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Research Paper | Engineering

A Newly Constructed Rectifier for Hybrid Wind-Solar Energy System

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ABSTRACT

This Paper deals a new system configuration of the front-end rectifier stage for a hybrid wind-photovoltaic energy system. This configuration allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources .The new rectifier configuration of this CUK-SEPIC fused converter, without any additional input filters to filter out high frequency harmonics. Harmonic content is determined for the generator lifespan, heating issues, and efficiency. The Hybrid combination proposed is a fusion of the buck and buck-boost converter. This system requires passive input filters to remove the high frequency current harmonics injected into the wind turbine generators. The harmonic content in the generator current decreases its life span and increases the power loss due to heating.

This paper main objective is Generation of maximum power by Hybrid Wind-Solar Energy system using the Modern Rectifier. The proposed design consists of the CUK and SEPIC converters. This fused multi input rectifier stage also allows Maximum Power Point Tracking (MPPT) to be used to extract maximum power from the photovoltaic cells. An adaptive Maximum Power Point Tracking (MPPT) algorithm will be used for the wind system and a standard perturb and observe method will be used for the Photo Voltaic system. Operational analysis of the proposed system will be discussed in this project. Simulation results are given to highlight the merits of the proposed system.

KEYWORDS: CUK-SEPIC fused converter, buck and buck-boost converter, CUK and SEPIC converters.

I. INTRODUCTION

The main theme of this paper is gaining maximum amount of energy through available sources wind and solar. Depending upon the availability of energy sources to extract maximum amount of energy using the Maximum Power pointing Tracking (MPPT).Generally this MPPT algorithm is extracted from the photo voltaic cells. The energy is extracted from the wind and solar energy sources.

WIND ENERGY:

The wind is a by-product of solar energy. Approximately 2% of the sun's energy reaching the earth is converted into wind energy. The circulation of air in the atmosphere is caused by the non-uniform heating of the earth's surface by the sun. The air immediately above a warm area expands; it is forced upwards by cool, denser air which flows in from surrounding areas causing a wind. Wind possesses energy by virtue of its motion. The power in the wind can be computed by using the concept of kinetics. The wind will works on the principle of converting kinetic energy of the wind to mechanical energy. Anemometer data is normally based on wind speed measurements from a height of 10m. Kinetic energy from the wind is used to turn the generator inside the wind turbine to produce electricity.

SOLAR ENERGY:

The solar energy is a form of heat energy comes from the sun. The sun's radiation gives heat and light that which heat is used to produce electrical energy. The source produce solar energy is by the photo voltaic cells or solar cells. These photo solar cells also treated as solar cells are made up of silicon. The present solar cells are working with the nano-technology. The process of production of heat energy is by when light hit the cells; they absorb the energy through photons.

HYBRID WIND SOLAR ENERGY SYSTEM:

The combination of both solar and wind energy sources are used to gain maximum amount of energy depending upon the availability of sources in nature. The wind is a form of solar energy. By combing using this two sources the system power transfer efficiency and reliability can be improved significantly. An adaptive maximum power point tracking algorithm will be used for the wind system and a standard perturb & observe method will be used for the photo voltaic system. Here in this system the separate dc to dc converters are connected in parallel in a stage.

II. BLOCK DIAGRAM OF HYBRID WIND SOLAR ENERGY SYSTEM

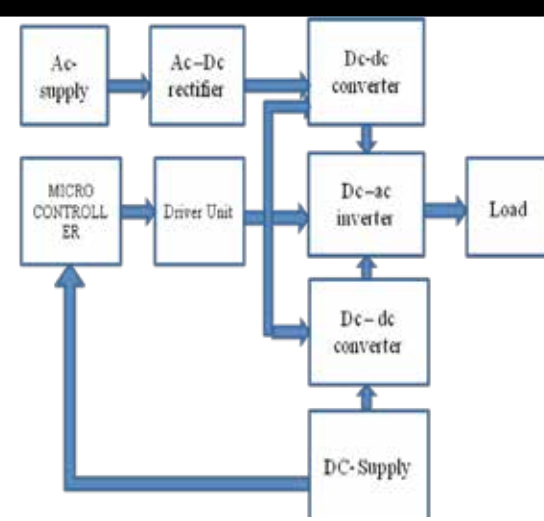


Fig.1. Block diagram of wind-solar energy system with modern Rectifier

AC SUPPLY:

This block deals with the input of the wind energy along with the continuity of the generator. The gained wind energy is collected and makes to pass through the generator for the power generation. As the power we are using is ac hence the ac supply is indicated in this block.

AC-DC RECTIFIER:

In order to convert the input for the better components operation ac to dc rectifier which means that diode Rectifier is used in this block. This diode rectifier converts the ac to dc input and even can eliminate the harmonics.

DC –DC CONVERTER:

Here in this block a new rectifier configuration is used to eliminate the high frequency harmonics without using any extra filters. It is a combination of CUK-SEPIC converter. The advantage of this configuration is that it can step up or step down the input.

DC SUPPLY:

Here in this block deals with the solar energy input. In this the photo voltaic plate cells are inserted on the earth so that it observes the heat and convert it into electrical energy in maximum with the phenomenon of the Maximum Power point Tracking (MPPT). The produced solar energy is given as input in conversion of heat to electrical energy.

DC-AC INVERTER: Generally the operation of inverter is to converter dc to ac. Hence the source that comes from the dc to dc converter can be again converted into ac for further operation. The harmonic free contented source of dc is converted into ac forward for further operation.

MICROCONTROLLER: This blocks deals with information about the type of micro controller used in this project we are using PIC 16F877A for producing switching pulses to multilevel inverter. So as to use those vectors this will not generate any common mode voltage at the inverter poles. This eliminates common mode voltage. Also it is used to eliminate capacitor voltage unbalancing. The microcontroller are driven via the driver circuit so as to boost the voltage triggering signal to 9V.To avoid any damage to micro controller due to direct passing of 230V supply to it we provide an isolator in the form of optocoupler in the same driver circuit.

Driver circuit: It is used to provide 9 to 20 volts to switch the MOSFET switches of the inverter. Driver amplifies the voltage from microcontroller which is 5 volts. Also it has a separate controller called optocontroller for isolating purpose. So damage to MOSFET is prevented.

LOAD: The load deals with the external supply given to the inverter for the better working. It acts like a feed back to the system.

III. RECTIFIER TOPOLOGY

The rectifier topology used in this paper is fusion of buck and boost converter. The multi input rectifier stage of boost converter is used. The rectifier topology is used to eliminate the high frequency harmonics without using the extra filters. The rectifier topology is combination of the CUK and SEPIC converter called as the front end rectifier stage. It is also termed as the fusion of the CUK-SEPIC converter. The individual operation of each rectifier is explained below.

The features of these two converters are that they are inherent in nature. Harmonic content is detrimental for the generator life span, heating issues, and efficiency. It can support to step up/step down operations for each renewable (can support a wide ranges of photo voltaic and wind input); Maximum power point tracking can be realized for each source. Individual simultaneous operation is supported.

CUK CONVERTER:

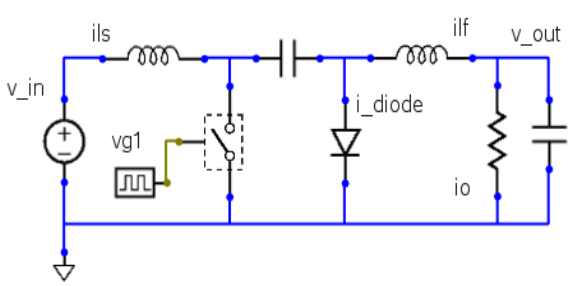


Fig.2. The schematic diagram of CUK converter

The CUK converter is used in the regulated dc power supplies, where the negative polarity output may be desired with respect to the common terminals of the input voltage and the average output is either higher or lower than the dc input voltage. The typical schematic circuit for the CUK Converter is as shown in Fig.3.2.1. The capacitor C1 acts as a primary means to store and transfer the power from input to output. The voltage vc1 is always greater than either input or output voltage. The average output to input relations are similar to that of a buck-boost converter circuit. The output voltage is controlled by controlling the switch-duty cycle. The term duty cycle is ratio of on time on the Switch to the total switching period.

SEPIC CONVERTER:

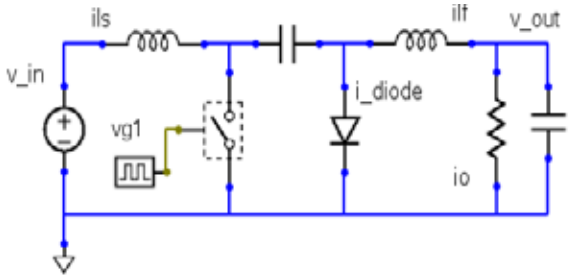


Fig.3 The schematic diagram of SEPIC converter

The Schematic diagram is drawn above of fig.3.The SEPIC converter can step up and step down the input voltage while maintaining the same polarity and the same ground reference for input and output. Hence it is termed as a buck-boost converter. It is used in battery power systems to step up or to step down depending upon the charge level of battery. The SEPIC converter is a new type of converter that is typical in designing since the research is going in the form to know about the operation of SEPIC converter using different methods such as controls systems by transfer function Method, PWM techniques etc.

DC analysis of the SEPIC converter:

Below figure.4 shows the equivalent circuit of the SEPIC converter with the DC portion of the PWM switch model in place. There place the inductors with short circuits, and the capacitors with open circuits for the DC analysis. You can, if you like, include any parasitic resistances in the circuit, but that's beyond the scope of this article.

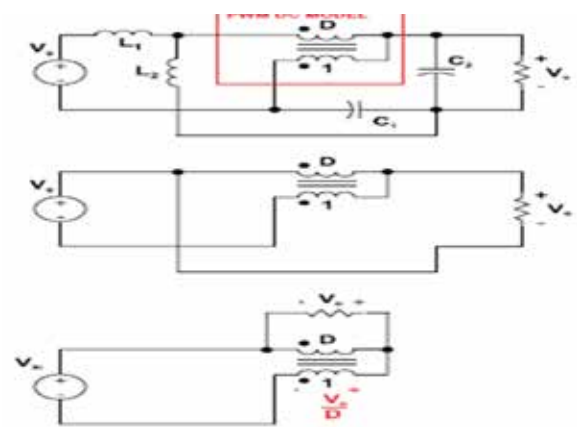


Fig.4. The schematic diagram of dc analysis of SEPIC converter

CUK-SEPIC CONVERTER:

The combination of CUK and SEPIC converter are drawn in fig.5. In this the arrangement of both the converters will be of parallel or series depending upon the flexibility and purpose. But in this parallel connection is done. One of the inputs is connected to the output of the photo voltaic array and the other input connected to the output of the generator. The fusion of two converters is achieved by reconfiguring the two existing diodes from each converter and the shared utilization of the CUK output inductor by the SEPIC converter. This configuration allows each converter to operate normally individually in the event that one source unavailable.

Depending upon active position of the source the working condition of each converter will change. The photo voltaic cells deals with the CUK converter while the wind source deals with the SEPIC converter.

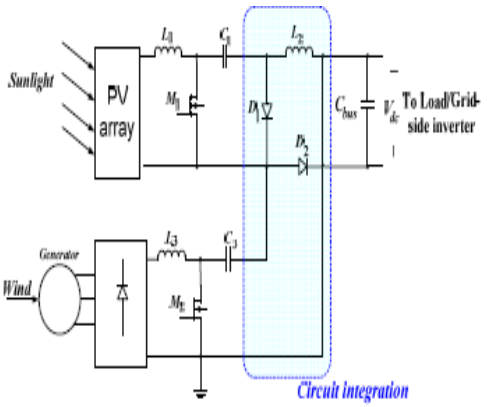
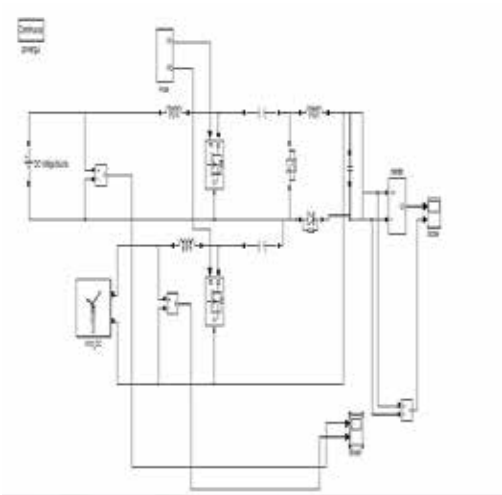


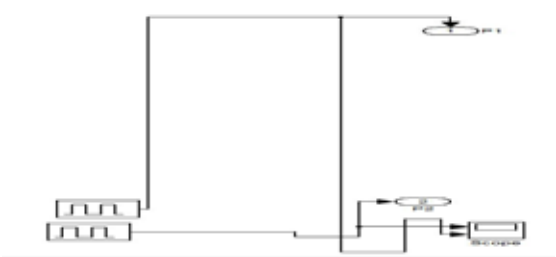
Fig.5. Schematic diagram of hybrid circuit integration of CUK and SEPIC converter

IV. SIMULATION RESULTS

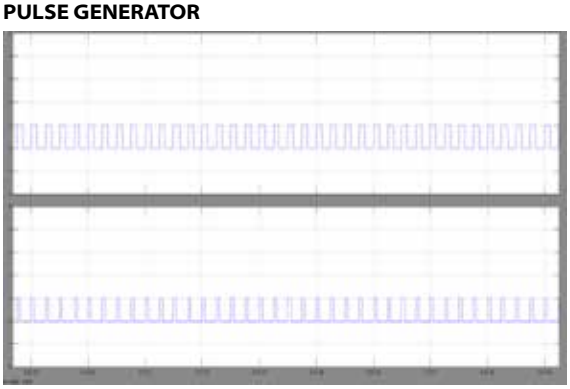
SIMULATION DIAGRAM OF HYBRID ENERGY WIND SYSTEM:

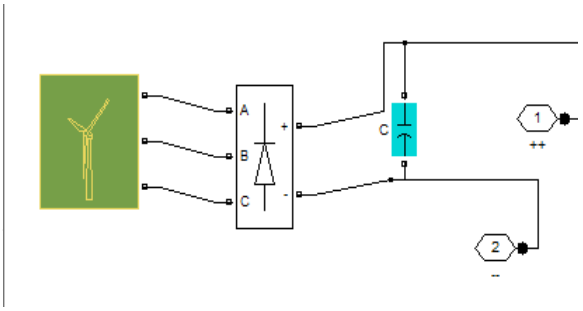


SIMULATION DIAGRAM FOR THE HYBRID WIND OF PULSE GENERATOR:

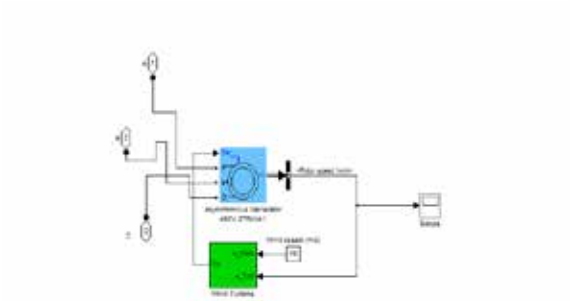


SIMULATION OUTPUT FOR HYBRID WIND ENERGY OF PULSE GENERATOR

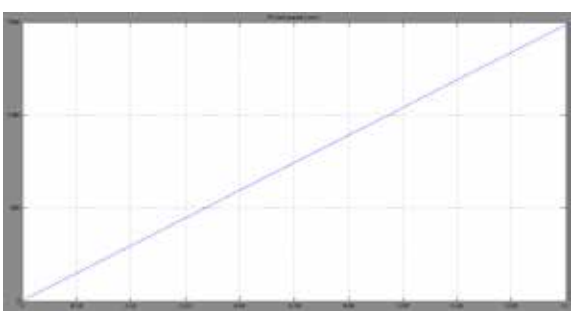




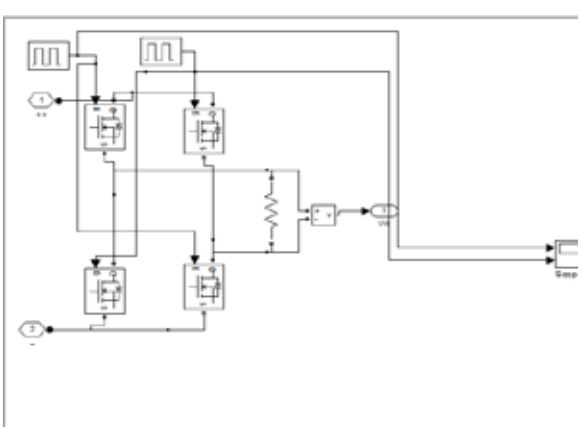
SUBCIRCUIT OF THE WIND DC SYSTEM:



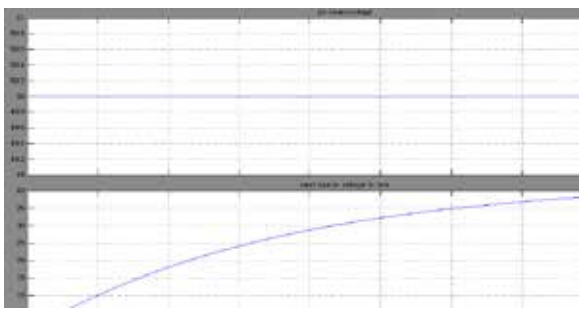
SIMULATION OUTPUT OF ROTOR SPEED FOR HYBRID DC SYSTEM:



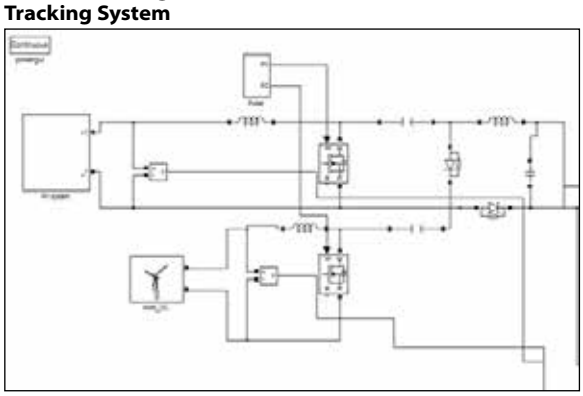
SUBCIRCUIT DIAGRAM OF INVERTER:



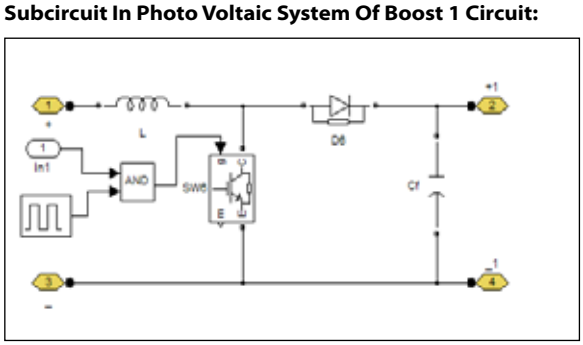
Simulation Output for Sub circuit Diagram of Inverter:



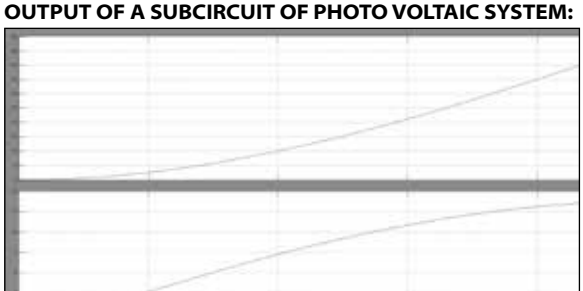
Simulation Diagram of the Solar Maximum Power Point Tracking System



Subcircuit In Photo Voltaic System Of Boost 1 Circuit:

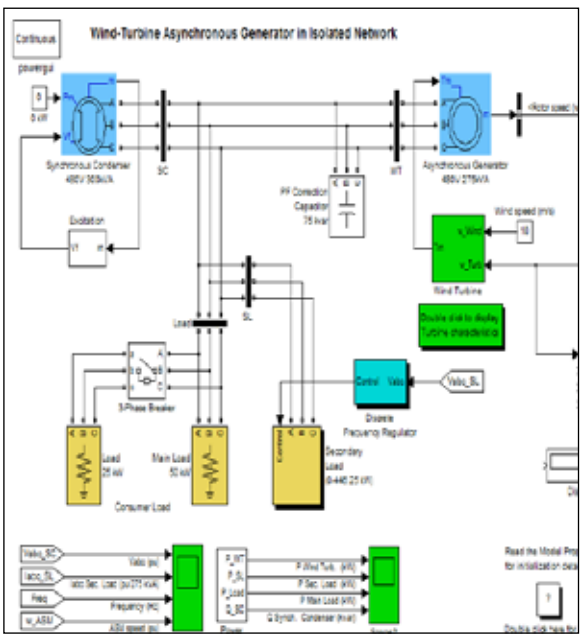


OUTPUT OF A SUBCIRCUIT OF PHOTO VOLTAIC SYSTEM:

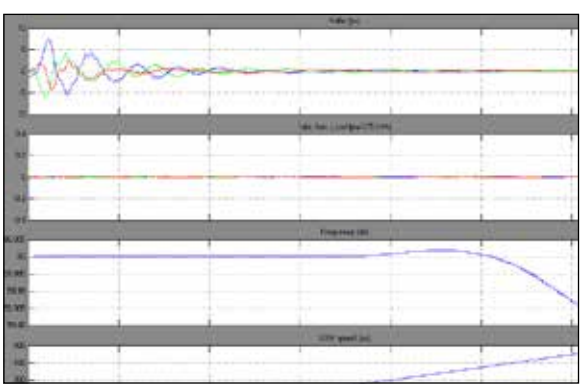


Output of Sub circuit Boost 1 Circuit Of Photo Voltaic SYSTEM:

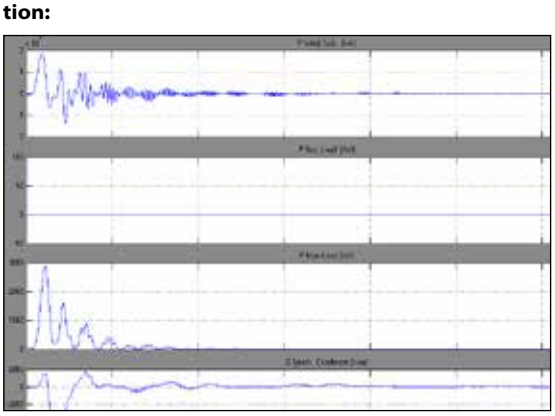
SIMULATION DIAGRAM OF THE POWER WIND GENERATOR:



Output of Voltage, Current, frequency and asynchronous motor:



Simulation Output of a Sub circuit For Power Consumption:



V. CONCLUSION

In this paper an implementation of front end rectifier stage is used to perform a free harmonic frequency system. In this project to extract maximum amount of energy from the wind and solar a phenomenon of maximum power point tracking algorithm is implemented. The different rectifier topology such as CUK and SEPIC converters are performed to eliminate the high frequency harmonics as mentioned above. The project deled with the operation of two stages of extraction of maximum amount of energy by the individual implementation of wind and solar energy sources. In the same process a combined fusion of wind and solar energy sources is used with the fusion implementation of CUK and SEPIC converter rectifier staged topology. In stage a maximum power point tracking algorithm is implemented to rectifier stage topology.

The conclusion of this paper is that continuous power generation with the two sources combine to overcome load demands according the availability of renewable energy sources wind and solar to extract maximum amount of energy by maximum power point tracking algorithm.

REFERENCES

[1] S.K. Kim, J.H Jeon, C.H. Cho, J.B. Ahn, and S.H. Kwon, "Dynamic Modeling and Control of a Grid-Connected Hybrid Generation System | with Versatile Power Transfer," IEEE Transactions on Industrial Electronics, vol. 55, pp. 1677-1688, April 2008. | [2] D. Das, R. Esmaili, L. Xu, D. Nichols, "An Optimal Design of a Grid Connected Hybrid Wind/Photovoltaic/Fuel Cell System for Distributed Energy Production," in Proc. IEEE Industrial Electronics Conference, pp. 2499-2504, Nov. 2005. | [3] N. A. Ahmed, M. Miyatake, and A. K. Al-Othman, "Power fluctuations suppression of stand-alone hybrid generation combining solar photovoltaic/wind turbine and fuel cell systems," in Proc. Of Energy Conversion and Management, Vol. 49, pp. 2711-2719, October 2008. | [4] S. Jain, and V. Agarwal, "An Integrated Hybrid Power Supply for Distributed Generation Applications Fed by Nonconventional Energy Sources," IEEE Transactions on Energy Conversion, vol. 23, June | [5] Y.M. Chen, Y.C. Liu, S.C. Hung, and C.S. Cheng, "Multi-Input Inverter for Grid-Connected Hybrid PV/Wind Power System," IEEE Transactions on Power Electronics, vol. 22, May 2007. | [6] dos Reis, F.S., Tan, K. and Islam, S., "Using PFC for harmonicmitigation in wind turbine energy conversion systems" in Proc. of the IECON 2004 Conference, pp. 3100- 3105, Nov. 2004