ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

Modelling and Simulation of Solar and Wind Energy Input DC-DC Boost Converter Based BLDC Motor Drive for Water Pumping System

V. M. Periyasamy[1], Dr. R. Shivakumar[2], P. Selvakumar[3]

Research Scholar, AP/EEE, Sona College of Technology, Salem, Tamilnadu, Email: swamymp@gmail.com [1]

Professor/EEE, Sona College of Technology, Salem, Tamilnadu, *Email:* mukil2005@gmail.com[2]

AP/EEE, Sona College of Technology, Salem, Tamilnadu, *Email:* pselvakumar11@gmail.com [3]

Abstract: This Paper presents a new three-input DC - DC boost converter for hybrid power system. The DC - DC boost converter is hybridized with renewable energy sources such as photovoltaic source, wind sources. The proposed method can be applied to BLDC Motor drive for water pumping system and many alternative applications where there is an excessive power demand. The converter is interfaced with unidirectional ports for the input power sources, a bidirectional port for a storage element, and an output port for load. The converter is current-source type at the both input power ports and is able to step up the input voltages. The proposed systems has the merits of including bidirectional power flow at the storage port, simple structure, low-power components, centralized control, eliminating the need of transformer, low weight, high-stability working point, independent operation of input power sources, and high level of boosting. The validity of the proposed converter and its control performance are verified by simulation result in MATLAB/SIMLINK for different load condition.

Keywords: BLDC Motor, DC – DC boost converter, photovoltaic source, wind sources, MATLAB/Simulation software.

I. Introduction

The photovoltaic (PV) energy appears quite attractive for electricity generation because of its noiseless, pollution-free, scale flexibility and little maintenance. Because of the PV power generation dependence on sun irradiation level, ambient temperature and unpredictable shadows, a PV-based power system should be supplemented by other alternative energy sources to ensure a reliable power supply. Wind energy is also another supplementary power sources due to their merits of cleanness, high efficiency and high reliability [1-2]. Batteries are usually taken as storage mechanisms for smoothing output power, improving start up transitions, dynamic characteristics and enhancing the peak power capacity [3-4]. Combining such energy sources introduces a PV/WIND/battery hybrid power system. Brushless DC motors (BLDC) are considered as high performance motors due to their high reliability, versatility, adequate torque and speed and low maintenance cost. BLDC a preferred solution in not just automotive fuel pumps but also in a broad range of applications using adjustable speed motors [5].

II. Block Diagram of Proposed System

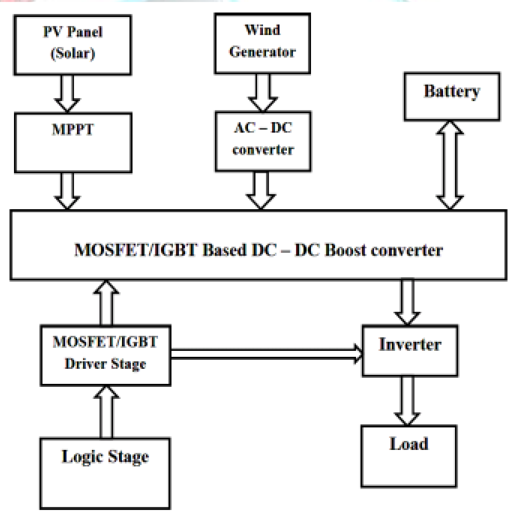

Figure 1. Block Diagram of Hybrid DC- DC boost converter system

The figure 1 shows the block diagram consists of two Input stage for solar, wind and bidirectional storage battery,

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

multi input DC- DC boost converter, MOSFET /IGBT driver stage, logic stage, inverter and load. The solar panel acts as one of source to the DC-DC converter. The DC output from the solar panel is given at one port of the integrated four port DC-DC converter. By switching ON and OFF the power devices the DC input is transferred to the inverter.

III. OPERATION OF PROPOSED SYSTEM

The solar power from the solar panel influenced by the sun light supply DC power to the four port DC-DC converter. The Wind power from the wind mill influenced by the wind supply AC power which is converted into DC supply using a rectifier, this is supplied to the DC-DC converter. The bi-directional storage port battery is used to supply power as well as act as storage and save excess power. The power switches are turned ON and OFF depending on the switching sequence developed under different source conditions with different independent duty ratios and the output DC boosts up the input and the boosted up voltage is supplied to the inverter. The inverter inverts the supplied DC power to BLDC Motor water pumping system.

IV. BLDC MOTOR AND CONTROLS

The easiest way to control a BLDC motor is called block commutation also known as six-step or trapezoidal drive. It is easy to implement on many logic gates, especially when the motor has Hall sensors. In this case, every slope on a Hall sensor signal triggers the next commutation [7]. Block commutation is often used in simple applications with moderate demands on dynamic behavior and acceptable torque ripple / noise. However, it is possible to optimize the motor construction for trapezoidal drive, reducing the noise and torque ripple. Setting up a three-phase PWM for block commutation is quite simple and does not necessarily need special waveform generator functions. [10] presented an Elaborate Study On Electronic Devices & Circuits to acquaint the students with the construction, theory and operation of the basic electronic devices such as PN junction diode, Bipolar and Field effect Transistors, Power control devices, LED, LCD and other Opto-electronic devices.

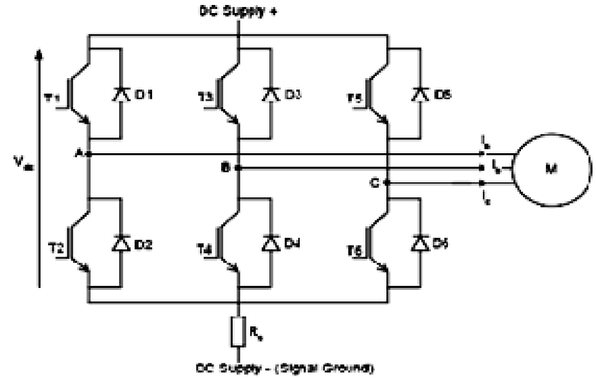

Figure 2. Control electronics for three phase BLDC motor drive system

V. SPEED TORQUE CHARACTERISTICS OF CENTRIFUGAL AND RECIPROCATING PUMPS

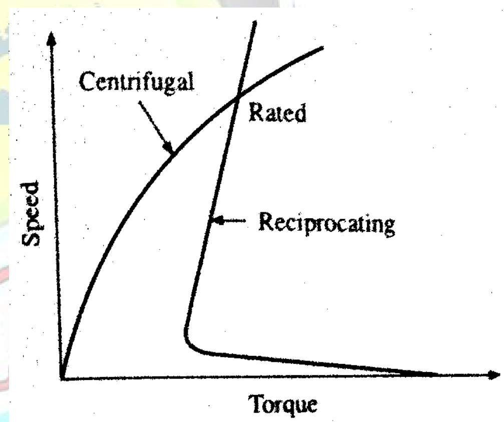

Figure 3. The speed torque characteristics of centrifugal and reciprocating pumps.

The centrifugal pumps and reciprocating pumps are the two types of water pumps. The centrifugal pump requires only a small starting torque and Reciprocating pump owing to stiction may require as much as three times the rated torque. Centrifugal pump output power is cube of speed and the output power reduces to half at a speed of 80%. Reciprocating pump with reduction in speed the torque reduces only by a small amount, the percentage reduction in output power is slightly more than the percentage of reduction in speed. This types of pumps are used in solar powered by permanent magnet dc motor or BLDC motor drive system.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

VI. SIMULATION MODEL OF PROPOSED SYSTEM

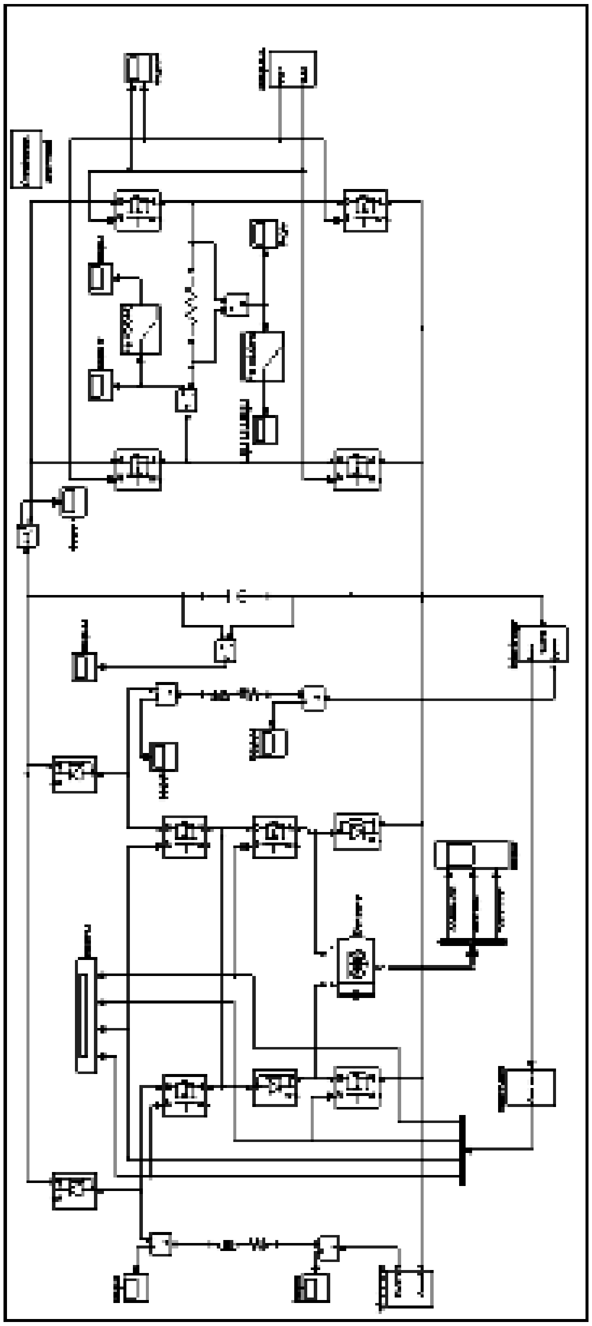

Figure 4. The Simulation circuit model of DC to DC hybrid system

The simulation circuit shows the overall DC to DC boost converter system, which controls the output of wind and solar energy and also charging and discharging of the storage element. This can be used for residential and commercial applications to meet the electricity demand.

The converter circuit consists of four power MOSFET switch and Four Power Diodes which operates under different duty ratios independently under three different modes depending on the input connected. The output remains constant even if the wind speed changes and constant output is obtained. The simulation model of DC to DC boost converter based hybrid system is shown in figure 4.

VII. SIMULATION MODEL OF WIND ENERGY SYSTEM

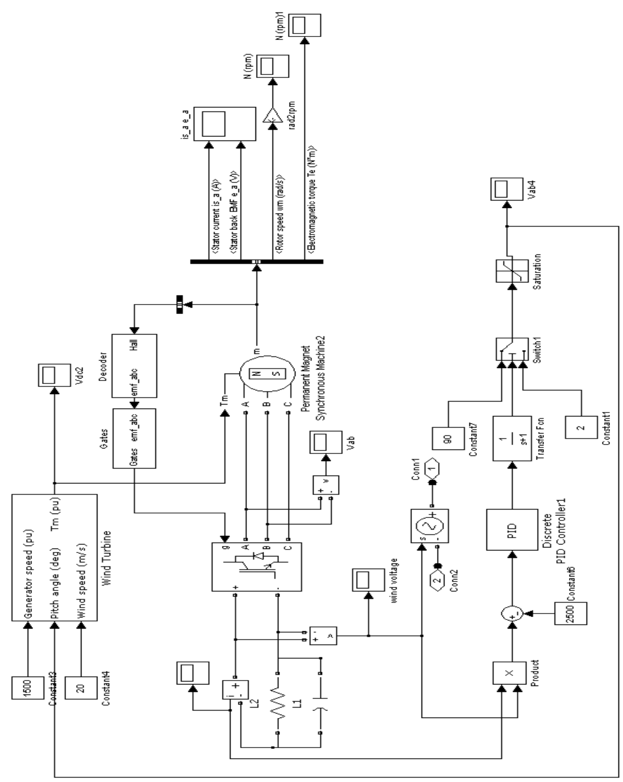

Figure 5. The Simulation circuit model of wind energy system

The simulation circuit shows the wind energy system which forms one of the inputs to the converter. The permanent magnet synchronous generator used in this wind

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

energy system for generating the output voltage. The figure 5 shows the simulation circuit model of wind energy system.

VIII. SIMULATION MODEL OF SOLAR ENERGY SYSTEM

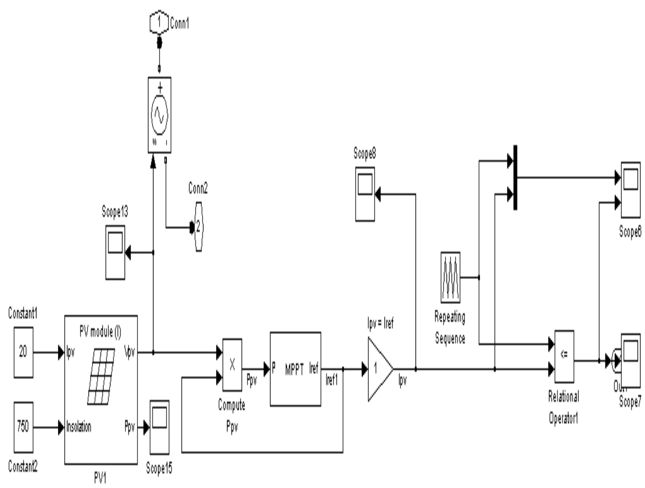

Figure 6. The Simulation circuit model of solar energy system

The figure 6 shows the simulation circuit for the solar energy system which forms one of the inputs to the converter. In this circuit MPPT converter is used to give the maximum power to the boost converter and the boosted power is stored in the storage element.

IX. EXPERIMETAL TEST RESULTS AND VERIFICATION

The experimental test results of output voltage and output current of BLDC motor is shown in the graphs.

A. TEST RESULTS FOR OUTPUT VOLTAGE

The figure 7 shown the output voltage of the BLDC motor drive system for the proposed hybrid system is verified by the MATLAB simulation software.

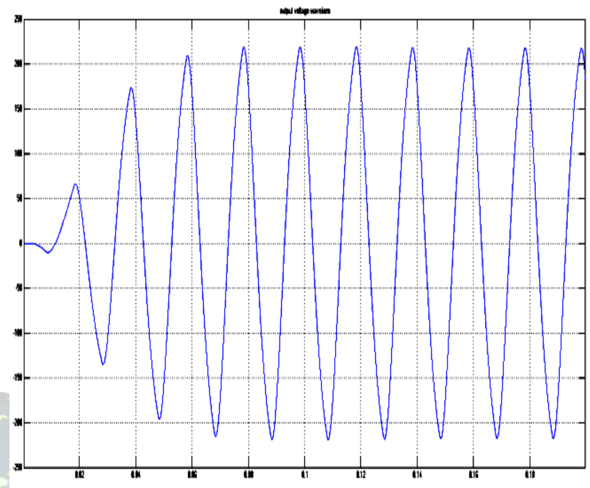

Figure 7. The Simulation results of an output voltage of BLDC motor connected system

B.TEST RESULT FOR OUTPUT CURRENT

The figure 8 shown the output current of the BLDC motor drive system for the proposed hybrid system is verified by the MATLAB simulation software.

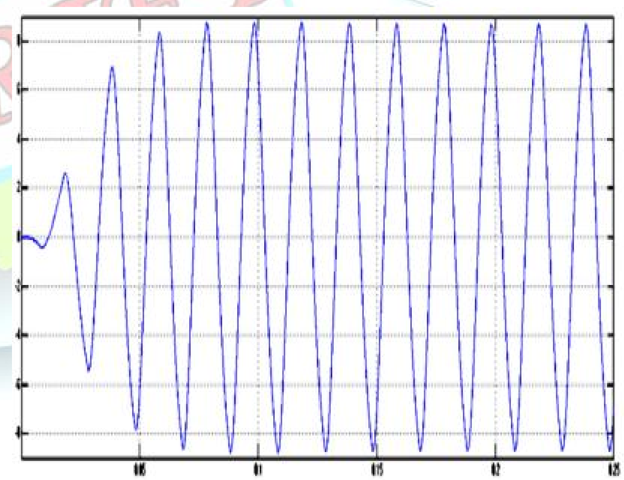

Figure 8. The Simulation results of an output voltage of BLDC motor connected system

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

X. CONCLUSION

The multi input DC-DC boost converter is most efficient with renewable energy resources to meet the present prevailing energy demand. The output of wind and solar given to DC – DC boost converter improves the quality of output obtained and also eliminates the requirement of filter and transformer section. Another advantage of this project is that if any input source is removed off the system can operate as a stand-alone system providing a continuous output.

This system will be more suitable to meet the energy demand in water pumping, residential and industrial sectors. The size of the wind turbine can be increased for higher power production. Similarly the MPPT can also be changed for maximum power. With Suitable improvement in wind energy generation and solar power generation the output power can be directly connected with the grid to meet the energy demand. By also suitable improvement in the hardware design can also lead to improved efficiency.

REFERENCES

[1] Chuang Y. C. and Ke. Y. L., "High- efficiency and low-stress ZVT-PWM DC-to-DC converter for battery charger," IEEE Transactions, Aug.2008.
[2] Chen Y. M., Liu Y. Ch., Hung S. C., and Cheng C. S., "Multi-input inverter for grid-connected hybrid PV/Wind power system," IEEE Transactions, May 2007.
[3] Chen Y. M., Liu. Y. Ch. and Wu. F. Y., "Multi-input DC/DC converter based on the multi winding transformer for renewable energy applications," IEEE Transaction, Jul./Aug. 2002.
[4] Duarte .J. L, Hendrix. M, and Simoes. M. G, "Three-port bidirectional converter for hybrid fuel cell systems," IEEE Transactions, Mar. 2007.
[5] Jianwen Shao, DennisNolan, Maxime Teissier and David Swanson., "A Novel Microcontroller-Based Sensorless Brushless DC (BLDC) Motor Drive for Automotive Fuel Pumps, IEEE Transactions, Nov/Dec.2003.
[6] Gopinath. R., Kim. S., Hahn, J. H., Enjeti. P. N., Yeary M. B., and Howze, J. W., "Development of a low cost fuel cell inverter system with DSP control," IEEE Transactions, Sep. 2004.
[7] M. Periyasamy and S. Vijay Shankar., "Development of six sequence commutation and drive electronics for three phase Brushless DC Motor., National conference at *Muthaiyammal Engineering College,2008.*
[8] Huang X., Wang. X., Nergaard. T., Lai. J. S., Xu. X., and Zhu L., "Parasitic ringing and design issues of digitally controlled high power interleaved boost converters," Sep. 2004.
[9] Jiang.W and Fahimi.b, "Active current sharing and source management in fuel cell-battery hybrid power system," Feb. 2010.
[10]Christo Ananth, P.Avirajamanjula, C.K.Sundarabalan, J.Sanjeevikumar. "An Elaborate Study On ELECTRONIC DEVICES", ACES Publishers, Tirunelveli, India, ISBN: 978-81-910-749-0-1, Volume 4,September 2017, pp:1-300.
[11]Liu. Y. Ch. and Chen. Y.M., "A systematic approach to synthesizing multi input DC–DC converters," Jan. 2009.
[12]Kwasinski A., "Identification of feasible topologies for multiple-input DC–DC converters," Mar. 2010.
[13]Krishnaswami. H and Mohan. N., "Three-port series-resonant DC–DC converter to nterface renewable energy sources with bidirectional load and energy storage ports," Mar. 2009.
[14]Matsuo H, Lin.W, Kurokawa. F, Shigemizu.T, and Watanabe. N, "Characteristics of the multiple-input DC–DC converter," Jun. 2004.
[15]Onara. O. C., Uzunoglu. M, and Alam. M. S., "Modeling, control and simulation of an autonomous wind turbine/photovoltaic/fuel cell/ultra capacitor hybrid power system," J, IEEE transactions, .Apr. 2008.
[16]Peng F. Z., H. Li, G. J. Su, and Lawler J. S., "A new ZVS bidirectional dc–dc converter for fuel cell and battery application," IEEE Transactions, Jan. 2004.
[17]Rajashekara.K, "Hybrid fuel-cell strategies for clean power generation," IEEE Transactions, May/Jun. 2005.
[18] Reddy. K. N. and Agrawal. V., "Utility-interactive hybrid distributed generation scheme with compensation featureSep. IEEE transactions, 2007.
[19]Sarhangzadeh M., Hosseini S. H., Sharifian M. B. B., and Gharehpetian G. B. "Multi-input direct DC–AC converter with high frequency link for clean power generation systems," IEEE transactions, Jun. 2011.
[20]Yan L., Xinbo R., Dongsheng Y., Fuxin L. "Synthesis of multiple-input DC/DC converters," IEEE transactions, Sep. 2010.

ISSN 2394-3777 (Print)
ISSN 2394-3785 (Online)
Available online at www.ijartet.com
International Journal of Advanced Research Trends in Engineering and Technology (IJARTET)
Vol. 4, Issue 9, September 2017

BIOGRAPHY

V. M. Periyasamy[1] has obtained his B.E degree in Electrical and Electronics Engineering from Sona College of Technology under Periyar University, Salem in the year 2003 and completed his M.E degree in Power electronics and Drives from Sona College of Technology under Anna University, Chennai in the year 2008 and pursuing Ph.D., in special machines and drives from Anna University, Chennai. He is currently working as Assistant Professor in Electrical Department and R & D activities at SonaSPEED research lab in Sona College of Technology, Salem, Tamilnadu, India. His area of interest includes Power Electronics, Special power electronic controls and drives, Control system and Special electrical machines.

Dr. R. Shivakumar[2] has obtained his B.E degree in Electrical and Electronics Engineering from Shanmugha College of Engineering, Tanjore, under Bharadhidasan University in the year of 1997, M.E degree in Power system engineering from Annamalai University, Chidambaram in the year of 1998, and completed Ph. D in Electrical Engineering, Anna University, Chennai, in the year of 2012. He is currently working as Professor in Electrical Department in Sona College of Technology, Salem, Tamilnadu, His area of interest includes Power System Stability and Control, Renewable energy conversion systems, Bio Inspired Optimization algorithms.

P.Selvakumar[2] has obtained his B.E degree in Electrical and Electronics Engineering from Mahindra Institute of Technology under Anna University in the year 2006 and completed his M.E degree in Power electronics and Drives from Sona College of Technology under Anna University, Chennai in the year 2009 and pursuing Ph.D., in special machines from Anna University, Chennai. He is currently working as Assistant Professor in Electrical Department and R & D activities at SonaSPEED research lab in Sona College of Technology, Salem, Tamilnadu, India. His area of interest includes Power Electronics, Special power electronic controls and drives, Control system and Special electrical machines.