iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 4 **Issue:** VI **Month of publication:** June 2016

DOI:

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Scheming and Analysing Rectifier Stage Topology for Hybrid Wind-Solar Energy System

Akshya R. Jaiswal[1], Prof. R.P. Hasabe[2]
[1,2]*Walchand College of Engineering, Electrical Engineering*

Abstract— Demand and supply of electrical energy is of great concern to the economy of Nation. So as to fulfil increasing demand of electrical energy use of nonconventional energy sources dominates the other options. Polluted nature of conventional energy sources affecting environment adversely so at this stage one has to think about non-conventional energy sources. Solar and Wind energy are best suitable to minimise gap between supply and demand and thus by preventing environment due to their non-polluting nature. In this paper Hybrid Wind-Solar energy system is proposed with use of New rectifier stage topology. Solar and Wind energies are dependent of weather and one individually cannot satisfy continuous requirement of electrical energy. The topology used here to combined both solar and wind in efficient manner so as to extract continuous energy from two sources. Presented topology has Cuk and SEPIC converter so need of additional filter is eliminated and Simulation results are specified to analyse of topology.

Keywords—PV- Photovoltaic, SEPIC- Single Ended Primary Inductance Converter, Cuk converter, Fused Cuk-SEPIC converter.

I. INTRODUCTION

Due to increasing need for electrical energy and due to shortages of conventional sources of energy along with increment in cost of those, renewable energy sources are of great concern. There has been a lot of developed technologies which can extract energy for solar and wind. Solar and wind energy system are location dependent, non-polluted in nature and sources of alternative energy options. Wind energy can supply large amounts of power but its unpredictable nature makes it unreliable for use because wind speed is not necessarily constant. Solar energy system is best among the renewable energy sources. Solar cell output is dependent upon intensity of irradiation and irradiation varies throughout day so constant power is not extracted from PV cell and one can ensure output power. The common demerits of above two individual systems can be eliminated by combining these two energy sources and thus reliability can be improved to admirable extent.

When one source is unable to fulfil the required demand, the other source comes into picture to satisfy the required demand. Some of Hybrid Solar-Wind energy systems are discussed in the works [1-5].

In this paper, an alternative Bi- Input rectifier configuration is proposed for Hybrid energy system.Fused Cuk-SEPIC converter is proposed and it is having following features:

There is no requirement of separate filters.
Both step up and step down operation is realized.
Simultaneous and individual operations can be realized.

II. PROPOSED RECTIFIER TOPOLOGY

Unregulated DC can be regulated by using DC-DC converters as switching mode regulators. By using Pulse width modulation technique at a fixed frequency one can achieve desired voltage regulation. For pulse width modulation use of switching devices like MOSFET, BJT are used. MOSFET is most popular switching device for low voltage and high current application. It may be illustrious that, as the turn-on and turn-off time of MOSFETs are lower as compared to other switching devices, the frequency used for the dc-dc converters using it (MOSFET) is high, thus, reducing the size of filters as stated earlier.

A. Cuk Converter

The Cuk converter is a type of DC-DC converter that has an output voltage magnitude that is either more than or less than the input voltage magnitude.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

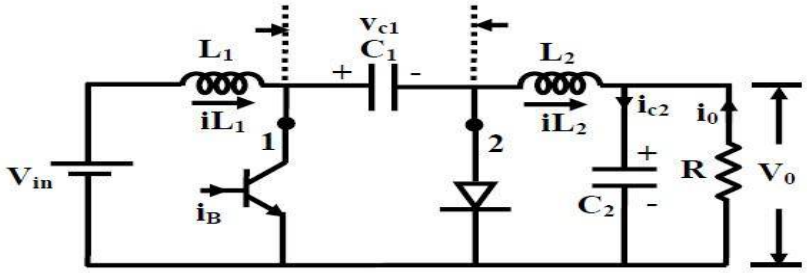


Figure 1: Circuit diagram for Cuk converter

It has the ability for both step up and step down operation. The output of Cuk converter has the negative polarity with respect to common terminal. Continuous conduction mode is always there for operation of Cuk converter .Capacitor works as energy transfer component for Cuk converter. When switch is turned on, the diode is reverse biased, the current in the inductor L1 and L2 increases and thus power is delivered to the load. When switch is turned off, diode turns on and the capacitor C1 is recharged.

B. SEPIC Converter

The abbreviation of SEPIC is "Single-Ended Primary Inductance Converter". But, one can recall more descriptively "Secondary Polarity Inverted Cuk". SEPIC is DC-DC converter and allowing output voltage to be more than, less than, or equal to that at its input. The SEPIC converter have step up or step down facility without reversing the polarity of the regulated output voltage. It is similar to a buck boost converter. It has the capability to perform both step up and step down operation. The output of the SEPIC converter has positive polarity with respect to common terminal.

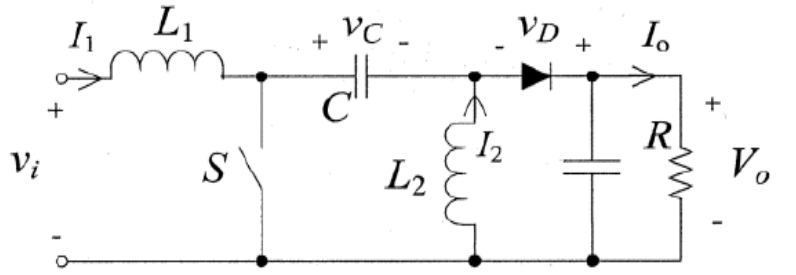


Figure 2: Circuit diagram for SEPIC converter

C. Block Diagram For Cuk-SEPIC fused topology

In this paper Fusion of solar and wind energy system is achieved by the means of fused Cuk-SEPIC converter. Both these wind and solar energy system combined together with the help of new stage rectifier topology.

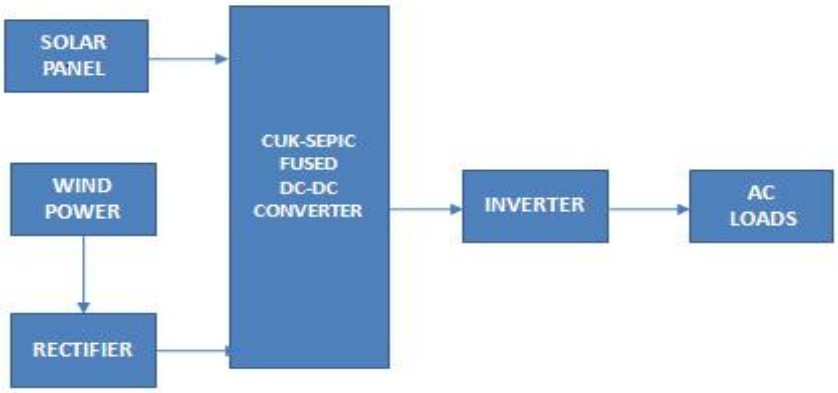


Figure 3: Block Diagram for Cuk SEPIC fused Topology.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Solar cell is input for Cuk converter and Wind energy system is input for SEPIC converter. Here individual operation and simultaneous operation is supported. When solar alone can give the output power then Cuk converter is there and when Wind alone can give the output power SEPIC is in the operation. When both are in operation simultaneously combined output can be taken out.

D. Circuit Diagram for Proposed Bi-Input Rectifier stage

Projected hybrid energy system combining solar and wind is shown in Figure 4, where one input is connected to PV array and other is connected to wind generator. The fusion of two converters is achieved by reconfiguring two diodes from each converter and utilization of Cuk output inductor is shared by SEPIC converter.

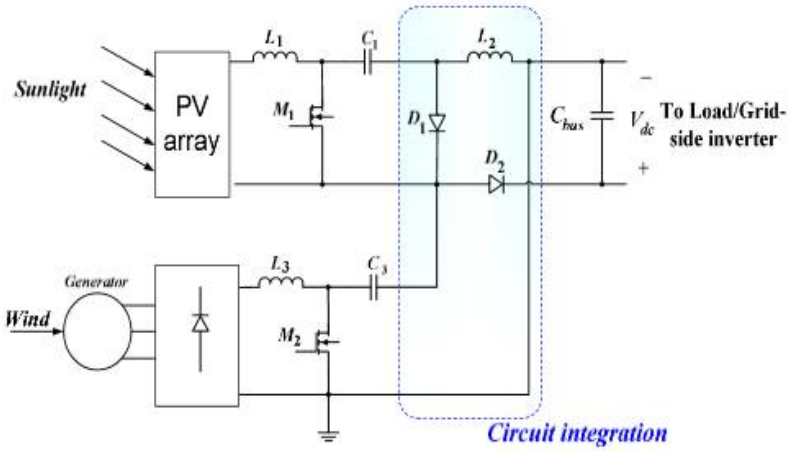


Figure 4: Proposed Bi-input rectifier stage topology. In this Bi-input arrangement each converter can operate individually when other is unavailable. Figure 5 shows the case when only the wind source is present.

In this case, diode D1 reversed biased and D2 gets forward biased, then proposed circuit becomes SEPIC converter and the input to output voltage relationship is given by (1). Also further, if only the PV source is available, then D2 gets reversed biased and D1 will always be on and the circuit turn out to be a Cuk converter as shown in Figure 6. The input to output voltage relationship is given by (2).

$$\frac{Vdc}{Vsolar} = \frac{D1}{1-D1} \quad (1)$$

$$\frac{Vdc}{Vwind} = \frac{D2}{1-D2} \quad (2)$$

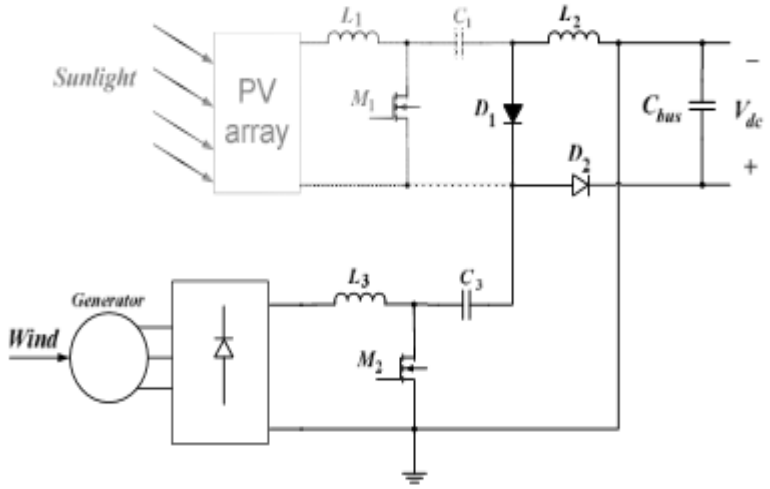


Figure 5: Wind acts alone, SEPIC operation.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

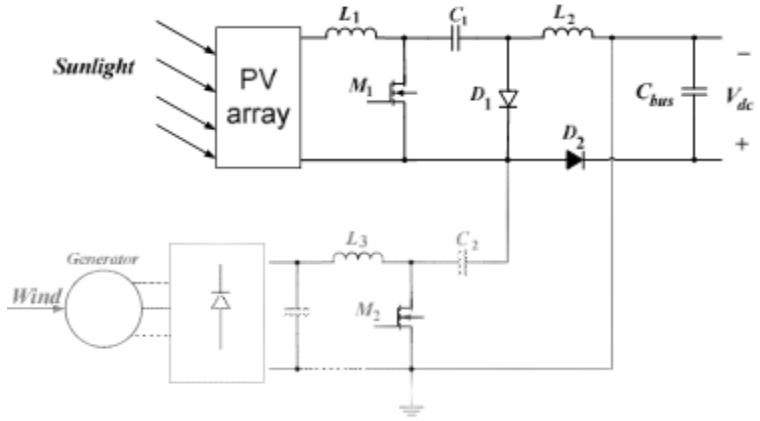


Figure 6: Solar acts alone, Cuk operation.

When both solar and wind acts simultaneously the output voltage is given by:

$$Vdc = \frac{D1}{1-D1} Vsolar + \frac{D2}{1-D2} Vwind \quad (3)$$

III.SIMULATION RESULTS

The MATLAB/Simulink software is used to perform simulation.

A. Solar Panel Model in MATLAB

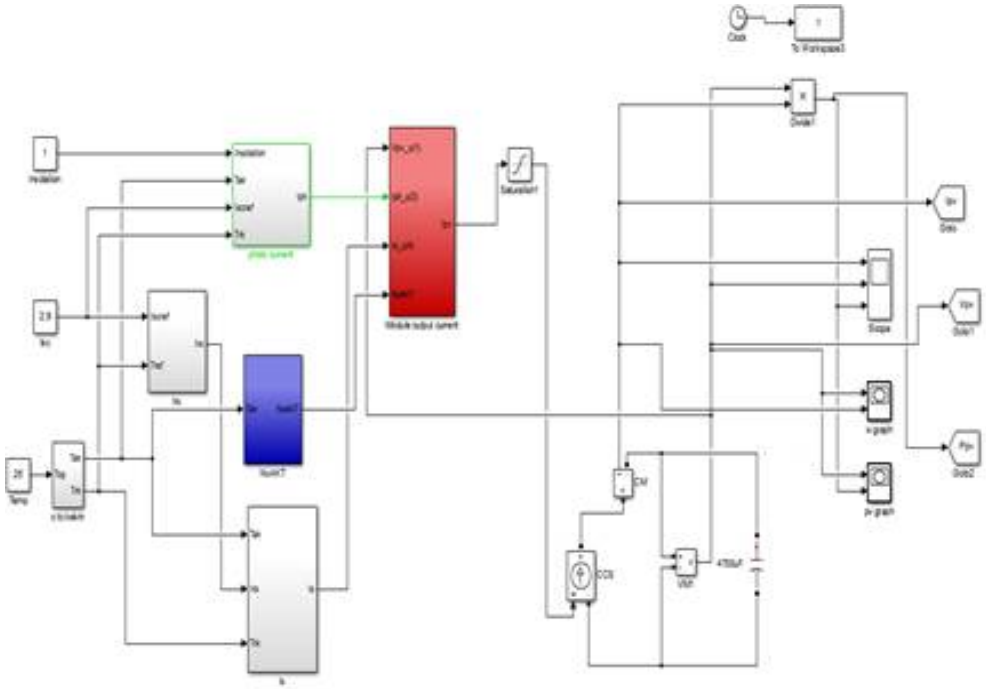


Figure 7: Simulink model for Solar Panel.

Solar irradiation is kept 1000W/m^2 with 36 cells. Above model is constructed and simulated in MATLAB and the output is obtained.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

B. PV and IV graph of Solar Panel

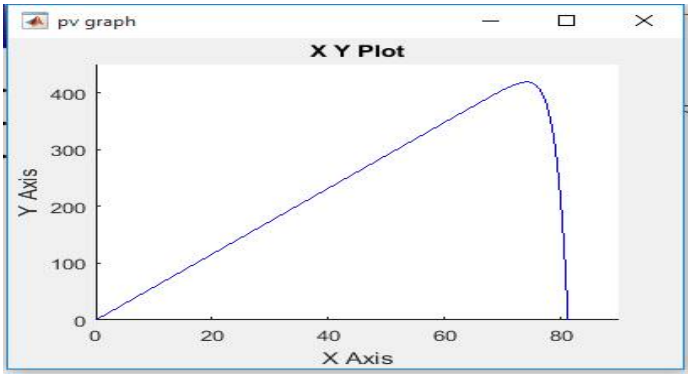


Figure 8: PV graph for Solar cell.

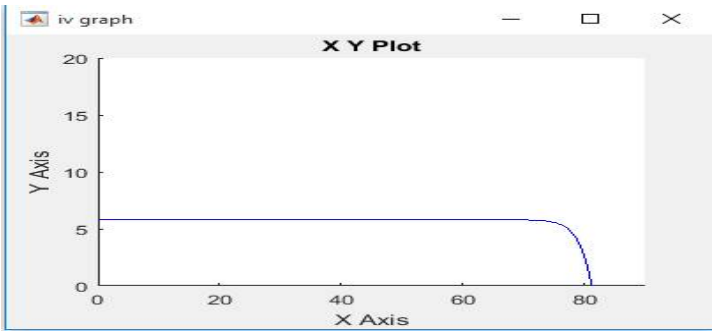


Figure 9: IV graph for Solar cell.

C. Cuk Converter operation mode (Solar alone)

The Cuk converter model has been simulated and parameters are given in Table:1 and results are given in Figure 10.

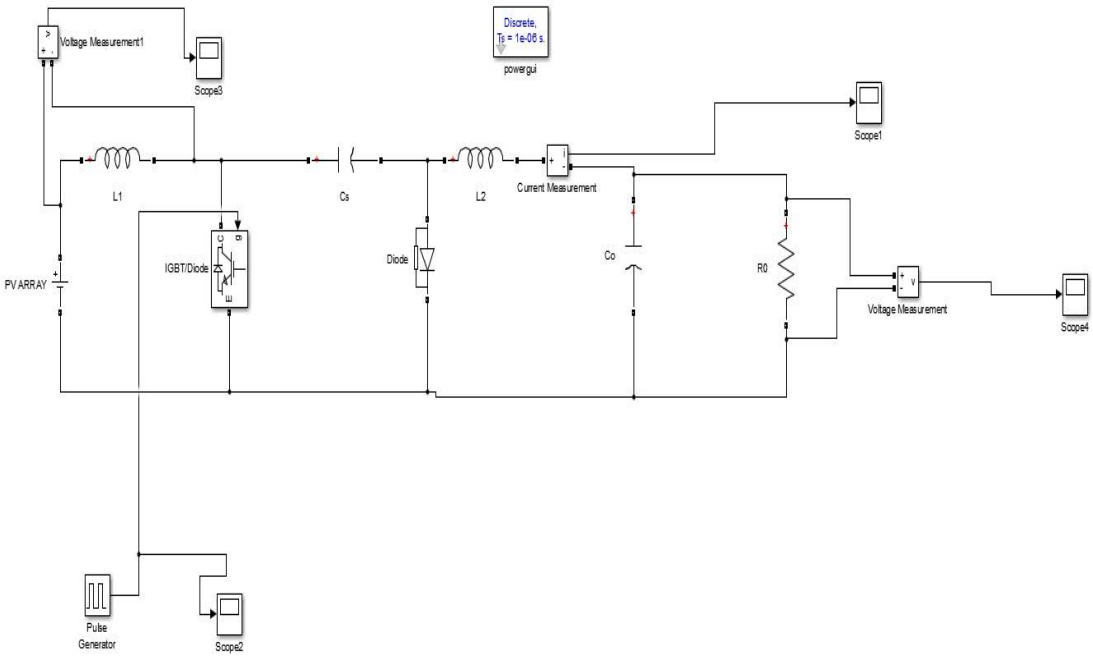


Figure 10: Simulink Model of Cuk converter.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table I: Parameters of Cuk Converter Model.

Parameters	Value
Input Voltage	60V
Output Voltage	100
Switching Frequency	20KHz
Duty Cycle	0.625
Output Current	1A
L1	3.75mH
L2	6.25mH
C1	3.907μF
C2	1μF
R	100Ω

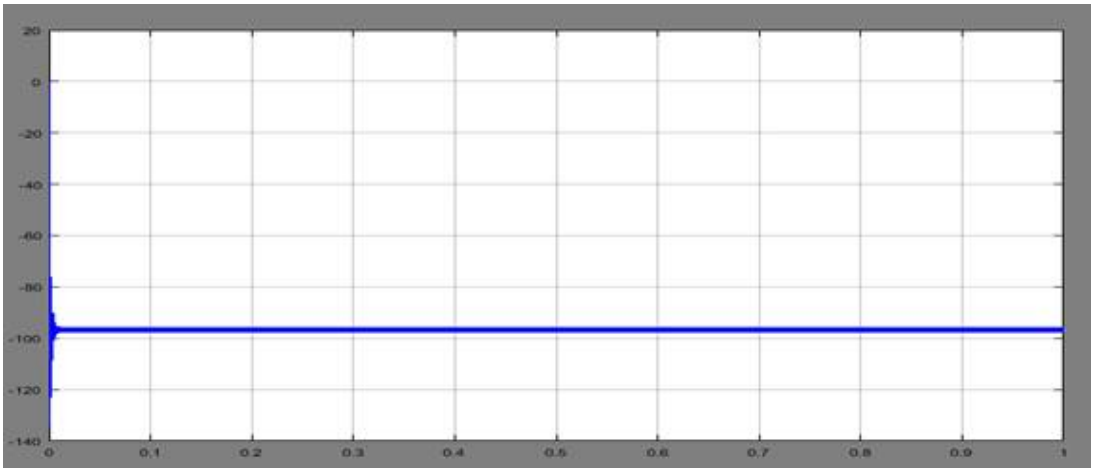


Figure 11: Output voltage of Cuk converter.

D. SEPIC Converter Operation mode (Wind alone)

The SEPIC Cuk converter model has been simulated and parameters are given in Table:2 and results are given in Figure 13.

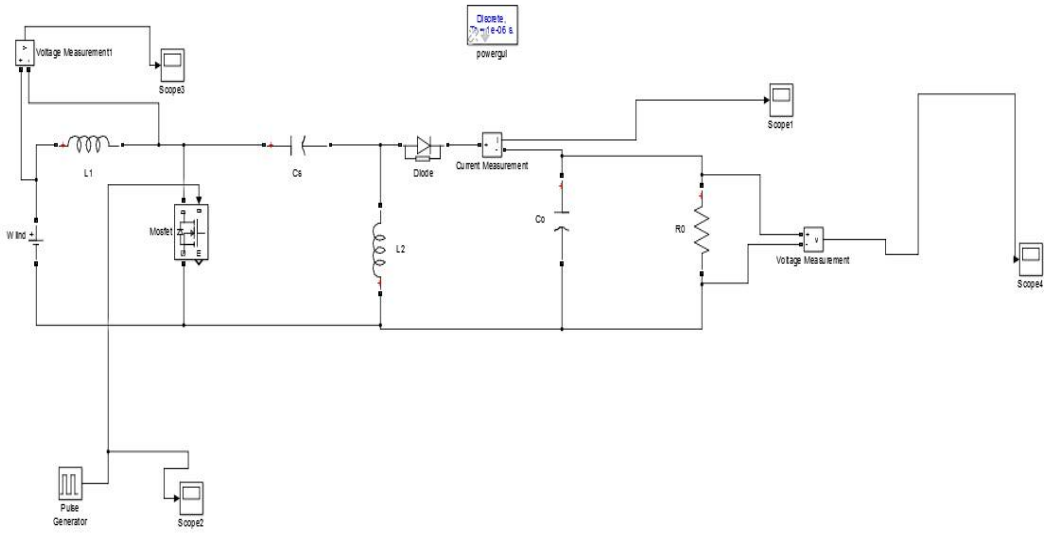


Figure 12: Simulink model of SEPIC converter

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

Table II: Parameters of SEPIC Converter Model.

Parameters	Value
Input voltage	70V
Output voltage	100V
Switching frequency	20KHz
Duty Cycle	0.5714
Output Current	1A
L1	5.371mH
L2	7.1433mH
C1	3.365μF
C2	1μF
R	100Ω

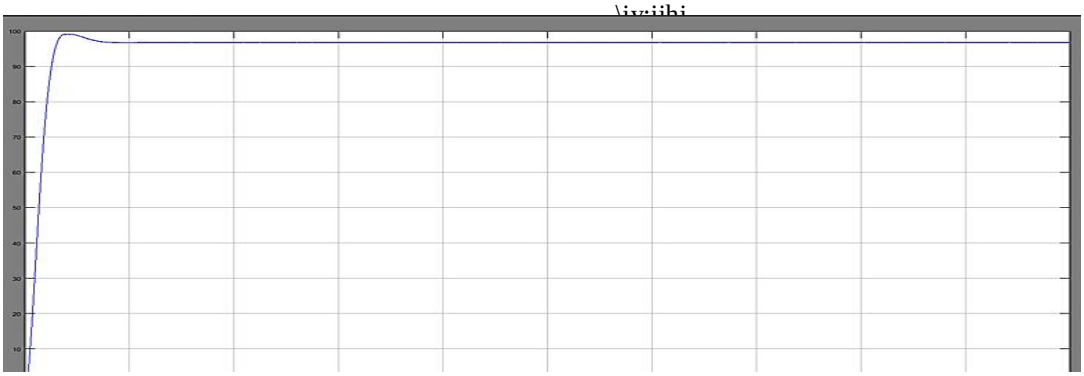


Figure 13: Output Voltage of SEPIC converter.

E. Combined mode of Operation of Cuk-SEPIC converter (Both solar and wind).

The Hybrid energy system is simulated along with Cuk-SEPIC fused topology and thus simulation results are obtained.

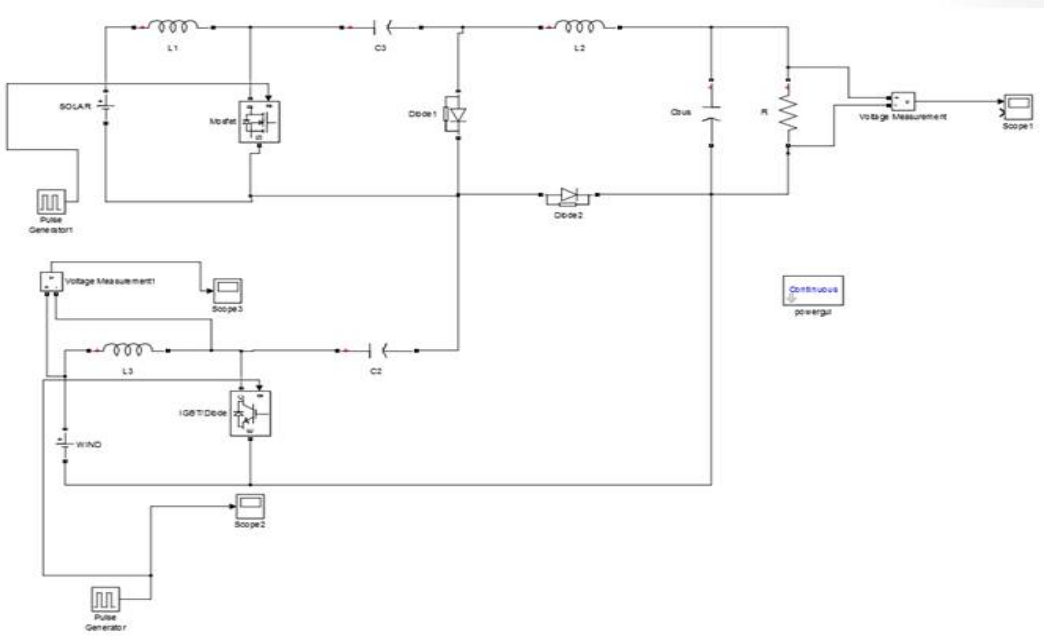


Figure 14: Simulink model for Hybrid energy system.

Volume 4 Issue VI, June 2016
ISSN: 2321-9653
International Journal for Research in Applied Science & Engineering Technology (IJRASET)

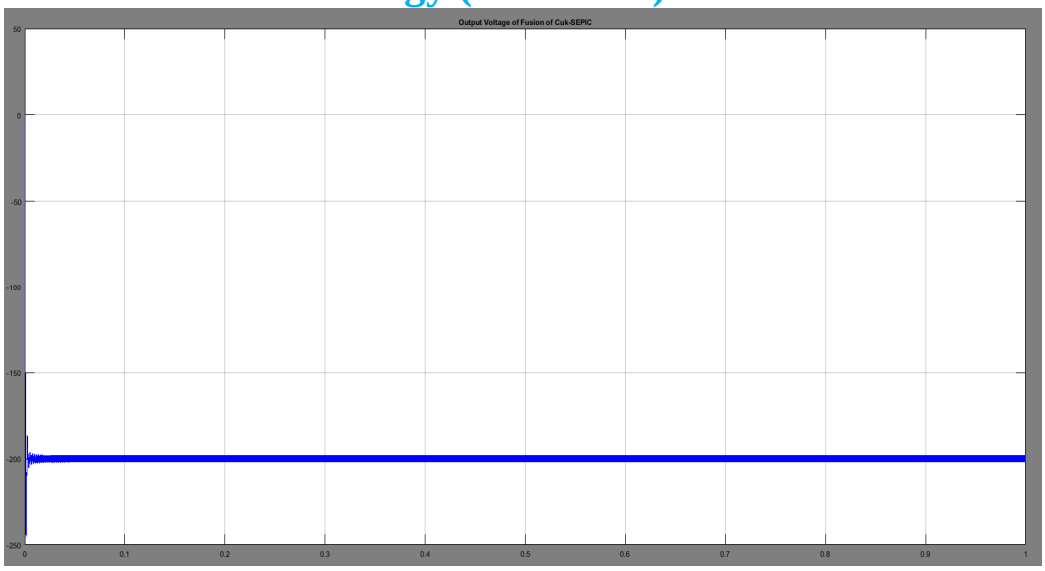


Figure 15: Cuk- SEPIC Output voltage.

IV. CONCLUSION

In this paper new stage rectifier topology is proposed for combined solar- wind energy system. By combining these two (solar and wind) systems continuous power generation is possible in order to meet load demand. In this new stage rectifier topology allowance of individual and simultaneous operation for wind and solar energy system is projected. The main advantage of this proposed topology is elimination of supplementary input filters to filter out the ripples. This proposed new stage rectifier topology for hybrid energy system supports the wide range of wind and PV input so as to get the desired output. In this paper Cuk and SEPIC simulations are simulated in MATLAB separately and results are obtained. Similarly fused configuration of Cuk-SEPIC is simulated in MATLAB to analyze the features of proposed topology. This proposed topology has lower operating cost and applicable in remote area power generation, electric vehicles and rural electrification.

REFERENCES

[1] S.K. Kim, J.H Jeon, C.H. Cho, J.B. Ahn and S.H.Kwon " Dynamic Modeling and Control of Grid-Connected Hybrid generation system with versatile Power Transfer " IEEE Transactions on Industrial Electronics, vol. 55, pp. 1677-1688, April 2008.

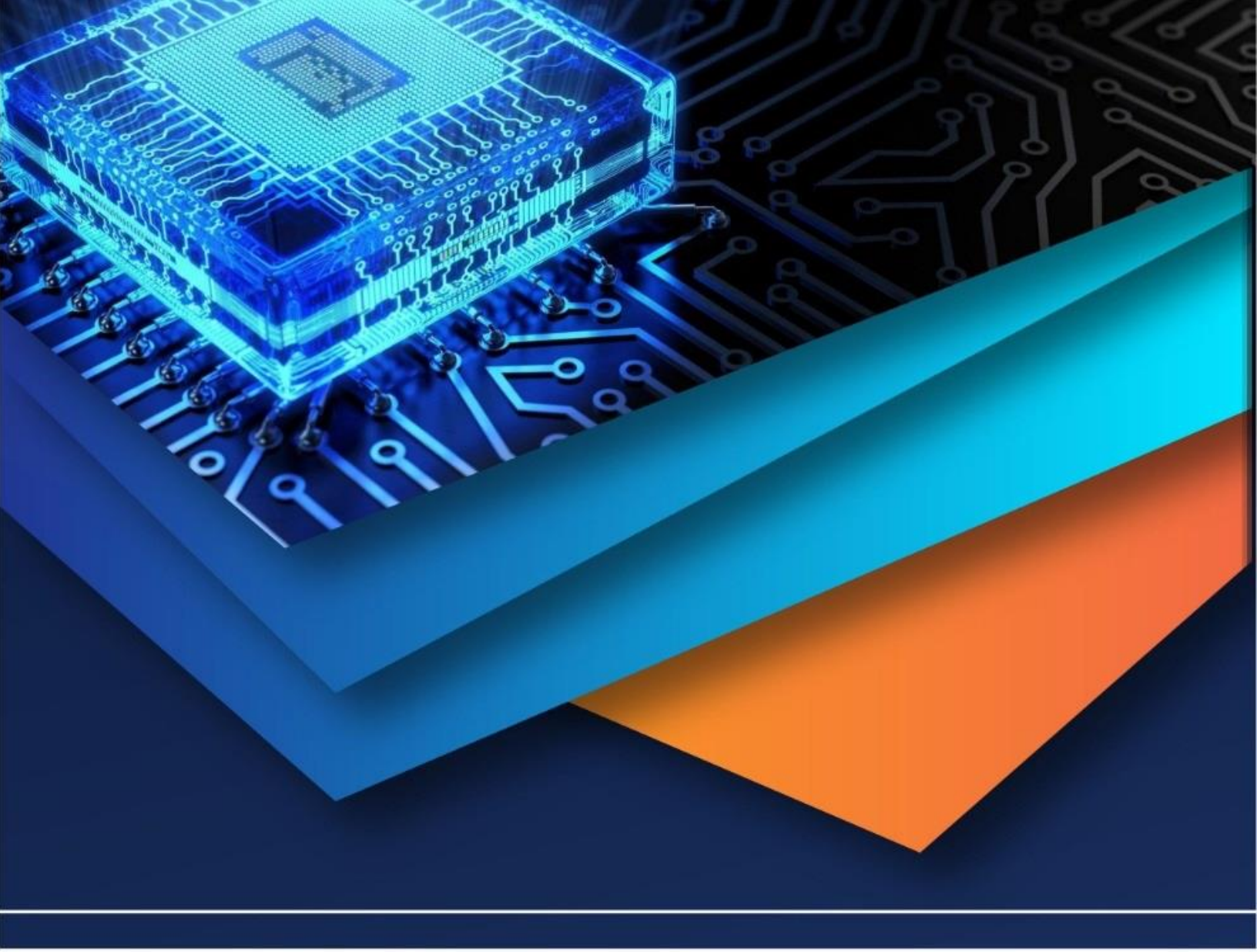
[2] D.Das, R.Esmaili, L.Xu,D.Nichols, " An Optimal Design of a Grid Connected Hybrid Wind/Photovoltaic/Fuel Cell System for Distributed Energy Production" in Proc.IEEE Industrial Electronics Conference,pp.2499-2504,Nov.2005.

[3] N. A. Ahmed, M. Miyatake, and A. K. Alothman,"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, October2008.

[4] S.Jain and V.Agarwal, " An Integrated Hybrid Power Supply for Distributed Generation Applications Fed by Nonconventional Energy Sources," IEEE Transaction s on Energy Conversion,vol.23,June, 2008

[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 Transaction s on Power Electronics, vol.22,May 2007.

[6] Dos Reis, F.S.Tan.K and Islam.S "Using PFC for harmonic mitigation in wind turbine Energy conversion Systems," in Proc. Of the IECON 2004 Conference, pp.3100-3105, Nov.2004.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY