**International Journal of Emerging Technology in Computer Science & Electronics (IJETCSE)**
**ISSN: 0976-1353 Volume 20 Issue 2 – FEBRUARY 2016.**

# MODELLING OF HYBRID WIND AND PHOTOVOLATIC ENERGY SYSTEM USING CUK AND SEPIC CONVERTER

S. Mutharasu[1] and R. Meena[2]

*[1]AP/EEE, Department of EEE, Vivekanandha College of engineering for women, Tiruchengode.*
*[2]PG student, Department of EEE, Vivekanandha college of engineering for women, Tiruchengode.*

***Abstract*--This project presents a new system configuration of the front-end rectifier stage for a hybrid wind/photovoltaic energy system. As the power demand increases, power failure also increases. So, renewable energy sources can be used to provide constant loads. Hybridizing solar and wind power sources provide a realistic form of power generation. In this topology, both wind and solar energy sources are incorporated together using a combination of Cuk and SEPIC converter. This configuration allows the two sources to supply the load separately or simultaneously depending on the availability of the energy sources. The fused multi input rectifier stage also allows Maximum Power Point Tracking (MPPT) to be used to extract maximum power from sun when it is available. An Incremental Conductance is used for the PV system. The average output voltage produced by the system is the sum of the inputs of these two systems. All these advantages of the proposed hybrid system make it highly efficient and reliable. Simulation results are given to highlight the merits of the proposed circuit.**

**Index Terms – SEPIC converter, Cuk converter, PV & wind source, MPPT**

## I. INTRODUCTION

Solar energy and wind energy are the two renewable energy sources most common in use. Wind energy has become the least expensive renewable energy technology in existence. Photovoltaic cells convert the energy from sunlight into DC electricity. PVs offer added advantages over offer renewable energy sources in that they give off no noise and practically require no maintenance.

Hybridizing solar and wind power sources provide a realistic form of power generation. When a source is unavailable or insufficient in meeting the load demands, the other energy source can compensate for the difference. Several hybrid wind/PV power systems with Maximum Power Point Tracking (MPPT) control have been proposed earlier. They used a separate DC/DC buck and buck-boost converter connected in fusion in the rectifier stage to perform the MPPT control for each of the renewable energy power sources. This system requires passive input filters to remove the high frequency current harmonics injected into wind turbine generations. The harmonic content in the generation current decreases its lifespan and increases the power loss due to heating.

In this topology, both wind and solar energy sources are incorporated together using a combination of Cuk and SEPIC converters, so that if one of them is unavailable, then the other source can compensate for it. The Cuk-SEPIC fused converters have the capability to eliminate the HF current harmonics in the wind generator. This eliminates the need of passive input filters in the system. These converters can support step up and step down operations for each renewable energy sources. They can also support individual and simultaneous operations. Solar energy source is the input to the Cuk converter and wind energy source is the input to the SEPIC converter. The average output voltage produced by the system will be the sum of the inputs of these two systems.

## II. DC-DC CONVERTERS

DC-DC converters can be used as switching mode regulators to convert an unregulated dc voltage to a regulated dc output voltage. The regulation is normally achieved by PWM at a fixed frequency and the switching device is generally BJT, MOSFET or IGBT.

### A. Cuk converter

The Cuk converter is a type of DC-DC converter that has an output voltage magnitude that is either greater than or less than the input voltage magnitude. It provides the negative output voltage. This converter always works in the continuous conduction mode. The Cuk converter operates when M1 is turned on, the diode D1 is reverse biased, the current in both L1 and L2 increases and the power is delivered to the load. When M1 is turned off, D1 becomes forward biased and the capacitor C1 is recharged.

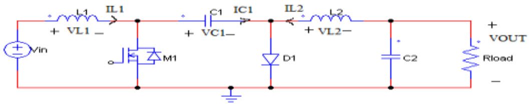


Figure1: Cuk converter

### B. SEPIC converter

Single-ended primary-inductor converter (SEPIC) is a type of DC-DC converter allowing the voltage at its output to be greater than, less than, or equal to that at its input. It is similar to a buck boost converter. It has the capability for both steps up and step down operation. The output polarity of the converter is positive with respect to the common terminal.

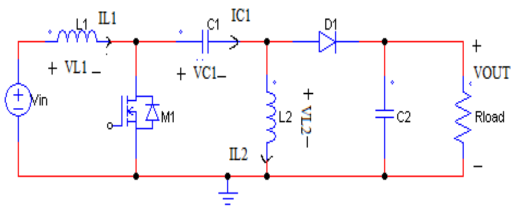


Figure 2: SEPIC Converter

The capacitor C1 blocks any DC current path between the input and the output. The anode of the diode D1 is connected to a defined potential. When the switch M1 is turned on, the input voltage, Vin appears across the inductor L1 and the current IL1 increases. Energy is also stored in the inductor L2 as soon as the voltage across the capacitor C1 appears across L2. The diode D1 is reverse biased during this period. But when M1 turns off, D1 conducts. The energy stored in L1 and L2 is delivered to the output, and C1 is recharged by L1 for the next period.

## III. PROPOSED HYBRID SYSTEM

In order to eliminate the problems in the stand-alone PV and wind system and meeting the load demand, The only solution to combine one or more renewable energy sources to meet the load demand. so the new proposed input side converter topology with maximum power point tracking method to meet the load and opt for grid connected load as well as commercial loads. The implementation of new converter topology will eliminate the lower order harmonics present in the hybrid power system circuit.

### A. BLOCK DIAGRAM

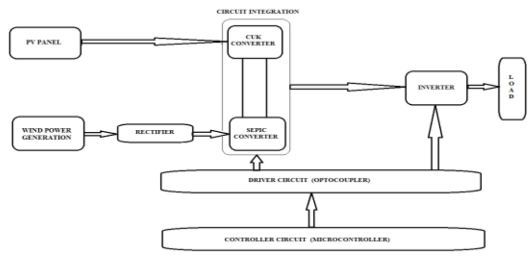


Figure 3: Block diagram of hybrid system

### B. CIRCUIT DIAGRAM

PV array is the input to the Cuk converter and wind source is the input to the SEPIC converter. The converters are fused together by reconfiguring the two existing diodes from each converter and the sharing the Cuk output inductor by the SEPIC converter. This configuration allows each converter to operate normally individually in the event that one source is unavailable. When only wind source is available, the circuit operates as a SEPIC converter. When only PV source is available, the circuit acts as a Cuk converter.

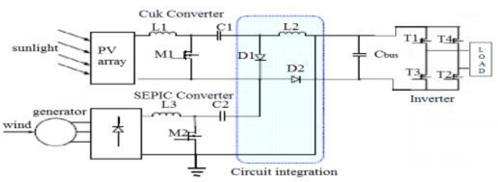


Figure 4: shows the converter topology for the hybrid system

### C. MODES OF OPERATION OF THE CONVERTER TOPOLOGY

a. MODE 1: WHEN M2 IS ON AND M2 IS OFF (SEPIC OPERATION)

When M2 is on condition, in the hybrid system, Wind energy will meet the load by a SEPIC converter operation. The wind energy will produce the Ac power, the Ac power further converted to dc power by using the rectifier. The converted dc power will stored in battery, and feed the load. Normally the SEPIC converter will triggered at 50% of the duty cycle to meet the load demand.

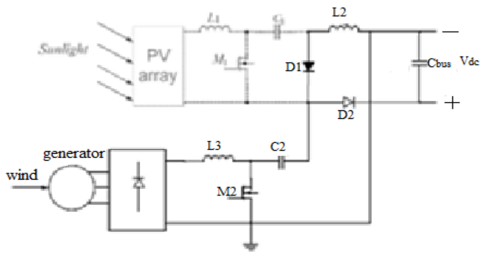


Figure 5: SEPIC operation alone

b. MODE 2: WHEN M1 IS ON AND M2 IS OFF (CUK OPERATION)

When M1 is on condition, in the hybrid system, solar energy will meet the load by a Cuk converter operation. The solar energy will produce the dc power; the dc power will stored in battery, and feed the load. Normally the SEPIC converter will triggered at 50% of the duty cycle by using the maximum power point tracking controller to meet the load demand.

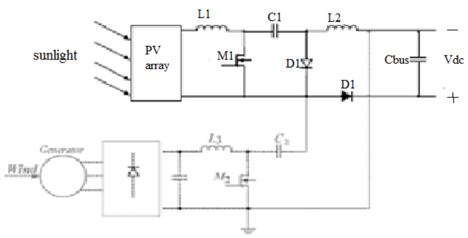


Figure 6: Cuk operation alone

c. BOTH WIND AND PV SOURCES

If the turn on duration of M1 is longer than M2, then the converter operates in state I, III and IV and if the turn on duration of M2 is longer than M1, then the converter operates in state I, II and IV. To provide a better explanation, the inductor current waveforms of each switching state are given as follows assuming that d2 > d1; hence only states I, III, IV are discussed in this example. In the following, Ii, PV is the average input current from the PV source; Ii, W is the RMS input current after the rectifier (wind case); and Idc is the average system output current. The key waveforms that illustrate the switching states in this example are shown in Figure 6. The mathematical expression that relates the total output voltage and the two input sources will be illustrated in the next section.

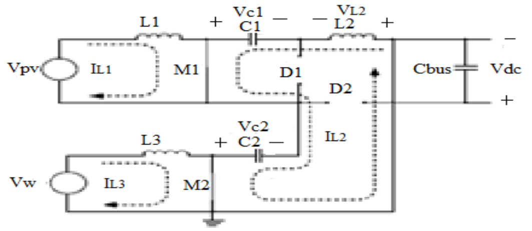


Figure 7(a): M1 ON, M2 ON

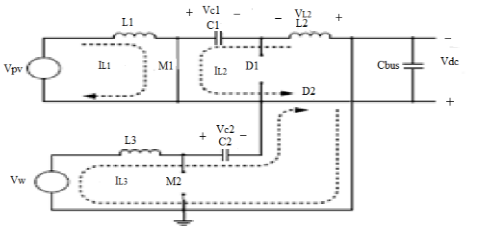


Figure 7(b): M1 ON, M2 OFF

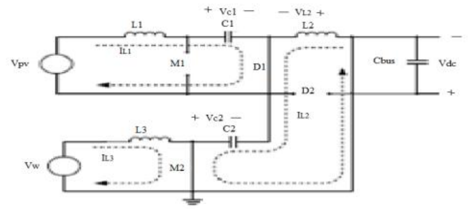


Figure 7(c): M1 OFF, M2 ON

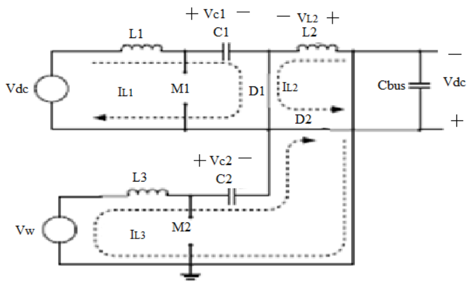


Figure 7(d): M1 OFF, M2 OFF

IV. SIMULATION RESULTS

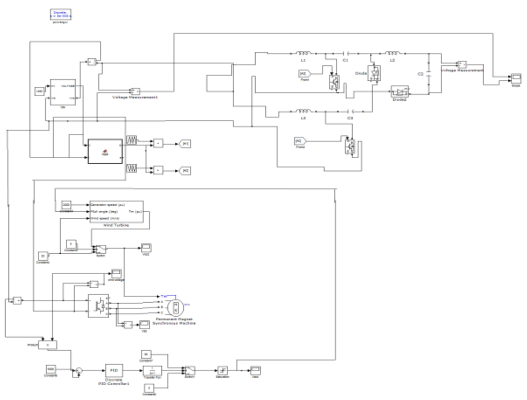

Figure 8: Matlab simulation for Hybrid System

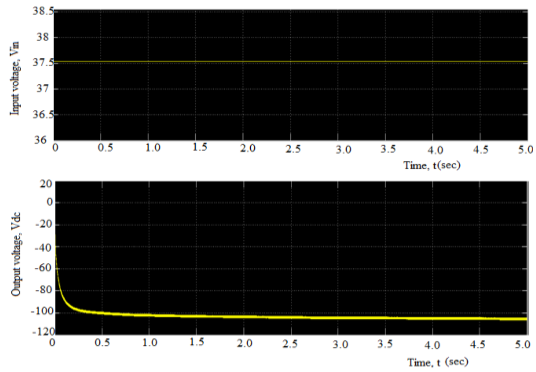


Figure 9: DC Output voltage Waveform of Solar Energy System in Boost mode

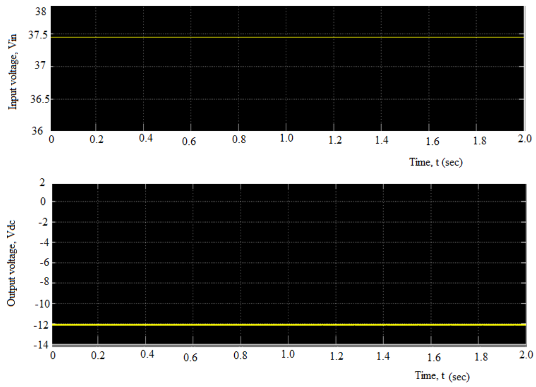


Figure 10: DC Output voltage Waveform of Solar Energy System in Boost mode

V. CONCLUSION

In this paper a new multi-input Cuk-SEPIC rectifier stage for hybrid wind/solar energy system has been presented. It can support step up/step down operations for each renewable source. Both converters are efficiently used to improve the system efficiency and voltage profile improvement. Additional input filters are not necessary to filter out high frequency harmonics. Here MPPT can be realized for each source. Individual and simultaneous operation is supported. The approach of varying complexity and current sharing performance has been proposed. The advantage of parallel connected power supply is low component stress, increased reliability, ease of maintenance and repair, thermal management. The presence of current sharing loop has been clearly proved for achieving good performance in paralleling of these converters. The input voltage of Cuk converter is 12 V and the output voltage is 34 V. The SEPIC converter input voltage is 12 V and the output voltage is 37 V. while combining the Cuk and SEPIC converter, the input voltage is 24 V and the output voltage is 42 V. A MATLAB Simulink has been developed and compared with the parallel schemes.

REFERENCES

[1] Divya Teja Reddy Challa, Raghavender Inguva (Nov 2012), “An Inverter Fed with Combined Wind-Solar Energy System Cuk-SEPIC Converter,” International Journal of Engineering Research and Technology (IJERT) Vol.1 Issue 9.

[2] Arun, Teena Jacob (Aug 2012), "Modelling of Hybrid wind and Photovoltaic Energy System using New Converter Topology," Electrical and Electronics Engineering: An International Journal (EEEIJ) Vol.1, No.2.

[3] P. Chidambaram, N. Subramani (Mar 2012) "Modelling and Simulation of Hybrid Wind-Solar energy System using CUK-SEPIC Fused Converter," International Journal of Communications and Engineering (IJCE) Vol 03, No. 3.

[4] Carlos A. Canesin, Senior Member, Leonardo P. Sampaio, Luigi G. Jr., Guilherme A. e Melo and Moacyr A. G. de Brito (2012) "Evaluation of the Main MPPT Techniques for Photovoltaic Applications", International Electrical and Electronics Engineering (IEEE).

[5] D. Das and S. K. Pradhan (2011), "Modelling and Simulation of PV Array with Boost Converter: An Open Loop Study", National Institute Of Technology, Rourkela.

[6] A. Bakhshai et al. (July 2010) , "A Hybrid Wind – Solar Energy System: A New Rectifier Stage Topology", IEEE Magazine.

[7] Chiang.S.J, Hsin-JangShieh, Member, IEEE, and Ming- Chen: (November 2009) "Modelling and Control of PV Charger System with SEPIC Converter", IEEE Transactions on Industrial Electronics, Vol.56, No.11.

[8] G. Adrian and D. C. Drago (2009) , "Modelling of renewable hybrid energy sources", Scientific Bulletin of the Petru Maior University of Tirgu Mures, Vol. 6.

[9] E. Koutroulis and K. Kalaitzakis (April 2006), "Design of a Maximum Power Tracking System for Wind-Energy-Conversion Applications", IEEE Transactions on Industrial Electronics, Vol. 53.

[10] D. Das, R. Esmaili, D. Nichols, L. Xu (Nov. 2005) , "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.

[11] Shu-Hung et al., (May 2003) "A Novel Maximum Power Point Tracking Technique for Solar Panels Using a SEPIC or Cuk Converter", IEEE Transactions on Power Electronics, Vol. 18.

[12] R. Billinton and R. Karki (November 2001) "Capacity Expansion of Small Isolated Power Systems Using PV and Wind Energy", IEEE Transactions on Power Systems, Vol. 16.