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A Photovoltaic based Single Stage Water Pumping System with Improved Control Technique

Ansar Balkhi[1], Prof. Rahul Malviya[2]

[1]Research Scholar, [2]Assistant Professor

Department of Electrical & Electronics Engineering,

IES College of Technology, Bhopal, India

Abstract— A Photovoltaic based electrical devices and systems are promising research area. It is good replacement of the conventional energy sources. Water pumping system is very useful in field of agriculture application. This paper presents a photovoltaic based single stage water pumping system with improved control technique. The novel controlling scheme with SRM motor is used to design the model. The MATLAB simulink software is used to implementation and simulation of the model. Simulation result shows the improvement in terms of the performance parameters.

Keywords— Photovoltaic, Water Pumping, agriculture, MATLAB, Simulink, SRM motor.

I. INTRODUCTION

Solar Photovoltaic is the most reassuring energy of the contemporary fuel sources which is gifted to satisfy the energy needs of the restricted rural regions. It fits flawlessly to the decentralization of power age for the little organizations comprehensively dispersed as demonstrated the sun oriented siphons whose movement is these days exhibited impeccable. The development of fundamental energy to the motor of the siphon, sun powered photovoltaic boards is put for changing over sunlight based energy into electrical energy. As the boards make an direct current (DC), it is routinely used DC/AC converter to change over the immediate current conveyed by the sunlight powered chargers into alternative current (AC) assuming the motor of the siphon is AC. On the contrary side, on the off chance that the motor is DC, the device shouldn't for a second mess around with a DC/AC converter. The energy conveyed by the boards can be used straightforwardly or taken care of. By virtue of an application for water pumping, it is also fascinating to use the energy to bring the water up in a fortification that fills in as tension driven energy accumulating.

Sun based photovoltaic water pumping framework for water system that is introduced at Madarpura (Jhotwada) of Jaipur Area in Rajasthan. A correlation between the pragmatic (field) execution information of working sunlight based photovoltaic water pump and PV system programming investigation of that pump has been completed.

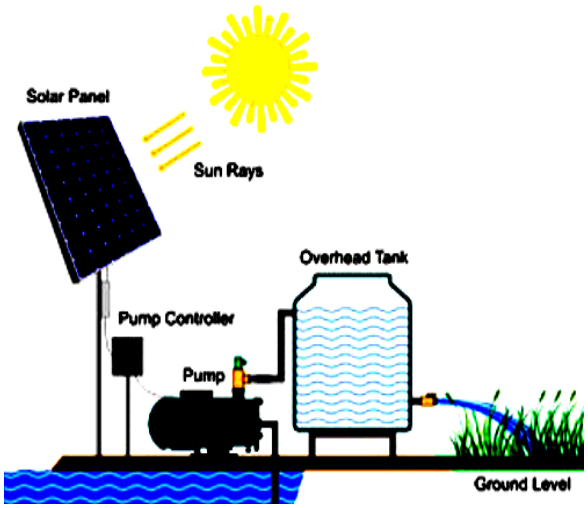


Figure 1: Solar power water pumping system

The point of correlation between genuine working pump and recreated pump utilizing PVsyst is to survey the presentation of sun powered water pump in contrast with an ideal PVsyst reproduced sunlight based water pump. Working long stretches of pump, energy produced by photovoltaic cluster, and the all out volume of water yield during nine months are considered for execution examination. As indicated by pragmatic information of the site, absolute volume of water pumped in nine months is 8,562.14 m 3 and normal month to month volume of water is 951.348 m 3. PVsyst programming predicts the absolute volume of water pumped in nine months is 16,412 m 3 and normal month to month large volume of water pumped [7].

Sun oriented pump introduced along the sun is perhaps the most monetarily practical photovoltaic applications in far off region, on the grounds that the photovoltaic energy is utilized straightforwardly from photovoltaic boards without transformation or capacity.

The identity of the pump framework introduced, that their attributes (stream rate, head, power, revolution speed) relies upon sun based illuminations which shifts throughout the days and periods of the year. Pumps introduced in this framework must be checked and controlled quickly to keep to them working with the best effectiveness. In this work, we utilized the P& O MPPT control, which is one the most MPPT control methods ordinarily used to follow the greatest power point of a photovoltaic (PV) framework. The reproduction of the entire framework has been performed by PSIM programming. The acquired outcomes show progressively the conduct of the pumping framework under various light and conditions and how much water conveyed [8].

The speed of SRM is constrained by fluctuating the dc-transport voltage of the mid-point converter. A dc-dc Cuk converter working in constant conduction mode (CCM) is utilized for dc-transport voltage control. The CCM activity of inductors assists with diminishing the ringing impact and diminishes the misfortunes of dc-dc converter. Current and voltage weights on gadgets including exchanging pressure of Cuk converter are likewise diminished in CCM. The Cuk converter works with the consistent and smooth information/yield flows to SRM drive with vast locale for most extreme power point following (MPPT) activity. The change in sync size of a steady conductance MPPT calculation works with the delicate beginning of SRM drive [9].

II. BACKGROUND

S. K. Hota et al., presents a method which comprises of presenting a fluffy PI regulator for speed guideline and force reference age. Irritate and Notice (P&O) calculation is used to extract the most extreme force from the PV board. The exhibitions of PV framework utilizing the recommended fluffy rationale regulator (FLC) are contrasted with those got from the traditional corresponding indispensable (PI) utilizing Matlab/Simulink programming. The recreation results indicated that the proposed PV water siphoning framework guarantee the best unique performances[1].

M. Rezkallah et al., presents another active force control (APC) with upgraded greatest force point tracking (MPPT) calculation are actualized to improve the exhibitions of a sun powered photovoltaic framework (SPV) based independent water siphoning station. The APC utilizes corresponding thunderous regulator with antiwindup (AWPRC) for ac voltage guideline without immersion wonders and with high force quality at the purpose of regular coupling. Moreover, the corresponding thunderous regulator plan strategy for ideal additions to achieve superior during change period as far as stage edge and wanted settling time is examined [2].

K. K. Jha et al., Presents a dynamic and consistent state assessment of BLDC engine with Cuk converter has been completed. The recreation in MATLAB/SIMULINK shows the quicker tracking speed with PSO based MPPT procedure in correlation with P and O. Notwithstanding this wavering at the working purpose of greatest force is seen to be less. The equipment results will be accessible at the last form of this composition [3].

A. Laaroussi et al., Shows the procedure doesn't produce any cost of fuel and keeps away from rehashed stops in light of the fact that the sun is a generally steady and dependable wellspring of energy. These components give this arrangement a decent rate of profitability and a superior cost/quality proportion contrasted with traditional siphoning frameworks. Our article is a near investigation of the two sorts of siphoning (gas and sun based) on the monetary side, natural impact, yet additionally the impact on the remuneration reserve [4].

W. Obaid et al., presents a cross breed power framework for water siphoning applications. The framework comprises of three force sources: sun oriented PV boards, wind turbines, and diesel generator. A voltage controller is utilized to keep up 12v from the sun powered PV boards yield voltage to charge the battery bank. A three-stage transformer is utilized to venture down the AC voltage from wind turbines and a three-stage AC-to-DC rectifier is utilized to change that voltage over to DC [5].

M. Errouha et al., presents the procedure comprises of presenting a fluffy PI regulator for speed guideline and force reference age. Perturb and Observe (P&O) calculation is used to extract the greatest force from the PV board. The exhibitions of PV framework utilizing the recommended fluffy rationale regulator (FLC) are contrasted with those acquired from the customary relative necessary (PI) utilizing Matlab/Simulink programming. The reenactment results demonstrated that the proposed PV water siphoning framework guarantee the best powerful exhibitions [6].

E. T. Maddalena et al., Presents a nonlinear regulator interconnection between the individual compensator of each stage is made to account for the low capacitance. Recreations and exploratory outcomes show the viability of the technique in balancing out the dc-connect voltage under abrupt sun oriented light changes. The last converter was conveyed in a distant rustic network in Guinea-Bissau for crop water system purposes. Regardless of the brutal conditions, for example, high temperatures and ocean breeze, in situ results were satisfactory and approved the framework power [7].

B. Singh et al., proposed framework is displayed, and its exhibition is mimicked in detail. The scalar control dispenses with the prerequisite of a speed sensor/encoder. Thus, the need of engine current sensor is additionally disposed of. Also, the elements are improved by an extra speed feed forward term in the control conspire. The proposed control conspire makes the framework innately invulnerable to the variety in the siphon consistent. The model of PV-fueled IMD copying the siphon characteristics is created in the research center to inspect the exhibition under various working conditions [8].

J. R. Maciel Ferreira Filho et al., present an answer for the siphoning of water for homegrown purposes or water system of little harvests. The essential wellspring of energy is the sun powered photovoltaic sort and without batteries. To decrease the quantity of boards, a high addition, high proficiency help converter is utilized to give managed voltage to a recurrence converter. This is made out of three-stage enlistment engine and lowered outward siphon. Another significant factor is the utilization of business hardware,

which facilitates the replacement in a potential disappointment. The tests show satisfactory outcomes, reaching in the most extreme force condition a progression of 1100 l/h at a weight 25 mca [9].

I. Dupont et al., presents the plan and execution of an IoT (Web of Things) information acquisition and checking framework applied to a photovoltaic (PV) water siphoning plant. The framework permits control and checking simple and computerized sensors arranged in decentralized age plants, utilizing a Simple/Advanced Converter Implanted Framework (ADCES) created in this work. The ADCES depends on a microcontroller arrangement of the PIC18Fxx5x family with USB interface known as SanUSB. A Raspberry Pi (Rpi) board was utilized to build up an Installed Linux Framework (ELS) to guarantee correspondence between the checked plant and cloud administrations. The fundamental commitment of this work is the likelihood to distantly screen and control any micro generation plant through the Web [10].

R. S. Kumar et al., presents a sunlight based fueled water siphoning framework utilizing an improved unbalanced converter took care of Exchanged Hesitance Engine is proposed. It gives a proficient and savvy PV based water siphoning framework. An improved lopsided half scaffold converter with diminished expense and volume is utilized to switch the SRM. MPPT regulator is utilized to upgrade the PVG yield force and keep it greatest at different irradiance. Landsman converter acts as a DC to DC converter between PV framework and engine siphon drive. The total framework is reenacted utilizing MATLAB Simulink model [11].

A. Aggarwal et al., gives the basic yet compelling plan of a sun powered water siphoning framework in GHAZIABAD for water system reason. In this work, the framework for rice and wheat crop has been planned comprising of SPV modules alongside greatest force point tracker (MPPT) to achieve most extreme force effectiveness, DC-DC Lift Converter, perpetual attractive DC(PMDC) engine and Submarine siphon. The reenactment of the framework has been done through MATLAB/SIMULINK which confirms the framework's usefulness alongside its parts. The examination additionally centers around the monetary assessment of environmentally friendly power over customarily utilized non-ordinary wellspring of energy [12].

III. PRESENT MODEL METHODOLOGY

The main contribution of the rresent research work is as followings-

The SRM drive has been chosen for present system due to its highly inductive nature, which makes it most appropriate for single stage system.

The other benefits such as low cost, high efficiency and requirement of simple power converter for phase energizing, make it suited for the grid interactive solar powered water pump.

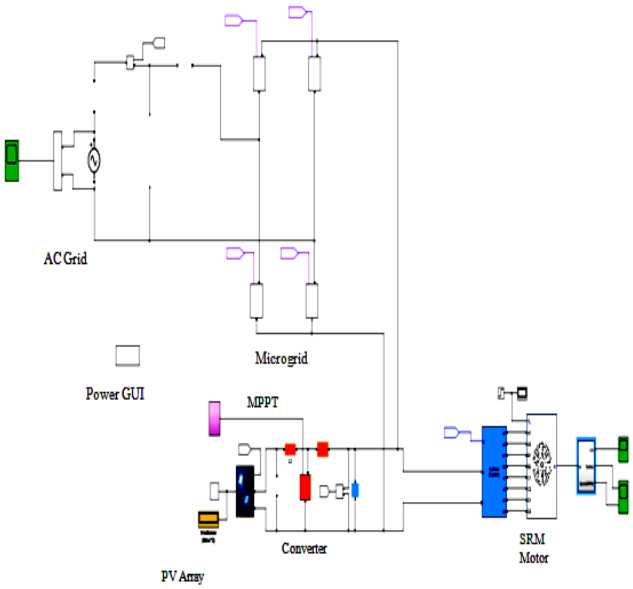


Figure 2: Present Model

Standard Solar, as of late finished one of the primary solar microgrid frameworks with a grid interactive battery bank in the nation. Being a first was a test it took a very long time of commitment, creative engineering and coordination with key accomplices, utilities and government workplaces to make this undertaking a reality. The primary portion of this work will set the stage by clarifying how the microgrid is arrangement, its usefulness and what makes it extraordinary. At that point I will investigate the stuff to plan and introduce a solar microgrid framework, the exercises gained from this historic task and what specialized contemplations should be made while executing this new innovation.

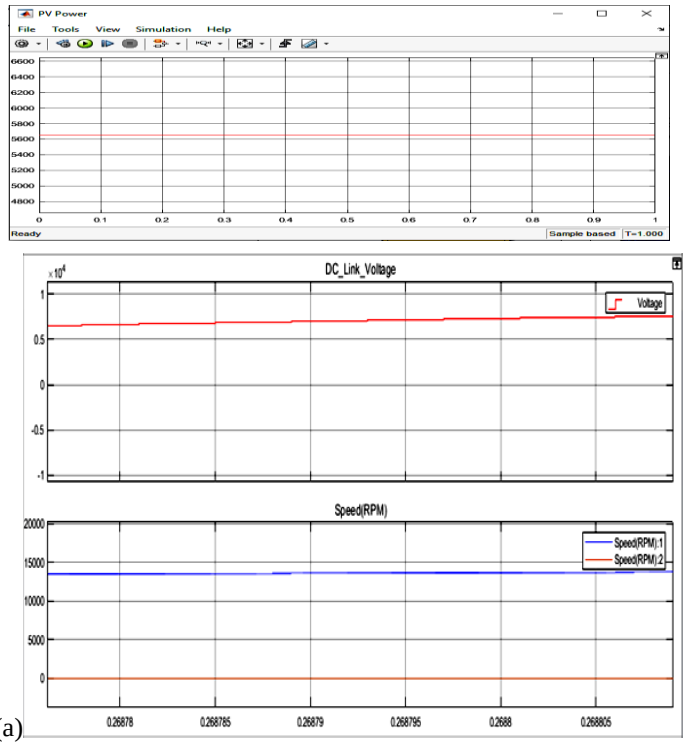
Maximum power point tracking (MPPT) is a calculation executed in photovoltaic (PV) inverters to ceaselessly change the impedance seen by the solar cluster to keep the PV framework working at, or near, the pinnacle power point of the PV panel under differing conditions, such as changing solar irradiance, temperature, and burden.

IV.SIMULATION RESULTS

The implementation of the Present algorithm is done over MATLAB 9.4.0.813654 (R2018a). The simulation toolbox helps us to use the functions available in MATLAB Library for various models, some of the blocks are scope, sink sin generator etc.

Stand-alone PV Water Pumping System

Case-I: In stand-alone system, when PV-power is 5650W, the motor runs at rated speed i.e. 14000 rpm by giving output as 5650 W.

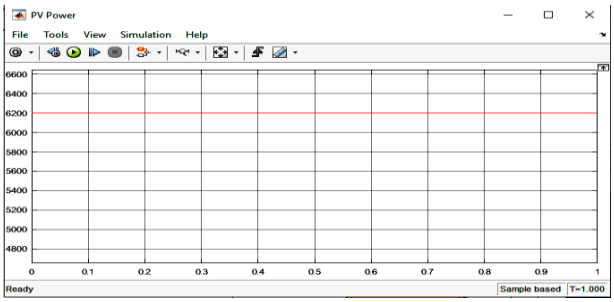


(a)

Figure 3: Performance of standalone solar water pumping system (a) PV-power vs Time (b) DC-link voltage vs time and Speed vs time

Figure 3 is showing the output performance of the PV power, motor speed and DC link voltage. Here it is clear from the waveform the PV power is 5650W, motor speed is 14000rpm and DC link voltage is 6000V.

Case-II: When PV-power increases to 6200 W, speed and power output of motor increased to 14000 rpm to 14250 rpm respectively.



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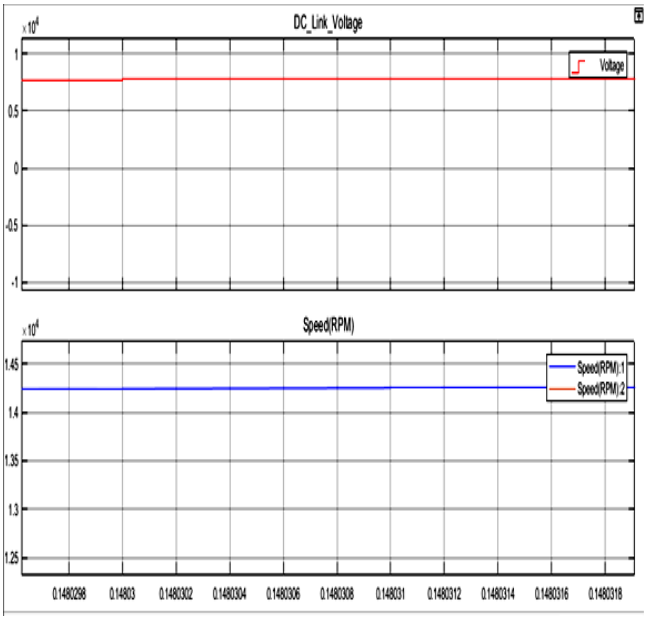
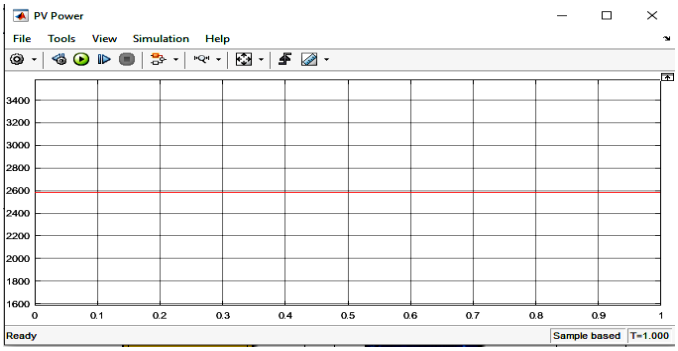


Figure 4: Performance of standalone solar water pumping system (a) PV-power vs Time (b) DC-link voltage vs time and Speed vs time

Figure 4 is showing the output performance of the PV power, motor speed and DC link voltage. Here it is clear from the waveform the PV power is 6200W, motor speed is 14250rpm and DC link voltage is 7500V.

Case-III: When PV-power decreased to 2583 W then motor output and speed reduces to 3500 rpm. The power variation of the above mentioned scenarios and the speed variation of SRM motor in accordance with the change in PV-power.



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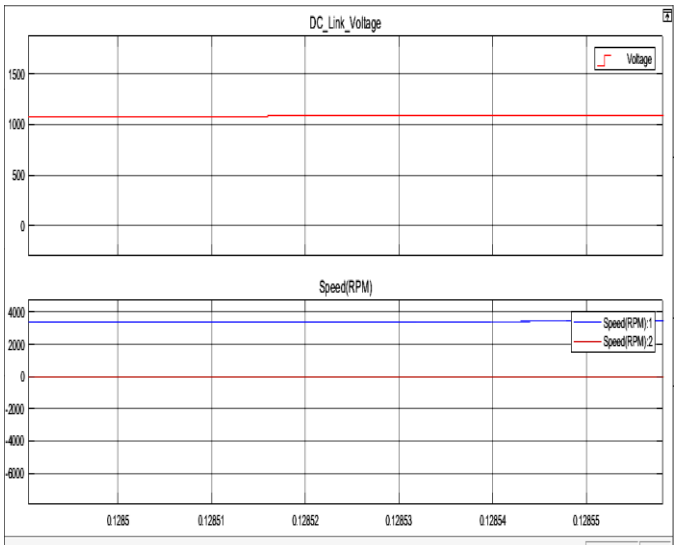
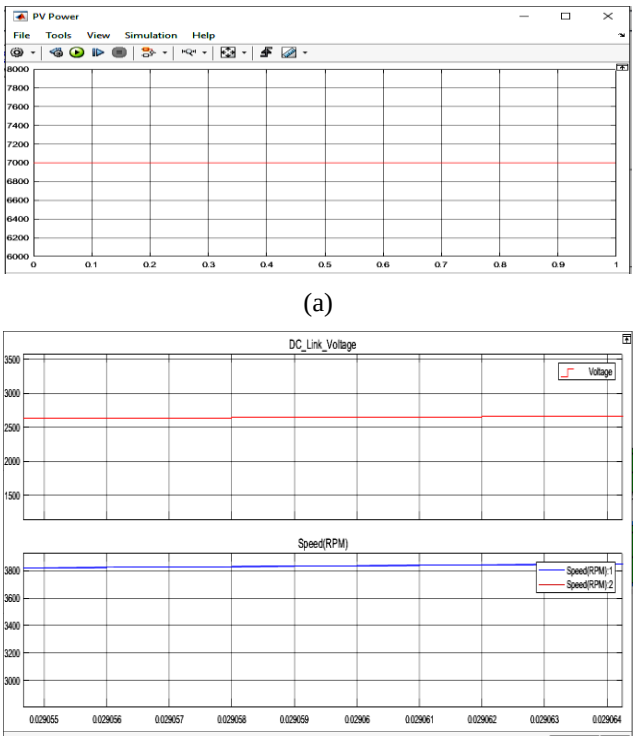


Figure 5: Performance of standalone solar water pumping system (a) PV-power vs Time (b) DC-link voltage vs time and speed vs time

Figure 5 is showing the output performance of the PV power, motor speed and DC link voltage. Here it is clear from the waveform the PV power is 2583W, motor speed is 3500rpm and DC link voltage is 1100V.

Grid-connected PV- Water Pumping System

In grid-connected system, here connected the microgrid system, the power exchange between grid and PV system is analyzed by considering PV power and rated grid power.



(a)

Figure 6: Performance of grid connected solar water pumping system (a) PV-power vs Time (b) DC-link voltage vs time and speed vs time

Figure 6 is showing the grid connected condition, the output performance of the PV power, motor speed and DC link voltage values as per the simulation waveform. Therefore the PV power is 7000W, motor speed is 3800rpm and DC link voltage is 2600V.

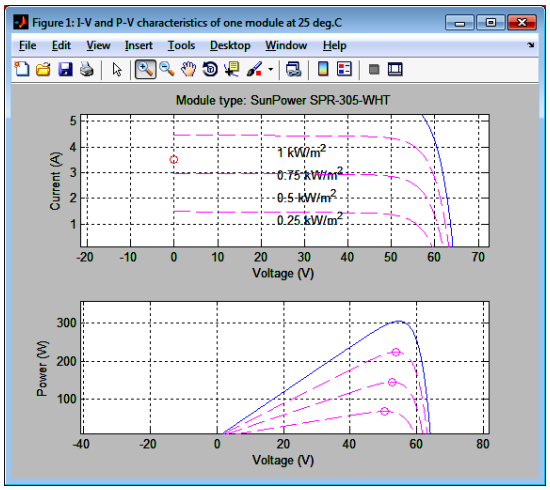


Figure 7: IV and PV waveform -1

Figure 7 is showing the IV and PV waveform. An I-V curve measurement is performed by applying a series of voltages to the device. At each voltage, the current flowing through the device is measured. The supplied voltage is measured by a voltmeter connected in parallel to the device, and the current is measured by an ammeter connected in series.

Table 1: Simulation Result when single solar panel

Sr. No	Parameter	Value
1	Sun Power	Single panel
2	Current	5A
3	Voltage	60V
4	Power	300W

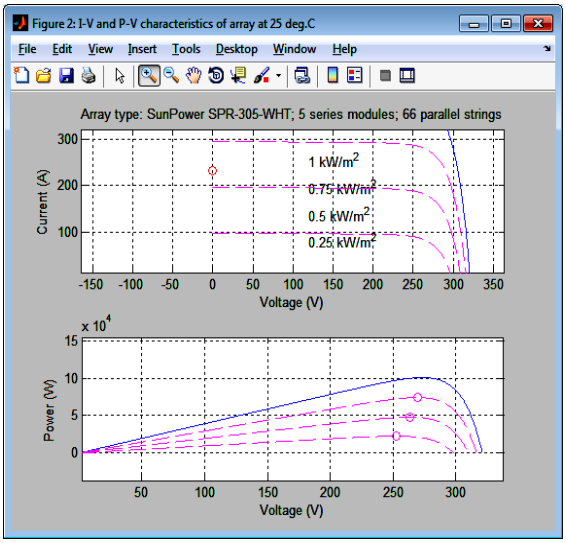


Figure 8: IV and PV waveform-2

Figure 8 is showing the solar array panel. % series modules and 66 parallel strings array type solar panel used.

Table 2: Simulation Result when array solar panel

Sr. No	Parameter	Value
1	Sun Power	Array
2	Current	300A
3	Voltage	320V
4	Power	1,00000W

Table 2 is showing the performance parameters of array solar in water pumping system. This simulation results is better than existing approaches.

Table 3: Results comparison of previous and present approach

Sr. No	Parameter	Previous Model	Present Model
1	Sun Power	Array	Array
2	Current	2.95A	5A (single), 300 (Array)
3	Voltage	310V	320V
4	Power	7000W	Upto 1,0000 W
5	Speed	3000	14500

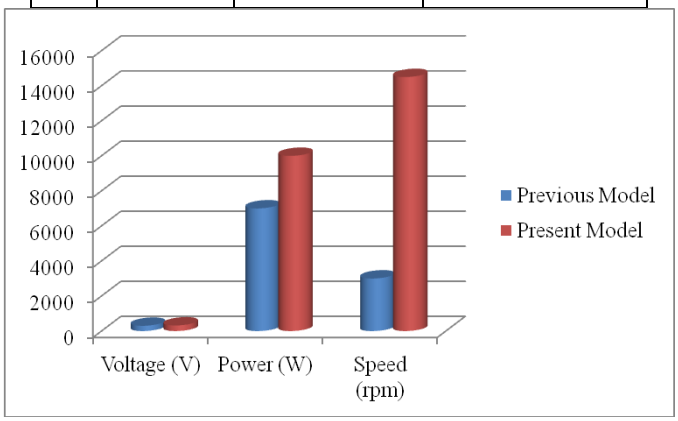


Figure 9: Result comparison

Figure 9 is showing the graphical representation of simulation results comparison. It is clear from the simulation results that the present model is giving the better results in terms of speed, voltage, current and power.

V. CONCLUSION

A Power System is the application of solid-state electronics to control and conversion of electric power. It also refers a subject of research in electronic and electrical engineering which deals with the design, control, computation and integration of nonlinear, time-varying energy-processing electronic systems with fast dynamics. The capabilities and economy of power electronics system are determined by the active devices that are available. Therefore, from the simulation results it can be say that the present model is giving the better results in terms of speed, voltage, current and power.

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