Implementation of Solar PV Array Fed BLDCMotor Driven Water Pump using Luo Converter

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Abstract- Nowadays solar energy is the best renewable energy resources when compared to the conventional energy resources. The operation of the solar powered pumps is cheaper to run, lower maintenance cost and lower operation. This project deals with the operation of the Luo (DC-DC) converter in solar PV array fed water pumping system as an intermediate DC-DC converter between the solar PV array and soft starting of BLDC motor. Among the several types of DC-DC converters, a Luo converter is selected and it is used to extract the maximum power which is available from the SPV array and BLDC motor. The intermediate Luo converter with semiconductor switches has the features of reducing ripple current in its output and provide endless region for maximum power tracking (MPPT). The positive output Luo converter performs the changes from positive input source to positive output load source. To avoid the high frequency switching losses the electronically commutated brushless DC with voltage source inverter can be operated at elementary frequency which results in higher efficiency. The various working conditions such as dynamic, starting and steady state performances has to be demonstrated and simulated by suitable simulated results using MATLAB/Simulink environment.

Keywords- Power flow control; Solar photovoltaic; Brushless DC motor; Voltage source converter; Luo converter; Voltage source inverter; Maximum power point; Power quality; Power factor; Total harmonic distortion.

I. INTRODUCTION

The continuously increasing carbon emission and diminishing of fossil fuels encourage the instant consumers to adopt the renewable energy. A solar photovoltaic (PV) generation is emerging as the best alternative of conventional sources for various appliances [1]. With reference to this, the water pumping has gained a broad attention in last few decades as a crucial application of PV energy [2-3]. The DC motors have been used initially to pump the water followed by an AC induction motor [4]. An innumerable research has been carried out on electric motor drives to improve the performance and efficiency of PV fed pumping systems with cost benefit. A permanent magnet brushless DC (BLDC) motor, due to its high efficiency, high power density, no maintenance, long service life, low electromagnetic interference (EMI) issues and small size, is being opted from last decade [5]. It has been determined that introducing this motor reduces the cost and size of PV panels in addition to improved performance and maintenance free operation [6].

Being a grid-isolated or standalone system, the existing BLDC motor driven water pumps fed by a PV array rely only on solar PV energy. Due to its intermittency, the solar PV generation exhibits its major drawbacks, which results in an unreliable water pumping system. In the course of bad climatic condition, water pumping is severely interrupted, and the system is underutilized as the pump is not operated at its full capacity. Moreover, an unavailability of sunlight (at night) leads to shutdown of the water pumping system. These shortcomings are required to be overcome in order to acquire a reliable PV based pumping system. Few attempts in this connection are found in [7-10], although not with BLDC motor drive, which deploy a battery as an energy storage. Associated with a bidirectional control, the battery is charged and discharged during full and poor solar radiation (or no radiation) respectively, thus it ensures a full water delivery continuously. Contrary to it, introducing a battery energy storage in PV based water pumping not only increases the overall cost and maintenance but also reduces its service life [11-12]. A lead acid battery which is mostly used, has a useful life of only 2-3 years [13].

The aforementioned demerits with the battery storage have turned the attention towards an alternate technological solution which may be best suited in every aspect for a reliable water pumping based on PV generation. These recently recognized technologies, in reality, interface a PV generating unit which is installed for water pumping, into a utility grid. The prime attention is to achieve an uninterrupted water pumping with its full capacity regardless of operating conditions, whether day or night. A grid connected solar water pumping system is reported in [14] wherein a power allocation system decides whether to draw power from PV array or from the utility (when PV array is insufficient to power the pump). A water pump along with a pump controller is connected at the common DC bus of PV array and grid connected inverter. No battery storage is used, a service life of the system is thus prolonged, and the maintenance and manufacturing cost are reduced. However, the developed control enables only a unidirectional power flow i.e. an excess power or an unutilized power (when pumping is not required) of PV array is not returned to the utility grid. Therefore, the PV installation is not fully utilized and a consumer must pay an electricity bill.

Such another system [13] first feeds the PV energy into the utility grid through a grid inverter and a water pump is then fed by that utility grid through a pump inverter. Although being a grid connected PV pumping system, it appears as a system operated by utility grid only. A kind of hybrid PV water pumping is presented in [15], wherein a battery is first charged by PV array through a charge controller and then it is discharged to feed the water pump via an inverter. The pump is also supported by a utility interface through an option switch. This system becomes expensive due to an added manufacturing and maintenance cost of the battery storage. A part of the PV installation is engaged in water pumping and the remaining part in feeding power to the grid in [16-17]. The system is not reliable as the pumping is dependent only on the PV energy and no power is drawn from the utility. A grid interfaced PV fed-BLDC motor driven water pumping with unidirectional power flow control is developed in [18], wherein the remaining power is drawn from the grid whenever required. The developed system fails to utilize the PV power in case the water pumping is not required.

All these aforementioned existing topologies of a PV based pumping systems present a unidirectional power flow control which either feeds the grid or draws power from the grid. A multifunctional system which may enable a bi-directional power flow depending on the operating circumstances such that both PV installation and pumping system are fully utilized, is yet to be developed. This work presents suchlike system employing first-time a BLDC motor drive. As mentioned, the proposed system deals with the development of a bi-directional power flow control, enabling the flow of power from PV array to the single phase utility grid in case a water pumping is not required, and from the grid to BLDC motor-pump in case the PV array power is not sufficient (or at night) to run the pump at its full capacity. This practice offers a source of earning to the consumers by sale of electricity to the utility. A unit vector template (UVT) generation, due to its simplicity and ability to serve the objective, is applied to perform a bi-directional power transfer. The proposed system also meets the power quality standards required by a utility grid as per IEEE-519 standard [19]. A grid interfaced PV based water pumping system, incorporating some of the aforementioned features, has been reported in [20]. A detailed design approach, control methodology, simulation analysis and hardware implementation are added here.

The MPPT (Maximum Power Point Tracking) of PV array [21-25] is achieved by an incremental conductance (InC) technique using a DC-DC LUO converter. The magnitude of stator current of BLDC motor at starting is controlled by operating the VSI (Voltage Source Inverter) in PWM (Pulse Width Modulation) mode for a pre-defined duration. However, once the motor is started, the VSI is operated with the pulses of fundamental frequency resulting in a minimized switching loss and an enhanced conversion efficiency. Moreover, no phase current sensor is used for BLDC motor control which leads to an increased cost benefit. The grid interactive PV based water pumping system using a BLDC motor drive is designed, modelled and simulated in MATLAB/Simulink platform, and its performances are evaluated through simulated results followed by hardware implementation to demonstrate the claims. The main contributions of this work are as follows:

- The BLDC motor-driven-solar water pumping system is interfaced to the utility grid in order to develop a reliable water pumping.
- A bidirectional power flow control is proposed, which leads to full volume of water delivery, continuously, regardless of the weather condition.
- The proposed system is controlled such that the power generated by the PV array is transferred to the utility grid in case the water pumping is not required. This feature offers a full utilization of the installed resources. Moreover, the system emerges as a source of income by sale of electricity to the utility.
- The proposed water pumping system is designed and controlled such that it also continues to deliver the water in case of grid failure. The volume of water delivery then depends on the available solar radiation.
- The three phase VSI, feeding the BLDC motor is switched at fundamental frequency. This results in a considerable reduction in the switching loss associated with the said VSI.
- Power quality standards at the grid are maintained as the IEEE-519 standard regardless of the direction of power flow (during both feeding and drawing of the power).

II. CONFIGURATION OF PROPOSED SYSTEM

A configuration of the proposed water pumping system is presented in Fig. 1, wherein a BLDC motor runs a water pump. A PV array feeds a BLDC motor-pump via a boost converter and VSI. The boost converter performs MPPT of PV array through InC algorithm while the VSI performs an electronic commutation of BLDC motor [5, 26]. An inbuilt encoder generates three Hall-Effect signals to carry out an electronic commutation. The DC bus of VSI is supported by a single-phase utility grid. A voltage source converter (VSC) enables a bi-directional power transfer through a DC bus capacitor. The PV array feeds the grid only when a water pumping is not required otherwise it is a preferred objective. An interfacing inductor is placed in the line to allow power flow between the grid and VSC, and to limit the harmonics current into the supply. A RC ripple filter is provided to limit the harmonics on supply voltage. An integrated mathematical modelling of the overall system is given in Appendices.

III. SPEED CONTROL OF BLDC MOTOR

As discussed before, the proposed BLDC motor drive eliminates the phase current sensors. It is desired to operate the BLDC motor-pump at its rated speed irrespective of the climatic condition. This is achieved by continuously regulating the DC bus voltage of VSI at the rated DC voltage of BLDC motor. A bi-directional power flow control enables, by regulating the DC bus voltage and hence the operating speed, to deliver a full amount of power required to pump the water with full capacity. In case the grid is not available, the DC bus voltage is not maintained at the rated DC voltage of BLDC motor under bad climatic conditions, and the speed is governed by a variable DC bus voltage

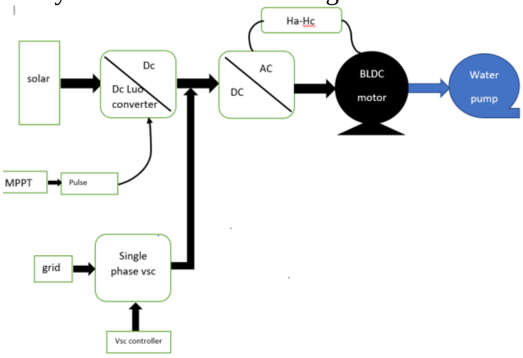


Fig.1: grid interactive PV array-based water pumping system using a BLDC motordrive

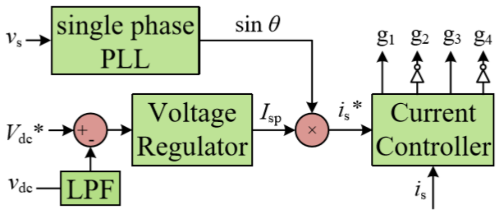


Fig.2: UVT based bi-directional power flow control of VSC

IV. BI-DIRECTIONAL POWER FLOW CONTROL

The development of a reliable water pumping system and full utilization of the resources are realized by a grid interactive PV generation. To allow the flow of power in either direction, a bi-directional power control based on a UVT generation [20, 27-28] is applied as shown in Fig. 2. This is the simplest technique and is easy to implement as it does not require any complex mathematical model or algorithm. A single phase PLL (Phase Locked Loop) is used to synchronize the utility grid voltage and current. It generates a sinusoidal unit vector of supply voltage, sin θ at fundamental frequency. On the other hand, an amplitude of fundamental component of supply current, I_{sp} is extracted by regulating the DC bus voltage, v_{dc}. A proportional-integral (PI) controller is used as a voltage regulator. v_{dc} is sensed and passed through a first-order low pass filter to suppress the ripple contents. The filtered v_{dc} is then compared with a set value, V_{dc}^*. A fundamental component of supply current, i_s^* is extracted by multiplying I_{sp} and sin θ. The sensed supply current, $i_s$is compared with i_s^* and error is processed through a current controller to generate the gating pulses for VSC.

When it is required to draw power from utility, the voltage regulator generates a positive I_{sp}. Therefore, an in-phase supply current is drawn from the grid. Likewise, when the utility is fed by PV array, a negative I_{sp} is generated resulting in an out-of-phase supply current. Thus, by reversing the direction of current, direction of power flow is controlled as per the requirement. An improved power quality at the utility grid is also ensured by the applied control technique in terms of totalharmonic distortion (THD) and power factor. In case the grid is not available, the DC bus voltage cannot be regulated. Nevertheless, the PV array is able to feed the water pump in standalone mode although being sensitive to the climatic condition. The detailed analysis of proposed bidirectional power flow control is given in Appendices.

V. SYSTEM DESIGN

Various operating stages associated with the configuration shown in Fig. 1 viz. PV array, boost converter, single phase grid, single phase VSC, three phase VSI and BLDC motor, are selected properly in order to get a good performance with their optimum design. The design approaches of these components are given in this section.

A. Design of PV Array

A 1.5 kWp-PV array is designed for a 1.3 kW-BLDC motor-pump. The power losses associated with the converters and the motor-pump are taken into account. The parameters are estimated at the standard test condition (1000 W/m2, 25°C, AM 1.5). A PV module-BMU/214 with an MPP voltage of 28.5 V and an MPP current of 7.5 A (complete specifications are given in Appendices) [29] is chosen to design a PV array of required capacity. First, the voltage of PV array, at MPP, is selected in view of the DC voltage rating of BLDC motor i.e. the DC bus voltage of VSI. It is selected as Vmpp = vpv = 200 V, and the remaining parameters are accordingly calculated as, The current at peak power point,

$$I_{mpp} = i_{pv} = \frac{p_{pv}}{v_{pv}} = 1500/200 = 7.5 \text{ A}$$

where ppv = Pmpp = 1500 W is the power of PV array at MPP.

Series modules are as,

$$N_s = \frac{V_{mpp}}{V_m} = 200/28.5 = 7$$

Parallel modules are as,

$$N_p = \frac{I_{mpp}}{I_m} = 7.5/7.5 = 1$$

where Vm and Im are MPP-voltage and MPP-current of a module. According to (2) and (3), seven modules are connected in series to design a PV array of required size.

B. Design of Boost Converter

The design of a boost converter consists of an estimation of input inductor, L. It is selected in a manner to operate the converter in CCM, irrespective of the weather condition. The duty ratio, D1 is estimated as [30],

$$D_1 = \frac{V_{dc} - v_{pv}}{V_{dc}} = \frac{270 - 200}{270} = 0.25$$

where Vdc = 270 V is the DC bus voltage of the VSI. The inductor,

L is estimated as,

$$L = \frac{D_1 v_{pv}}{f_{sw}\Delta I_L} = \frac{0.25\times 200}{10000\times(7.5\times 0.2)} = 3.3\ \text{mH}$$

where fsw is the switching frequency of boost converter; ΔIL is ripple in the current through L,

IL (= Impp).

C. *Design of Three Phase VSI*

A three phase VSI is used to feed the BLDC motor. Its design consists of an estimation of voltage, current and VA ratings. As the DC bus voltage is 270 V, the required voltage rating of an IGBT switch is calculated as,

$$V_{VSI} = V_{dc}\times 1.4 = 270\times 1.4 = 378 \approx 400\ \text{V}$$

A voltage safety factor of 1.4 is selected to accommodate the switching transients. Similarly, the required current rating of an IGBT switch is calculated as,

where 1.3 is a current safety factor.

Finally, the required VA rating of VSI is estimated as,
$VA_{VSI} = V_{VSI} \times I_{VSI} = 400\times 7.5 = 3$ kVA

D. *Design of Single Phase VSC*

A single-phase VSC is used to control a bidirectional power flow. In a single-phase VSC, the blocking voltage of switching devices is equal to the DC link voltage. As the DC link voltage is 270 V, the switches have to block this voltage. A safety factor of 1.4 is selected to accommodate the voltage transients due to a high frequency switching. Therefore, the voltage rating of the IGBT devices are estimated as

VVSC = Vdc×1.4 = 270×1.4 = 378 ≈ 400 V

The VSC has a maximum current drawn from the grid or to be fed to the grid. The said current is estimated

$$I_{s,\max} = \sqrt{2}\frac{P_{mpp}}{V_s} = \sqrt{2}\frac{1500}{180} = 11.78\ \text{A}$$

where Vs = 180 V is rms value of the utility grid voltage. Thus, the maximum current rating of IGBT devices is 11.78 A. Considering a safety factor of 1.3,

the current rating is estimated as,

IVSC = Is, max × 1.3 = 11.78 × 1.3 = 15.3 ≈ 15 A

Finally, the required VA rating of VSC is estimated as,

VAVSC = VVSC × IVSC = 400×15 = 6 kVA

E. *Design of Common DC Link Capacitor*

The DC link capacitor, C is common to the boost converter, three phase VSI and single phase VSC. It is tuned for the second harmonic component of single-phase grid voltage, which is appeared on the DC bus of a single phase VSC. Thus, the capacitor, C is estimated as [31]

$$C = \frac{I_{dc}}{2\omega_L \Delta V_{dc}} = \frac{1500/270}{2\times(2\pi\times 50)\times(270\times 0.008)} = 4700\ \mu\text{F}$$

where Idc is an average current flowing through the DC bus, ωL is the line frequency in rad/s, and ΔVdc is ripple in the DC bus voltage.

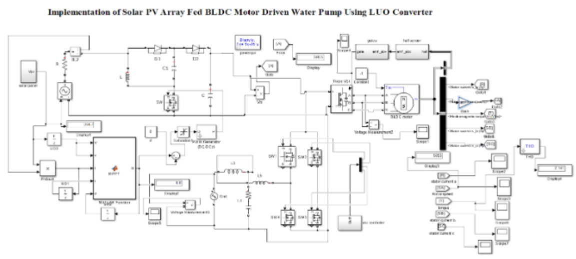
F. *Design of Interfacing Inductor*

The selection of an interfacing inductor, Lf depends on the permitted current ripple ΔIVSC. It is estimated as,

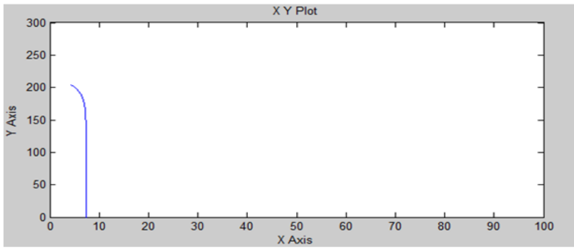
$$L_f = \frac{mV_{dc}}{4af_{SW}\Delta I_{VSC}} = \frac{1\times 270}{4\times 1.2\times 10000\times(1500/180)\times 0.2} = 3.3\ \text{mH}$$

where modulation index, m =1, over loading factor, a =1.2, switching frequency, fSW = 10 kHz, current ripple, ΔIVSC = 20% of IVSC.

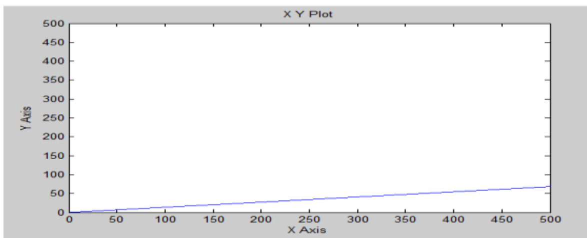
VI. SIMULATION RESULTS



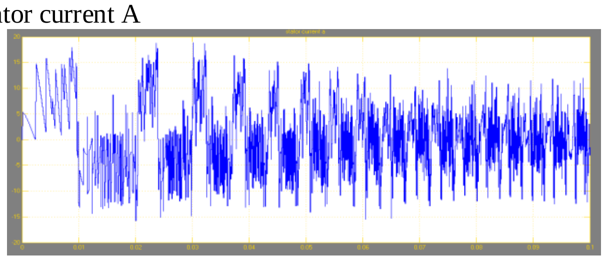
Solar IV characterises



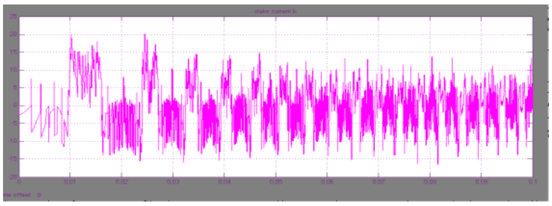
Solar PV characterises



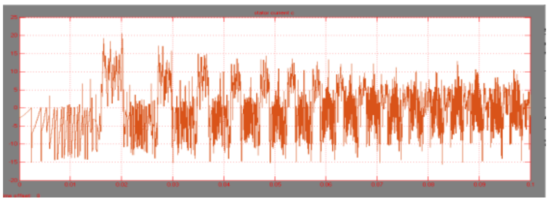
Stator current A



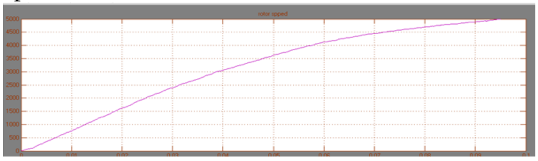
Stator current B



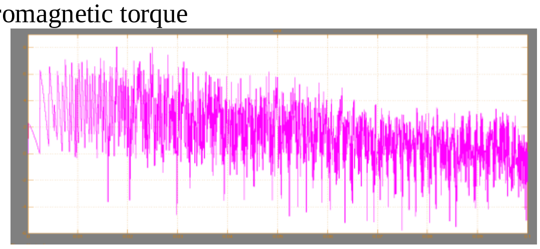
Stator current C



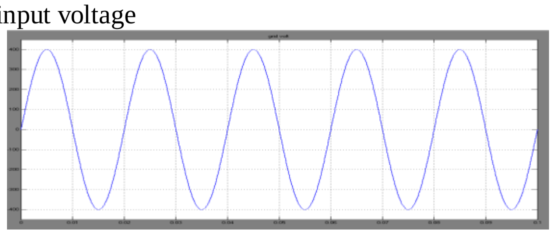
Rotor speed



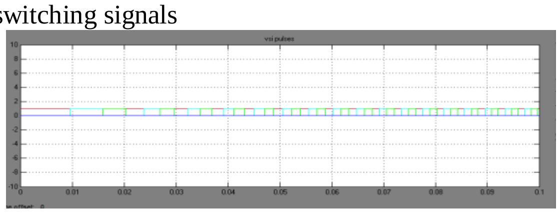
Electromagnetic torque



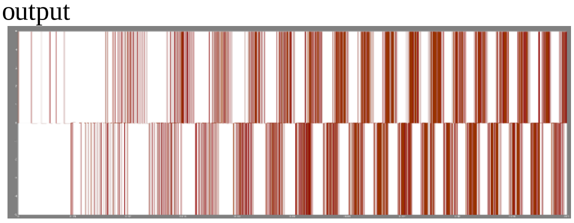
Grid input voltage



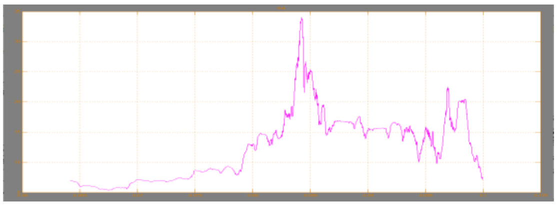
VSI switching signals



VSI output



THD 7.141



VII. CONCLUSION

A single part grid interactive PV array based mostly water pumping system employing a BLDC motor drive has been projected and incontestable. A bidirectional power flow management of resource and water pumping with most capability in spite of the climate. a straightforward UVT generation technique hasbeen applied to regulate the ability flow as desired. All the ability quality aspects are met asper the IEEE-519 normal.

The speed management of BLDC motor-pump has beenachieved with none current sensing parts. A harmonic change of VSI has contributed toreinforce the potency of overall system by reducing the change losses.

The projected resolution has emerged as a reliable water pumping system, and as a supply ofearning by sale of electricity to the utility once water pumping isn't needed by using the LUOconverter in this project the conversion of power is high with less switching losses hightorque pulsation, less harmonic distortion.

VIII. REFERENCE

[1]. M. T. A. Khan, G. Norris, R. Chattopadhyay, I. Husain and S. Bhattacharya, “Autoinspection and permitting With a PV Utility Interface (PUI) for Residential Plug-and-Play Solar Photovoltaic Unit,”IEEE Trans. Ind. Appl., vol. 53, no. 2, pp. 1337-1346, March-April 2017.

[2]. M.Montorfano, D. Sbarbaro and L. Morán, “Economic and Technical Evaluation of Solar-Assisted Water Pump Stations for Mining Applications: A Case of Study,” IEEE Trans. Ind. Appl., vol. 52, no. 5, pp. 4454-4459, Sept.-Oct. 2016.

[3]. BillelTalbi, FatehKrim, ToufikRekioua, SaadMekhilef, AbdelbasetLaib and AbdesslamBelaout, “A high-performance control scheme for photovoltaic pumping system under sudden irradiance and load changes,” Solar Energy, vol. 159, pp. 353-368, 2018.

[4]. PackiamPeriasamy, N.K. Jain and I.P. Singh, “A review on development of photovoltaic water pumping system,” Renewable and Sustainable Energy Reviews, vol. 43, pp. 918-925, March 2015.

[5]. R. Kumar and B. Singh, “BLDC Motor Driven Solar PV Array Fed Water Pumping System Employing Zeta Converter,” IEEE Trans. Ind. Appl., vol. 52, no. 3, pp. 2315-2322, May-June 2016.

[6]. Bhim Singh and Rajan Kumar, “Solar PV Array Fed Water Pump Driven By BLDC Motor Using Landsman Converter,” IET Renewable Power Generation, vol. 10, no. 4, pp. 474-484, April 2016.

[7]. K. Rahrah, D. Rekioua, T. Rekioua and S. Bacha, “Photovoltaic pumping system in Bejaia climate with battery storage,” International Journal of Hydrogen Energy, vol. 40, no. 39, pp. 13665-13675, 19 October 2015.

[8]. AblaKhiareddine, Chokri Ben Salah and Mohamed FaouziMimouni, “Power management of a photovoltaic/battery pumping system in agricultural experiment station,” Solar Energy, vol. 112, pp. 319-338, February 2015.

[9]. Sara GhaemSigarchian, Anders Malmquist and TorstenFransson, “Modeling and Control Strategy of a Hybrid PV/Wind/Engine/Battery System to Provide Electricity and Drinkable Water for Remote Applications,” Energy Procedia, vol. 57, pp. 1401-1410, 2014.

[10]. A. Khiareddine, C. Ben Salah and M. F. Mimouni, “Strategy of energy control in PVP/battery water pumping system,” International Conference on Green Energy, Sfax, 2014, pp. 49-54.

[11]. J. H. Ugale and M. S. Panse, “Single phase AC drive for isolated solar photovoltaic water pumping system,” International Conference on Green Computing and Internet of Things (ICGCIoT), Noida, 2015, pp. 1285-1287.

[12]. A. Boussaibo, M. Kamta, J. Kayem, D. Toader, S. Haragus and A. Maghet, “Characterization of photovoltaic pumping system model without battery storage by MATLAB/Simulink,” 9th International Symposium on Advanced Topics in Electrical Engineering (ATEE), Bucharest, 2015, pp. 774-780.

[13]. Zhao Yan, “Photovoltaic Pumping System Using Power Grid as Energy Storage Device,” Chinese Patent CN 202455296 U, Sept. 26, 2012.

[14]. Huang, “Photovoltaic Water Pumping and Residual Electricity GridConnected System,” Chinese Patent CN 204131142 U, Jan. 28, 2015.

[15]. Wang Xing, “High-Efficiency Photovoltaic Pump System,” Chinese Patent CN 203884338 U, Octo. 22, 2014.

[16]. Chen steel, Ai Fang, Sun Weilong, Guo Jing and Zhao Xiong, “Photovoltaic Agricultural Power Generating Unit,” Chinese Patent CN 203859717 U, Octo. 1, 2014.

[17]. Li Tong qiang, “Solar Power Station with Water Pumping and Energy Storage,” Chinese Patent CN 103595337 A, Feb. 19, 2014.

[18]. R. Kumar and B. Singh, “Grid interfaced solar PV based water pumping using brushless DC motor drive,” IEEE International Conference on Power Electronics, Drives and Energy Systems (PEDES), Trivandrum, 2016, pp. 1-6.

[19]. IEEE Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems, IEEE Standard 519, 1992.

[20]. R. Kumar and B. Singh, “Grid interactive solar PV based water pumping using BLDC motor drive,” IEEE 7th Power India International Conference (PIICON), Bikaner, Rajasthan, India, 2016, pp. 1-6.

[21]. A. El Khateb, N. A. Rahim, J. Selvaraj and M. N. Uddin, “Fuzzy-LogicController-Based SEPIC Converter for Maximum Power Point Tracking,” IEEE Trans. Ind. Appl., vol. 50, no. 4, pp. 2349-2358, JulyAug. 2014.

[22]. M. Metry, M. B. Shadmand, R. S. Balog and H. Abu-Rub, “MPPT of Photovoltaic Systems Using Sensorless Current-Based Model Predictive Control,” IEEE Trans. Ind. Appl., vol. 53, no. 2, pp. 1157-1167, March April 2017.

[23]. M. A. Legend, D. J. Atkinson and B. Zahawi, “Experimental investigation of the incremental conductance maximum power point tracking algorithm at high perturbation rates,” IET Renewable Power Generation, vol. 10, no. 2, pp. 133-139, Feb. 2016.

[24]. A. Thangavelu, S. Vairakannu and D. Parvathyshankar, “Linear open circuit voltage-variable step-size-incremental conductance strategy based hybrid MPPT controller for remote power applications,” IET Power Electron., vol. 10, no. 11, pp. 1363-1376, Sept. 2017.

[25]. X. Li, H. Wen, L. Jiang, W. Xiao, Y. Du and C. Zhao, “An Improved MPPT Method for PV System With Fast-Converging Speed and Zero Oscillation,” IEEE Trans. Ind. Appl., vol. 52, no. 6, pp. 5051-5064, Nov.-Dec. 2016.

[26]. V. Bist and B. Singh, “Reduced sensor configuration of a power factor correction based single-ended primary inductance converter fed brushless DC motor drive,” IET Power Electronics, vol. 8, no. 9, pp. 1606-1615, Sept. 2015.

[27]. N. Patnaik and A. K. Panda, “Comparative analysis on a shunt active power filter with different control strategies for composite loads,” IEEE Region 10 Conference, Bangkok, 2014.

[28]. S. Premalatha, SubhransuSekhar Dash and Paduchuri Chandra Babu, “Power Quality Improvement Features for a Distributed Generation System using Shunt Active Power Filter,” Procedia Engineering, vol. 64, pp. 265-274, 2013.

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