PERFORMANCE MODELING AND OPTIMUM SIZING OF SOLAR PHOTO VOLTAIC (SPV) WATER PUMPS USING SOFT COMPUTING TECHNIQUE FOR DIFFERENT CLIMATE CONDITIONS .

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Abstract

The growth of utilization of electricity and diesel affects the performance of pumping capability of waters supplies and irrigation and it also enhance the overall cost. The other alternative is the use of solar water pumping rather than using traditional diesel and electricity based pumping system. The solar water pumping system is the one that utilizes photovoltaic (PV) technology to run the water pump motor. The PV based pump converts solar energy to electrical energy. In this paper we review various literatures based on solar pumping technology, also evaluate and identify the costs associated and gives research gaps. The study is based on analyzing various factors affecting the performance of PV water pumping system.

Keywords: **Photovoltaic(PV) , Solar pumping system,**

Introduction

The traditional water pumping is based on electricity or diesel and this dependence increase costs included. So to minimize the dependency on diesel, gas and oil based system solar water pumping is used now days. The diesel or oil based pumping system is expensive as well as it also creates pollution based on air or noise. Thus the use of solar photovoltaic pump reduces the cost of maintenance, operation and upfront and also its replacement is easy. The solar pumping system is environment friendly as well as it has very low cost associated.

Keeping in view the lack of grid power in rustic and remote regions in many pieces of world, PV pumping is a standout amongst the most encouraging uses of solar vitality. The innovation is like some other traditional water pumping framework with the exception of that the power source is solar vitality. PV water pumping is picking up significance as of late due to non-accessibility of power and increment in diesel costs. The stream rate of siphoned water is subject to episode solar radiation and size of PV cluster. A legitimately structured PV framework results in critical long haul cost investment funds when

contrasted with customary pumping frameworks. Likewise, tanks can be utilized for water stockpiling instead of necessity of batteries for power stockpiling. Farming creation in creating nations is to a great extent subject to downpours and is unfavorably influenced by the non availability of water in summers. Be that as it may, most extreme solar radiation is accessible in summers all things considered more water can be siphoned to meet expanded water necessities.

Urban water supply frameworks are likewise reliant on power to siphon water in towns. There is a wide extension to use PV pumping frameworks for water supplies in rustic, urban, network, industry and instructive organizations. In this examination, an audit of momentum condition of research and use of solar water pumping innovation is introduced. The investigation centers around late progression of the PV siphon innovation, execution assessment, ideal estimating, demonstrating and reproduction, corruption of PV generator providing capacity to siphon, monetary and ecological perspectives, and suitability of PV water pumping frameworks for water system, domesticated animals and network water supplies in rustic, urban and remote districts. The examination discoveries of solar photovoltaic water pumping frameworks of various setups are introduced for further follow-up research. The primary target of the examination is to display momentum inquire about status, and recognize investigate gaps and hindrances in the across the propagation of solar water pumping innovation. The system and approach issues for the advancement of PV water pumping are additionally introduced. The paper is composed as pursues: the flow condition of solar water pumping innovation is portrayed in Section 2; the writing study of PV water pumping framework studies and research discoveries are given in Section 3; in Section 4 comparison table is given and section 5 gives concluding statements.

Literature survey

The literature based on optimizing sizing of PV pump is as given as below:

(Gad) proposed a technique that is directly coupled with PV water pumping system. The overall performance is analyzed hourly by using various orientation of PV. It is found that the system is capable of pumping more water in summers as compared to winters[1] .

(Katan et al) provides way to analyses the performance of solar water pumping system by using maximum power point tracker. It consists of sun tracker, a magnet and DC motor that are attached with pump and analysis of PV array is done[2].

(Khan et al) structured a solar photovoltaic water siphon by including a DC– DC buck converter to give ebb and flow boosting to the DC siphon. No battery and inverter are utilized in the framework in order to diminish the expense and support. The most elevated no heap speed goes up to 3000–3200 cycles for every moment (rpm). The outcomes from the no heap test uncovered that the joining of DC engine with the diffusive siphon has coordinated impeccably. A direct coupled framework without a Power Conditioning Unit

(PCU) is contrasted and DC– DC convertor type framework. The DC engine working voltage, working momentum, shaft rpm and the release rate at various weights amid various occasions of multi day for the two frameworks are estimated and improvement in the electrical power yield is found in the structured DC water pumping framework. The result of this technique is given within the figure 1 [3].

(Mokeddem et al) examined the execution of a straightforwardly coupled DC controlled PV water pumping framework. The framework works without battery and electronic controls. The engine siphon effectiveness did not surpass 30%, which is run of the mill for a legitimately coupled photovoltaic pumping framework; yet such a framework is reasonable for low head water system in remote territories. The proficiency of the framework can be expanded by choosing the span of PV cluster, its introduction and engine siphon framework. The result of this technique is given within the figure 1 [4].

(Kou et al) built up a technique to foresee the long haul execution of a direct-coupled PV pumping framework. The technique utilizes PV module and pump– engine producer information in the investigation. Climate information are created from month to month midpoints of even radiation and encompassing temperature. The strategy predicts month to month siphoned water to inside 6% of TRNSYS expectation dependent on hourly climate information and can be utilized in planning and evaluating the long haul execution of a PV water pumping framework for US atmospheres. The result of this technique is given within the figure 2[5]

(Pande et al) structured and built up a PV pump worked dribble water system framework for parched locales considering distinctive plan parameters like siphon estimate, water necessity, diurnal variety in siphon weight because of progress in irradiance and weight pay in the drippers. Creators announced that a PV framework with (900 Wp PV cluster, 800 W DC engine siphon mono-square) can give 70– 100 kPa weight at the conveyance side with a release of 3.4– 3.8 l/h from each dripper amid various hours of the day. The emanation consistency was observed to be 92– 96% in a field of 1 ha. It is recommended that PV water pumping frameworks should be broadly tried for water gathering tanks with lower suction head for developing plantations in dry area. The result of this technique is given within the figure 2[6].

(Wagdy et al) proposed an 'exchanged mode' PV-controlled pumping framework. This framework couples the pump to the PV cluster legitimately when the capacity battery is completely charged, with the target of most extreme use of accessible solar radiation to limit the expense by thinking about three fundamental parameters: PV exhibit estimate, stockpiling battery size and water tank measure. Creators revealed that the ideal arrangement is one that limits the PV cluster estimate in light of the fact that the exhibit cost is the real thing and discovered that expanding battery stockpiling without expanding cluster measure has little impact on framework execution[7].

(Argaw) exhibited a straightforward non-direct advancement method which is utilized to take care of the heap coordinating issue of a PV water pumping framework and announced that an ideal coordinating variable of best 0.74 and least 0.55 can be accomplished utilizing a 1.76 kWp M55 type PV cluster and M40USP5A-7 type engine/pump with SA1 500 DC/AC inverter interfacing gadget and proposed that it is conceivable to accomplish a higher burden coordinating component by choosing cautiously the best possible size of exhibit and engine pump[8].

(Zvonimir and Margeta) reproduced a PV water system water pumping framework utilizing a scientific half and half reenactment enhancement display for ideal measuring which utilizes dynamic programming for improving. The requirements are characterized by the recreation show, by considering components pertinent to PV pumping framework: drill openings, neighborhood atmosphere, soil, yields, and water system framework. The model was tried on two areas in Croatia. This model thinks about every single trademark esteem and their relations in the coordinated framework. It is discovered that the electrical intensity of PV generator, acquired by the new enhancement technique, is moderately littler than that gotten by the typical strategy[9].

(Yahia et al) built up an ideal estimating model to streamline the limit sizes of various segments of an independent photovoltaic water pumping framework utilizing a water tank and investigated a pumping framework, which is intended to supply water for drinking and water system situated in Ghardaia, Algeria. Creators reenacted the PV water pumping framework by utilizing a created program and decided the connections between framework control unwavering quality and framework arrangements. The ideal designs of the pumping framework are resolved for various wanted framework dependability prerequisites (LPSP) and the existence cycle cost (LCC) [10].

(Kaldellis et al)researched a PV fueled water pumping framework which can meet extra electricity stacks other than water pumping necessities at Athens, Greece. The outcomes acquired by ideal estimating approach are approved by exploratory estimations. The two-level examination is utilized for measuring of the framework. The scientific methodology depends on both the basic conditions and the utilization of a numerical calculation PHOTOVIV. It is appeared and tentatively that a legitimate planned PV-based electricity generator with a fitting vitality stockpiling gadget can meet the electricity needs of remote customer alongside water pumping[11].

(Hamidat and Benyoucef) proposed two mathematical models for PV pumping sizing. These models link the operating electrical power to the water flow rate of the pump versus total head. Two pumping subsystems of different technologies and manufacturers are studied. The first pump is the centrifugal pump which consists of a three-phase AC engine and a centrifugal pump. The second is the positive displacement pump which consists of a DC engine and a positive displacement pump. The results show that the displacement pump has better performance (higher efficiency, higher average volume of water

pumped, and low energy losses) in comparison to a centrifugal pump[12].

TABLE 1 :-Comparison Of Various Techniques For Optimal Sizing.

S.no.	Reference	System type	Optimal sizing technique	Research findings
1	Wagdy et al.[3]	Direct coupled and battery buffered	Switched mode Optimization	provides maximum utilization of available solar radiation to minimize cost
2	Argaw[4]	Direct coupled interfaced with PWM DC/AC inverter	Non-linear optimization	Optimum matching factor of 0.74 and 0.55 are found using DC/AC inverter interfacing device.
3	Yahia et al.[5]	Direct coupled	Loss of power supply probability (LPSP) Program	developed for relationship between system power reliability and system configurations.
4	Kaldellis et al.[6]	Battery based	Two-level analysis	Energy storage capability of a properly designed PV system determined analytically and experimentally to meet the electricity and water needs.
5	Zvonimir et al. [7]	Inverter coupled with AC pump	Hybrid simulation Electrical power of the PV generator	obtained by the new optimization method is relatively smaller as compared to usual method.
6	Hamidat and Benyoucef[8]	Inverter coupled with AC pump	Conventional method DC engine and a positive displacement	pump shows best performance when compared with AC engine centrifugal pump.
7	Firatoglu and Yesilata[9]	Direct coupled	Multi-step optimization System	performance is found better for lower

				photovoltaic array area.
8	Cuadros et al.[10]	Inverter coupled with AC pump	Multi-step optimization	Output yield of crops can be improved by photo irrigation.

Results :-

The comparative results are as given below that gives the variation of efficiency with changing flow – rate at a constant pumping head.

technique	Switched mode optimization[3]	Non linear optimization[4]
Power (W)	Mechanical Frequency (Hz)	Mechanical Frequency (Hz)
200	17	13
450	20	19
550	26	24
700	30	29
850	34	33
1000	40	39
1200	47	42
1400	50	46
1700	57	56

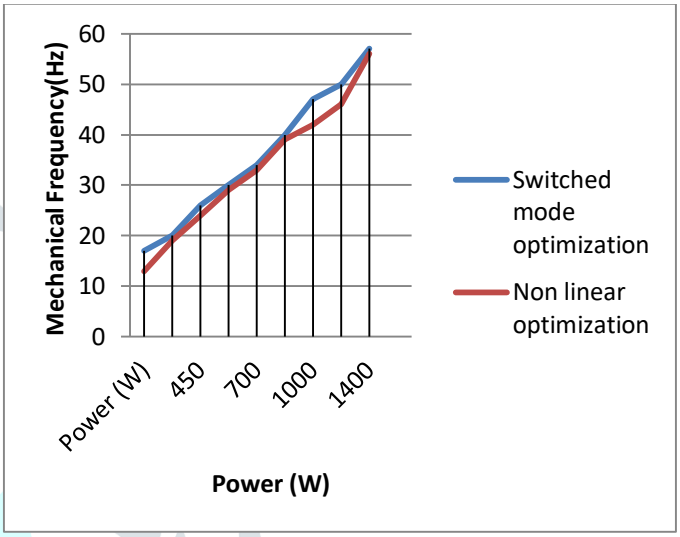

Figure1: shows power utilization of solar water pumps from the literature conducted in literature survey. The efficiency is shown of literature [3] and [4].

Table 2 :- Comparison Of LPSP And Two Layer Analysis.

Technique	LPSP [5]	Two Layer Analysis[6]
Frequency	Efficiency	Efficiency
17	25.6	11.9
20	20.8	37.9
26	10.5	14.4
30	28.8	12.7
34	18.4	10.0
40	22.1	17.8
47	10.5	15.7
50	18.7	12.2
57	21.0	13.6

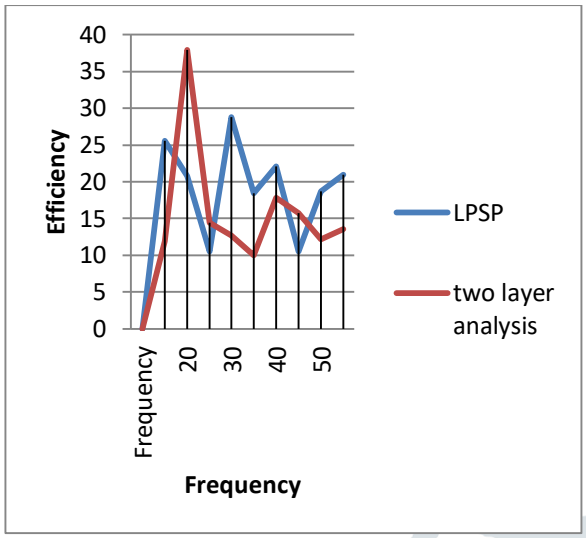

Figure 2: shows efficiency of solar power pumps of literature [5] and [6]

The result obtained from the inverter coupled mechanism is shown through the figure 3

Table 3 :-Comparison Of Inverter Coupled And Direct Coupled Mechanism

Technique	Inverter Coupled [5]	Direct Coupled[6]
Frequency	Efficiency	Efficiency
17	26.6	28.9
20	25.8	27.9
26	20.5	24.4
30	18.8	22.7
34	18.4	20.0
40	17.1	17.8
47	17.0	17.7
50	16.7	17.2
57	16.0	16.6

The mechanism using direct coupled is much more efficient as compared to inverter coupled mechanism as clear from reading obtained.

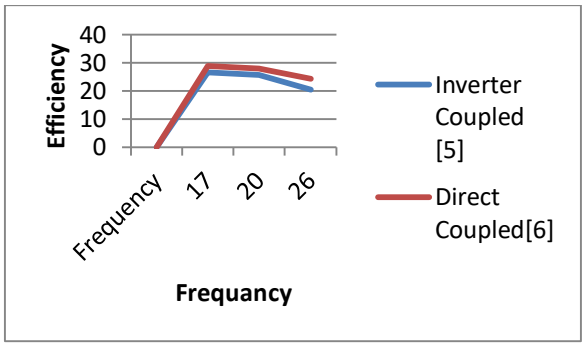

Figure 3: Plots in terms of frequency and efficiency

The comparison of result from the figure 1,2 and 3 is indicated through the figure 4. The result comparison indicates that direct coupling mechanism is much more efficient as compared to other coupling within solar power mechanism

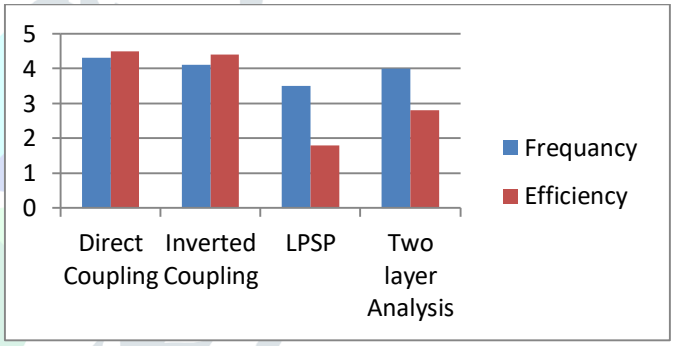

Figure 4: Comparison of frequency and energy efficiency.

The comparison shows direct coupling is performing better as compared to other coupling mechanisms.

Conclusions:-

A survey of current status of solar photovoltaic water pumping framework innovation research and applications is displayed. The investigation centers around update on solar water pumping innovation, execution examination contemplates completed around the world, ideal estimating strategies,

corruption of PV generator providing capacity to pump, monetary assessment, natural viewpoints and ongoing advances in materials and productivity improvement of photovoltaic innovation and experience of utilizing solar PV pumps around the world. In light of the examination fundamental ends are as per the following: PV water pumping innovation is dependable and monetarily feasible option in contrast to electric and diesel water pumps for water system of farming harvests. PV water pumping for urban, rustic and network water supplies and establishments, is another potential practical part however isn't even now generally used. The remote blocked off areas with no lattice electricity additionally need uncommon consideration. These divisions still rely upon customary electricity or diesel based pumping framework bringing about expanded repeating expenses to the users attainable segment however isn't in any case broadly used. The remote difficult to reach areas with no network electricity additionally need unique consideration. These segments still rely upon ordinary electricity or diesel based pumping framework bringing about expanded repeating expenses to the clients.

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