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# To Study the Performance Analysis of Solar Water Pumping System in Different Losses Condition

Nandita Pakhmode<sup>1</sup>, Amit Agrawal<sup>2</sup>, Pragya Patel<sup>3</sup>

Dr. C V Raman Institute of Science and Technology, Chhattisgarh, India

Asst. Professor, Department of EE, Dr. C V Raman Institute of Science and Technology, Chhattisgarh, India

Asst. Professor, Department E.E., Dr. C V Raman Institute of Science and Technology, Chhattisgarh, India

**ABSTRACT:** Agricultural technology is changing rapidly. Farm machinery, farm building and production facilities are constantly being improved. Agricultural applications suitable for photovoltaic (PV) solutions are numerous. These applications are a mix of individual installations and systems installed by utility companies when they have found that a PV solution is the best solution for remote agricultural need such as water pumping for crops or livestock. A solar powered water pumping system is made up of two basic components. These are PV panels and pumps. The smallest element of a PV panel is the solar cell. Each solar cell has two or more specially prepared layers of semiconductor material that produce direct current (DC) electricity when exposed to light. This DC current is collected by the wiring in the panel. It is then supplied either to a DC pump, which in turn pumps water whenever the sun shines, or stored in batteries for later use by the pump. The theoretical design, performance and simulation analysis of PV based water pumping system with the use of the computer software PVsyst is carried out. According to the analysis, the solar water pumping system has a different type of losses conditions .Therefore SWPS is strongly recommended for both urban as well as rural water supply system.

**KEYWORDS:** Solar water Pump, Losses Analysis, PV Syst 6.4.3 Softwares

### I. INTRODUCTION

Photovoltaic (PV) panels are often used for agricultural operations, especially in remote areas or where the use of an alternative energy source is desired. In particular, they have been demonstrated time and time again to reliably produce sufficient electricity directly from solar radiation (sunlight) to power livestock and irrigation watering systems.



## Figure 1– A typical solar-powered water pump system, which includes a solar array, controller, pump, and storage tank

The following sections will first provide an introduction to the basic concepts involved in solar-powered pump systems, then descriptions of and design considerations for the previously mentioned, individual system components.



(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: <u>www.ijareeie.com</u>

### Vol. 7, Issue 4, April 2018

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. In recent years, one of the suitable solar photovoltaic (PV) applications is a water pumping system. The simplest solar PV pumping system consists of PV array, DC-DC converter, DC motor, and water pump.

### **II. PROBLEM IDENTIFICATION**

With the increasing acuity of water supply problems especially in developing countries, solar pumping systems are taking a great importance, which will still increase in the next years.

However, Solar pumping system sizing and optimization is a rather complex task, involving a lot of variables, which mix together in a way that is not intuitive. Most pump manufacturers do indeed propose their own "standard" system configurations, valid for given typical conditions (usually based on one standard clear day). Their specifications or sizing tools don't allow to estimate the net water yield during a specified meteo time series.

To our knowledge, there is no general tool available on the market, able to size and simulate such systems with sufficient generality and accuracy, in order to compare the performance of different system configurations in a given situation.

Therefore the engineer doesn't avail of any tool for optimizing a photovoltaic pumping system, exactly suited for a specific situation (meteo, levels, available flows, etc) and well-defined needs. The aim of this study is to offer the required computing basis, either for the sizing or for the detailed performance comparison of different technological options, as well as their economical evaluation. This tool should of course avail of a real components database, including the newest devices available on the market.

This facility should be integrated in the software PVsyst, a widely used general software for the detailed study and simulation of other PV systems (Grid-connected, stand-alone or hybrid).

A solar irrigation pump system methods needs to take account of the fact that demand for irrigationsystem water will vary throughout the year. Peak demand during the irrigation system seasons is often more than twice the average demand. This means that solar pumps for irrigation are under-utilized for most of the year. Attention should be paid to the system of irrigation water distribution and application to the crops. The irrigation pump system should minimize water losses, without imposing significant additional head on the irrigation pumping system and be of low cost

In the "System" definition panel, you can modify the "Detailed losses" (soiling, IAM, module temperature parameters, wiring resistance, module quality, mismatch, unavailability, etc).eventually define a Horizon profile (far shadings), Module Layout for a description of the PV modules in the system, for the detailed calculation of the electrical shading losses.

#### III. PROJECT DESIGN OF SOLAR WATER PUMPING

This part aims to perform a thorough PV-system design and performance analysis using detailed hourly simulations. These are organised in the framework of a Project, which essentially holds the geographical situation and meteorological hourly data. Optimisations and parameter analysis can be performed through different simulation runs, called variants.





Figure 2 (a) Pumping system presizing at Lormi. (b) Pumping site at Lormi.



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### Vol. 7, Issue 4, April 2018

### (i)Project Design

he Project includes mainly the geographic SITE definition, and the associate roject's name Pumping project at Lormi	d METED hourly life ? Date 4/ 1/2018 C & Reorder variants	Field type Fixed	d Tilted Plane	•
arameter           # Site and Meteo         # Albedo - setting:	Coad project     New project     Save Project     Delete project	Field Parameters Plane Tilt 15 +[1]	Tilt 15°	Azimuth 0°
stem Varrant (calculation version) aniantn' VCA : 5 m3/day, H=32+6 m, PV=240w/p, Pumps: 2 x 99w uput parameters	direct coupling	Azimuth 0.0 + [1]		West East
Mandatory Uptional Orientation     Near Shading:	Simulation     Simulation     Securits	Onlineation by respect to	Winter meteo yield	South
System     Cash diagon     Commission	E Save variant	C Yearly iradiation yield ?	Transposition Factor Loss By Respect To Global on collector pl	FT 1.13 Optimum -5.7% ane 1177 kWh/m <sup>2</sup>
	±"] Delete variant		Show	Optimisation

(ii) Water needs and Hydraulic Pressure/Head, Variant As shown in figure 4

Water of Holdskill Canzill         Water weeks and Hold definition           Pumping System Type         Deep Well to Storage           Wate characteristics         Static depth         22.0           Static depth         22.0         n           Value provide depth         25.0         n           Providesh         26.0         n           Wate state of the	ding level
Pumping System Type         Deep Well to Storage           Vial characteristics:         Storage Tank         Fer           Static depth         32.0         n         20.0         n2           Max purping depth         30.0         n         20.0         n2           Paro depth         50.0         n         Water United Tage 7.00         n	ding level
Well characteristics         Statege Task         Fe           Static depth         22.0         m         Volume         70.0         m3           Max, punping depth         38.0         n         Dameter         35.0         n           Punp depth         40.0         s         Water M height (200         n	
Static depth         32.0         m         Volume         20.0         m3           Max. pumping depth         58.0         m         Diameter         3.50         m         Greater           Pump depth         40.0         m         Water kill height         20.0         m         Greater	
Max pumping depth 38.0 m Diameter 3.50 m Greanny Pump depth 40.0 m Water full height 2.08 m	
Pump depth 40.0 m Water full height 2.08 m	
a second se	Static level
Borehole diameter 18.0 cm Feeding aktude 6.00 m	
Spec. drawdown ? 1.00 m/m3/h T Bottom almentation ? Pum	Burne O Max. depth
Hydraulie Circuit         140	th friction loss diff. OUT-N awdown own limit
Piping length 90 m	
Number of ebows	
Other Inction losses 0.00 ? Head Graph 20	1
Curton rine Provertier Provertier	3 4 5 6 7

Figure 5 Pumping Hydraulic Circuit

Pumping Hydraulic Circuit	Water needs and Head definitio	ns
Water needs		Hydro units
<ul> <li>Yeally average</li> <li>Seasonnaly value</li> <li>Monthly values</li> </ul>	Whole Year needs : 5.0 m²/day	Pumped Volumes m²/day • Powrate m²/m • Head / Pressure meter// •
?		Yearly summary
Well static depth var	iations	Water needs average         5.000 m²/day           Yeady water needs         1825 e²           Yeady Head average         38.0 meterW
Yeady constant     Seasonnal value:     Monthly values	Whole Year:	Hydawlic energy 189563 W PV needs (very roughly) 538152 W
?		Model File

Figure 6 Water needs and Head definitions

### (iii) System properties.

	Pumping System definition, Varia	nt "5 m3/day, H=32+6 r	n, PV=240Wp, Pumps; 2 x 98W, direc
Presizing help Average daily needs : Head min. 38.8 meter/w/ Head max 45.5 meter/w/ Volume 5.0 m²/day	Requested autonomy 4 1 day(s) Accepted missing : 5 1 % ?	Suggested tank volume Suggested Pump power Suggested PV power	20 m² 119 w ? 529 W/p (nom.)
Pump(y) model and layout		E	E I/V Matching
Shutto	W 6-70 m Well, DE, Membrane/Dia	phrage 1000 Series	R Dpen
I     ⇒     Pumps in serie (electrically)       I     →     Pumps in parallel Powps in parallel FlowB = 0.0 m/h.	The Purep Boseate is slightly condensitied by respect to the make means. at Purep's Phase, or 1.0 of the with PV(1604/00).	2 Pumps, total power 17 Nominal voltage Neminal current	6₩ (All pump 6♥ Hover are 7 A Dataliel)
I'V array : Select module)	4		
Sort modules by: (# Power	C Technology	All modules	L th annul
2     ↓     ✓     Modules in serie       2     ↓     ✓     Modules in parallel       4     Modules	Regid, and power cond. Direct coulding The only content is signed undersized	Anay nom power (STC) : Anay voltage (50°C) 2 Anay current (STC)	40 Wp 9.6 V 7.2 A
	X Cancel	OK. Begut	dion pre-

**Figure 7 Pumping System Definition** 

For a given project, you are advised to first construct a rough variant keeping all parameters to their proposed default values.

#### (iv) Detailed losses

In the "System" definition panel, you can modify the "Detailed losses" (soiling, IAM, module temperature parameters, wiring resistance, module quality, mismatch, unavailability, etc). Module Layout for a description of the PV modules in



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### Vol. 7, Issue 4, April 2018

the system, for the detailed calculation of the electrical shading losses. The following diagram shows an outline of the project's organization and simulation process.

### > Thermal Losses

The parameters of the Thermal behaviour of the field are defined in the "Array Losses". The thermal behaviour of the field - which strongly influences the electrical performances - is determined by an energy balance between ambient temperature and cell's heating up due to incident irradiance.

			9		PV field	detailed losses parameter
Model quark Model quark Mendel.h      You can drive where the Falt themail Loss     Representation      Falt Themail Loss fact     You can drive where the Falt themail Loss     Representation      Falt Themail Loss fact     You can drive but     You can drive but	Soling Loss   MM Losse   D.M Infaster of the rear-dead NGCT of the operations of the infasterial Soliton of MDCT Network Deaving often specifically an auto- soliton of the operating and applied is the operating an operating soliton of the specifical solito	ngudaton Conficient Confisionent in Inclumentation für Verberaten to für Verberaten	Thermid personnel ( DEC clean) Obtain rine Vidage De	Other Lettern         Model casely         Memory           at shade forses for the amory         model         model           rgs statutes         [61]         model           rs bas handon af STC         [5]         3           rs pa across seles doub         [0]         V	Soling Loss   MM Losser Colouland Databa Coloub	Degestition   tabled computation 2
E Laura and	¥ Carrel	100		Es Losses graph	X Cancel	✓ OK

Figure 8 Thermal Losses

Figure 9 Ohmic Losses

### > Ohmic Losses

The ohmic resistance of the wiring circuit induces losses between the power available from the modules and the power at the terminals of the sub-array.

### > Soiling Losses

Accumulation of dirt and its effect on the system performance is an uncertainty which strongly depends on the environment of the system, raining conditions, etc. In medium-rainy climates (like middle of Europe) and in residential zones, this is usually low and may be neglected (less than 1%). In rural environments with agricultural activity, it may be important during some seasonal activities.

parameter   Ohmic Losses   Module quality - Mismatch	h Solling Loss   LAM Losses   Degradation	Thermal parameter   Ohmic Losses   Module quality - Mismatch   Soiling Loss   IAM Losses   Degradation
Yearly soling loss factor Yearly loss factor 30 z pr		Incidence Angle Modifier
C Define monthly values		0.2     IAM = 1 - bo (1/cos i - 1)       0.2     with bo = 0.05       0.1     0.2       0.1     0.2       0.2     0.0

Figure 10 Soiling Losses

Figure 11 IAM (Incidence Angle Modifier)losses

### Incidence Angle Modifier losses

Theincidence effect(the designated term is IAM, for "Incidence Angle Modifier") corresponds to the decrease of the irradiance really reaching the PV cells' surface, with respect to irradiance under normal incidence. This decrease is mainly due to reflexions on the glass cover, which increases with the incidence angle.



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Vol. 7, Issue 4, April 2018





Fig 12Pumping PV system Losses Diagram

VSYST V8.43					Page 2/	
Pumpin Project : Pump Simulation variant : 5 m3/	g PV System: Deta ing project at Lormi day, H=32+6 m, PV=241	iled Simulation Wp, Pumps: 2 x 3	parameter SW, direct co	supling		
Main system parameters System Requirements	System type Basic Head	Deep Well to Storage 38.0 meter/V	Water needs 5.0 m²/day		ŋ	
PV Array System Configuration	Model / Manufacturer No. of modules Control Strategy	AP-6106 / Astro Pover 2 5 x 2 P Direct coupling	Array Pr	wer 240 Wp	p	
System Operating Control Direct coupling between the PV arr. The controller only assumes the ove PV Array loss factors	(G av and pump : ricad protections!	Generic device, params ad	justed acc. to the	ejetent)		
Thermal Loss factor	Uc (const)	29.0 Wim%	Uv (wind)	0.0 W/m% / m	15	
Wring Onnic Loss Module Quality Loss Module Mismatch Losses	Global array res.	69 mOnm	Loss Fraction Loss Fraction Loss Fraction	1.5 % # STC 3.0 % 2.5 % (beck	(scate)	
				Contract of the second		

Fig14 Pumping Detailed Sim. Parameter



Fig 13 Pumping : Basic Sim. Parameter



Fig 15 Pumping : Main Result

When the simulation is completed, you will enter the "Results" dialog, and consult the main results on the "Report" document. After simulation, each variant may be saved for further comparisons (please use "Save as" to avoid overwriting your previous variants). You are advised to define a significant description for each variant, in order to easily retrieve them in the list and to obtain a suited title in your final report

### V. SOFTWARE SIMULATION

PV SYST V6.43 is a PC software package for study sizing and data analysis of complete PV system. It deals with grid connected, stand-alone, and pumping, DC-grid PV systems, and includes extensive meteo and PV system components databases, as well as general solar energy tools. The software is geared to the needs of architects, engineers, researchers. It is also very useful for educational training.



(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: <u>www.ijareeie.com</u>

### Vol. 7, Issue 4, April 2018

PVSyst V6.43 offers 3 levels of PV System study, roughly corresponding to the different stages in the development of the real projects.

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