse)	Waste to Energy	Waste to Energy (Off-grid)	Bio Power Total	Ground Mounted Solar	Rooftop Solar	Hybrid Solar Comp.	Off-grid Solar	Solar Power Total	
		(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)	(MW)
1	Andhra Pradesh	162.11	4096.65	378.10	105.57	53.16	29.21	566.04	4271.59	164.79	0.00	88.34	4524.72	9349.52
2	Arunachal Pradesh	133.11						0.00	1.27	4.34	0.00	5.91	11.52	144.63
3	Assam	34.11			2.00			2.00	105.00	33.48	0.00	9.44	147.92	184.03
4	Bihar	70.70		112.50	12.20		1.32	126.02	141.06	30.55	0.00	21.28	192.89	389.61
5	Chhatisgarh	76.00		272.09	2.50		0.41	275.00	506.51	50.98	0.00	386.73	944.22	1295.22
6	Goa	0.05				0.34		0.34	0.95	25.33	0.00	0.12	26.40	26.79
7	Gujarat	89.39	9860.62	65.30	12.00	7.50	25.93	110.73	6248.27	2206.27	0.00	46.20	8500.74	18561.48
8	Haryana	73.50		151.40	89.26	11.20	7.02	258.88	265.80	418.16	0.00	306.71	990.67	1323.05
9	Himachal Pradesh	960.71			9.20		1.00	10.20	38.10	19.31	0.00	29.98	87.39	1058.30
10	Jammu & Kashmir	144.68						0.00	2.49	22.30	0.00	24.11	48.90	193.58
11	Jharkhand	4.05			4.30			4.30	19.05	35.29	0.00	40.57	94.91	103.26
12	Karnataka	1280.73	5268.15	1867.10	20.20	1.00	13.85	1902.15	7454.96	400.30	0.00	30.31	7885.57	16336.60
13	Kerala	266.52	62.50		2.27		0.23	2.50	286.48	381.11	0.00	20.76	688.35	1019.87
14	Ladakh	40.79						0.00	6.00	1.80	0.00	0.00	7.80	48.59
15	Madhya Pradesh	123.71	2844.29	92.50	14.85	15.40	9.00	131.75	2459.02	229.86	0.00	85.90	2774.78	5874.53
16	Maharashtra	381.08	5012.83	2568.00	16.40	12.59	39.43	2636.42	2091.10	1385.16	0.00	169.87	3646.13	11676.46
17	Manipur	5.45						0.00	0.00	6.36	0.00	5.92	12.28	17.73
18	Meghalaya	32.53			13.80			13.80	0.00	0.21	0.00	3.94	4.15	50.48
19	Mizoram	41.47						0.00	0.10	1.56	0.00	6.35	8.01	49.48
20	Nagaland	31.67						0.00	0.00	1.00	0.00	2.04	3.04	34.71
21	Odisha	115.63		50.40	8.82			59.22	403.56	21.66	0.00	27.50	452.72	627.57
22	Punjab	176.10		299.50	173.95	10.75	14.74	498.94	831.75	244.41	0.00	77.05	1153.21	1828.25
23	Rajasthan	23.85	4681.82	119.25	2.00		3.83	125.08	13403.27	835.00	1579.00	523.48	16340.75	21171.50
24	Sikkim	55.11						0.00	0.00	2.76	0.00	1.92	4.68	59.79
25	Tamil Nadu	123.05	9936.02	969.10	43.55	6.40	23.65	1042.70	5982.31	368.50	0.00	61.55	6412.36	17514.13
26	Telangana	90.87	128.10	158.10	2.00	45.80	13.84	219.74	4360.49	281.73	0.00	8.71	4650.93	5089.64
27	Tripura	16.01						0.00	5.00	4.78	0.00	6.89	16.67	32.68
28	Uttar Pradesh	49.10		1957.50	159.76		75.63	2192.89	2074.50	258.78	0.00	151.88	2485.16	4727.15
29	Uttarakhand	218.82		72.72	57.50		9.22	139.44	298.40	262.71	0.00	14.35	575.46	933.72
30	West Bengal	98.50		300.00	19.92		3.78	323.70	113.80	53.04	0.00	12.99	179.83	602.03
31	Andaman & Nicobar	5.25						0.00	25.05	4.59	0.00	0.27	29.91	35.16
32	Chandigarh							0.00	6.34	51.54	0.00	0.81	58.69	58.69
33	Dadar & Nagar Haveli							0.00	2.49	2.97	0.00	0.00	5.46	5.46
34	Daman & Diu							0.00	10.15	30.86	0.00	0.00	41.01	41.01
35	Delhi					84.00		84.00	8.96	201.06	0.00	1.46	211.48	295.48
36	Lakshwadeep							0.00	0.75	0.00	0.00	2.52	3.27	3.27
37	Pondicherry							0.00	0.80	34.55	0.00	0.18	35.53	35.53
38	Others		4.30					0.00	0.00	0.00	0.00	45.01	45.01	49.31
	Total (MW)	**4924.65**	**41895.28**	**9433.56**	**772.05**	**248.14**	**272.09**	**10725.84**	**51425.37**	**8077.10**	**1579.00**	**2221.05**	**63302.52**	**120848.29**
MW = Megawatt														

Fig-1: State wise installed capacity of renewable power as on 31.12.2022 (Ministry of new and Renewable Energy)

SOLAR PHOTOVOLTAIC WATER PUMPING SYSTEM (SPVWPS) FOR FARM IRRIGATION

Pumping for a wide range of tasks, particularly for water irrigation in agricultural areas, uses photovoltaic energy. Additionally, it can be used for bug control, fencing, illumination for cattle, and refrigerating fruits and vegetables. Only those activities that require a minimal power input can utilise the strategies employed in the PV system. They are inappropriate for high-powered agricultural processing and other sectors that consume a lot of power, such as rice mills (Singh et al., 2020). Farmers currently find it challenging to water their plants to keep their produce green under the blazing sun. Because of their erroneous beliefs that power is easily accessible, they endure negative consequences. One solution to this issue is the solar pumping system. The electric “solar panels, pump controller, submersible pump, converter, storage tank, and rechargeable battery” are typically the primary components of a solar pumping system. PVWPS (Photovoltaic water pumping systems) harness the sun's rays and transform them into electricity to run the pump. Technology that uses solar energy to pump water could one day replace systems that use conventional fuels like gasoline, diesel, or electricity, due to its low cost and environmental friendliness. Solar pumping devices can collect water from a source even in the absence of an electricity supply (a river, basin, well, etc.). These systems are typically used to supply drinking water, agriculture, or to fill reservoirs in the most inaccessible places. In addition to irrigation, PV systems can be used for drinking water delivery, water purification, and desalination. It is critical to have access to clean water, yet in some underdeveloped countries, this benefit is not always available. Furthermore, many rural regions lack access to a centralised infrastructure for supplying drinking water. In these instances, SPVWP (solar PV water pumping) technology may be an excellent option (Mamta Shukla et al., 2022b). Irrigation is becoming more important as the global population continues to grow and more food must be produced to feed everyone. However, freshwater resources are becoming depleted as the climate changes, making increased food production more difficult. Irrigation pumping needs, for both small and large farmers, are impacted by high diesel and electricity costs and frequently unstable energy supplies. In many remote regions, power from the grid is either not available or is only supplied intermittently. Compared to the use of electricity or diesel-powered pumps, the use of solar energy to move irrigation water holds great potential. Water pumps that use either a direct current (DC) or an alternating current (AC) motor can be powered by the sun using photovoltaic (PV) technology (Hartung, n.d.).

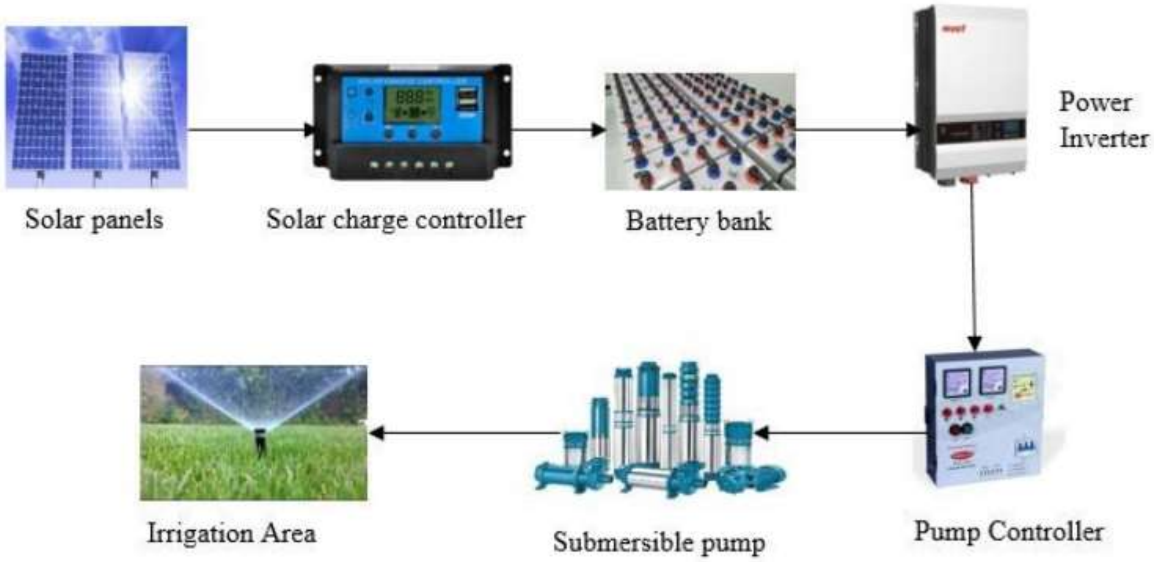

Fig-2: Solar water pumping system (Kanna et al., 2020b)

FUTURE OF AGRICULTURE AND FARMING SECTOR IN INDIA USING RENEWABLE ENERGY

Solar PV pumping systems are being installed all over the country with 70–80% government assistance because of the hefty installation costs. For instance, it costs about Rs 3 lakh and Rs 5 lakh, respectively, to install solar PV pumping systems of 3 HP and 5 HP on a farmer's land. Beneficial farmers are successfully employing these pumps to irrigate mainly horticultural crops. Farmers are eager to install the system on their fields, but fewer people are receiving benefits under a government subsidy programme than expected. Ultimately, as groundwater depth increases, the size of the solar PV modules in a solar PV pumping unit increase. Because PV modules account for the majority of the cost of a solar PV pumping system, the overall cost of pumping groundwater rises as the depth of the groundwater increases. A recently launched programme called KUSUM (Kisan Urja Suraksha Evam Utthaan Mahaabhiyan) seeks to install 10,000 MW of solar farming systems across the country. In addition, it is required to evaluate the performance of acceptable crops for Agri-voltaic methods used in various ecological regions. India is ranked fifth globally for the installation of all wind energy but tenth globally for solar photovoltaic systems. Approximately 1.8 x 1011 MW of solar energy is blocked by the earth. Consequently, one of the most potential unconventional energy sources is the vast bulk of our country's territory, which receives solar radiation every day of the year. India receives roughly 1800 J/cm2 of solar radiation on average per day on a yearly basis. Many agricultural goods have traditionally been dried in the sunlight (Mamta Shukla et al., 2022b).

CONCLUSION

The only clear answer to the non-renewable energy challenge is to identify sustainable energy sources to replace today's declining quantities of cheaply accessible fossil fuels. Solar energy is the only completely renewable energy source, at least for the near future. Many different things can generate renewable solar energy, such as wind turbines, falling water, solar collectors, and photovoltaic cells. Green plants are by far the most frequent type of solar energy collector. After all, the fossil fuels we use today were initially captured by plants. It is reasonable to think of agriculture as a significant source of renewable energy as a result (Mamta Shukla et al., 2022b). The majority of Indian farmers today use solar energy for their agricultural fields' irrigation needs, notably in the water sector. However, farmers do not consider the generating and operating costs of both systems and believe that the initial cost of SPVWPS (solar photovoltaic water pumping systems) is higher than that of diesel water pump systems. The SWPS (solar water pump system) PV array, which may be used to generate energy when irrigation is not necessary, is one of its most important components. Marginal farmers that use landholding arrangements can readily satisfy their irrigation water needs using solar water pumping equipment. In India, pump sets are increasingly being used as a result of the country's consistently rising fuel prices. The use of a solar water pump system reduces the need for diesel. Solar technology is being used more and more in agriculture by a wide range of people with different goals. This could help reduce greenhouse gas emissions in an industry that is under pressure to cut pollution (Lefore et al., 2021; Renewable Energy Agency, 2015).

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