Comparative Study of DC-DC Converters For Dc Microgrid Applications

1st M Madeshwaran,2nd Dr.T.R. Sumithira.

[1] PG Scholar,Depermeant of EEE,Govermeant College of Engineering Salem,Tamilnadu,India.
[2] Assistant Professor, Depermeant of EEE,Govermeant College of Engineering Salem,Tamilnadu,India.

[1] Govermeant College of Engineering, Salem,Tamilnadu,India.
[1]Madeshwaranbe1999@gmail.com,

Abstract - To meet the ever increasing electrical energy demand, energy conversion from PV sources is gaining prominence. When used in the conjunction with existing power system network, the energy extracted from the renewable energy sources can be utilized to electrify remote areas also. The advancements in DC-DC converter topologies the wide emergence of grid tied PV systems. The efficiency at which power is a fed to the grid hinges largely on this proper choice and performance of the DC-DC converter stage. Hence, thereis a compelling need to thoroughly review the performance of existing DC-DC converter topologies. In this work, a comparative study of dc-dc converters for dc microgrid applications for solar PV fed system is presented.There are four novel converter topologies that have been derived by using the proposed strategy are elaborated to is illustrate the validity of the adopted synthesis methodology. The features and the feasibility of connecting the derived topologies to the DC grid/micro grid are highlighted. All the simulation work is done in MATLAB.

Index Terms - DC/DC Converter, Buck converter, Boost converter, Zeta converter, Sepic converter, DC microgrid.

I. Introduction

Power converters have known as outstanding evolution for recent years due to the need of this converters in a large number of applications such as photovoltaic systems, DC microgrids is a inter connection especially because of their intermittent and low voltage power sources [1], [2], electric vehicle charging and discharging [3], [4] and energy storage devices [5]. These applications require DC/DC converters with high power quality, high static gain, reduced output ripple, small size and light weight in order to connect to the DC bus voltage to which loads and storage devices are also connected [6], [7]. All sources and loads are connected to a common DC bus of V; the adopted voltage level was a chosen to be more suitable for this DC microgrid [8]. To interface with this DC bus, a power converter stage is required: DC/DC in order to adapt the voltagelevelt. As can be seen in this figure, most of the used converters are DC/DC converters.

Hence, in order to improve the yield of the systems, a better DC/DC converter is more than a need. In the literature, different classifications of the DC/DC converters were suggested [9], as for example isolated [10] and non- isolated [11], In this paper, a special attention was given DC/DC converters is a four topologies: the basic buck converter boost converter and Zeta converter and Single ended primary inductance (sepic) converter. Recently, many research papers have been focused in Sepic converter [12]-[13] due to its several advantages such as good power and voltage quality and reduced size. such as Sepic converter with coupled-inductor with double windings replacing both basic inductors [14]. Fig.1 Block diagram of dc-dc converters for dc microgrid applications.

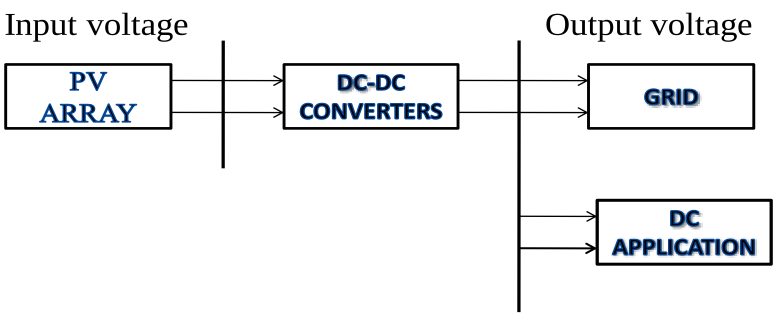

Fig.1 Block diagram of dc-dc converters for dc microgrid applications.

The structure of block diagram is Pv array, DC/DC converters, grid, DC bus, DC application.

II. LITERATURE SURVEY

Manel Jebali Ben Ghorbal[a] Sonia Moussa[b], Jihen Arbi Ziani[c], Ilhem Slama-Belkhodja[d] - DC microgrids are the new trend for renewable energy distributed systems due to their high efficiency and more suitability to new load appliances. However, some problems are still open to discussion as it is an emerging concept. In a DC microgrid, a very important issue consists on an enhanced control of the DC bus voltage. This control should be reliable especially towards power flow variations which can be caused by distributed generation sources or by abrupt load demand.

Pandav Kiran Maroti1, Soroush Esmaeili2, Atif Iqbal1 , Mohammad Meraj1 - The proposed converter consists of a modified SEPIC converter along with a boosting module to obtain a high-voltage gain at a low-duty ratio. It has all advantages of the SEPIC converter such as continuous input current, which makes it applicable for renewable energy sources such as photovoltaic systems. The proposed converter is able to attain a higher voltage gain in comparison with similar previous transformer-less DC–DC converters.

K. Manikandan, A. Sivabalan, R. Sundar, P. Surya - DC-DC converters available are vast inpower conversion system. Neverthless they are different in circuit configuration and ripple reduction. According to the performance and its efficiency for photovoltaic system, the converters are choosed.

H. Chen, X. Hu, Y. Huang, M. Zhang & B. Gao, - The inrush current problem of diode capacitors is restrained by the leakage inductance of the coupled inductor. The above characteristics are the reason for the high-voltage gain and high efficiency of the converter.

III. DESCRIPTION OF THE STUDIED DC MICROGRID

The studied DC microgrid is a DC/DC converter and DC/DC load converters The choice of the input voltage level is due to the fact that the primaryenergy source is a PV panel [8].

DC/DC load converters are connected in the DC bus and behave as Constant Power Loads.. The power circuits of Buck and Boost and Zeta and sepic converters are given in Fig. 2 and Fig. 3 and Fig.4 and Fig .5 respectively

(1)Buck converter

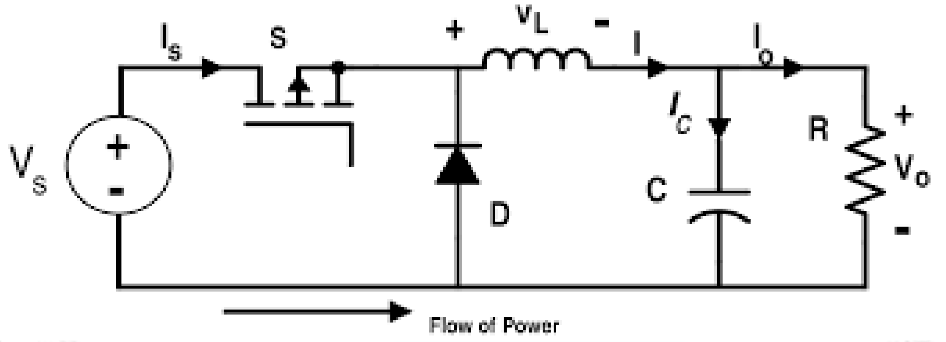

Fig.2 Buck converter power circuit

The voltage gain is given as follows

$$V_o = V_{in} * D$$

(2) Boost converter

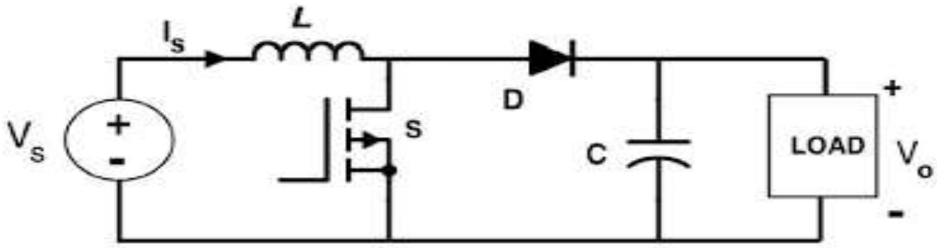

Fig. 3. Boost converter power circuit

The voltage gain is given as follows

$$\frac{\text{Vout}}{\text{Vin}} = \frac{1}{1 - \text{D}}$$

(3) Zeta converter

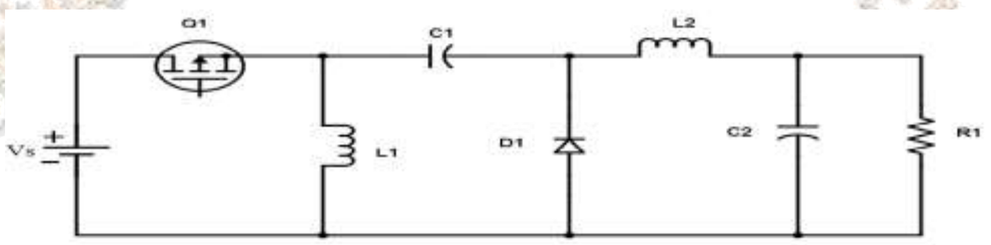

Fig. 4. Zeta. converter power circuit

The voltage gain is given as follows

$\frac{Vo}{Vi}$=D/1-D

(4) Sepic converter

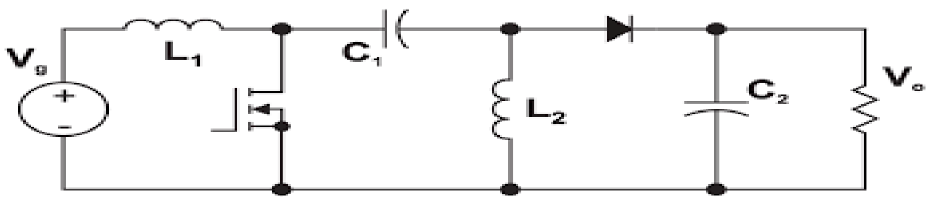

Fig. 5. Sepic converter power circuit

(5)Tables

TABLE 1: Voltage gain conversion ratios

S.NO.	CONVERTER TYPE	VOLTAGE GAIN
1	Buck converter	V_{IN} *D
2	Boost Converter	$\frac{1}{(1-D)}$
3	ZETA converter	$\frac{D}{(1-D)}$
4	SEPIC converter	$\frac{D}{(1-D)}$

TABLE 2: Simulation parameters for DC-DC converters

PARAMETERS	VALUES
Input Voltage, V_i	9 V
Inductor, L_1	89.410^{-6}H
Inductor, L_2	50Mh
Capacitor, C_1	99.510^{-6}F
Capacitor, C_2	66.6710^{-6}F
Duty ratio, D	50%
Switching frequency, f_s	50µHz
Output voltage, V_o	8.197 V

IV. SIMULATION RESULTS FOR DC-DC CONVERTERS

To the MATLAB software platform has been used to simulate the DC/DC converters topology. For (Fig. 6 and 7) all the power circuits, the input values is Vi = 9v , L =$89.4e^{-6}$, C = $99.5e^{-6}$, R = 10 ohm, and the switching frequency of F_s = 50µHz , and the duty ratio, is D = 50% .

The figure 7 & 8 simulation input values is Vi = 9v , L_1 =$89.4e^{-6}$,L_2 =50Mh , C_1 = $99.5e^{-6}$, C_2 = 66.6710^{-6}F, R = 10 ohm, and the switching frequency of F_s = 50µHz, and the duty ratio, is D = 50% .

(1)Buck converter

When the buck converter having the input of 9V, when the simulation circuit is shown.

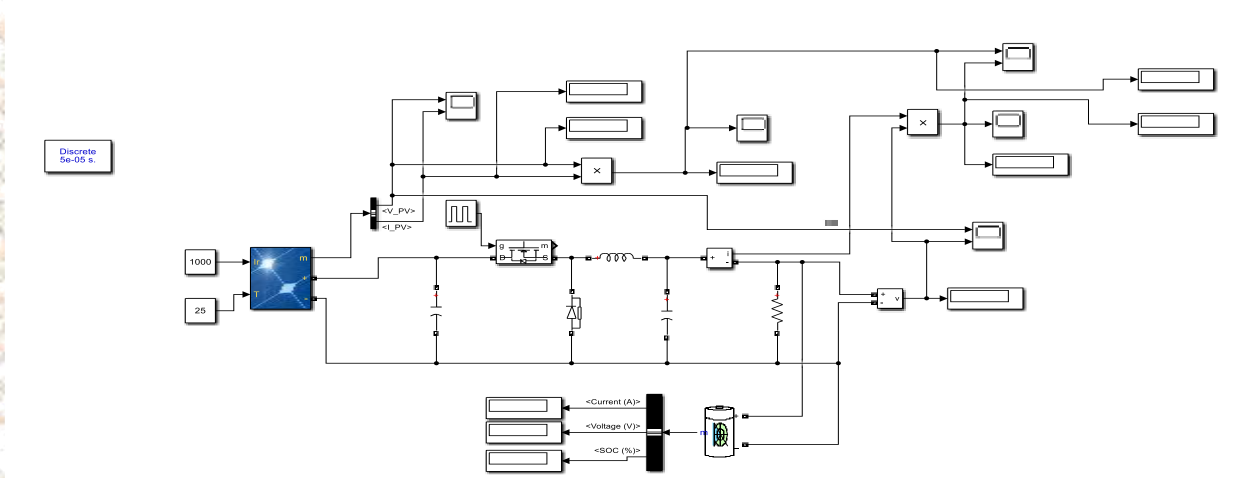

Fig.6 Buck converter simulation model.

The results obtained from the simulation circuit is given in the input values form of output voltage.

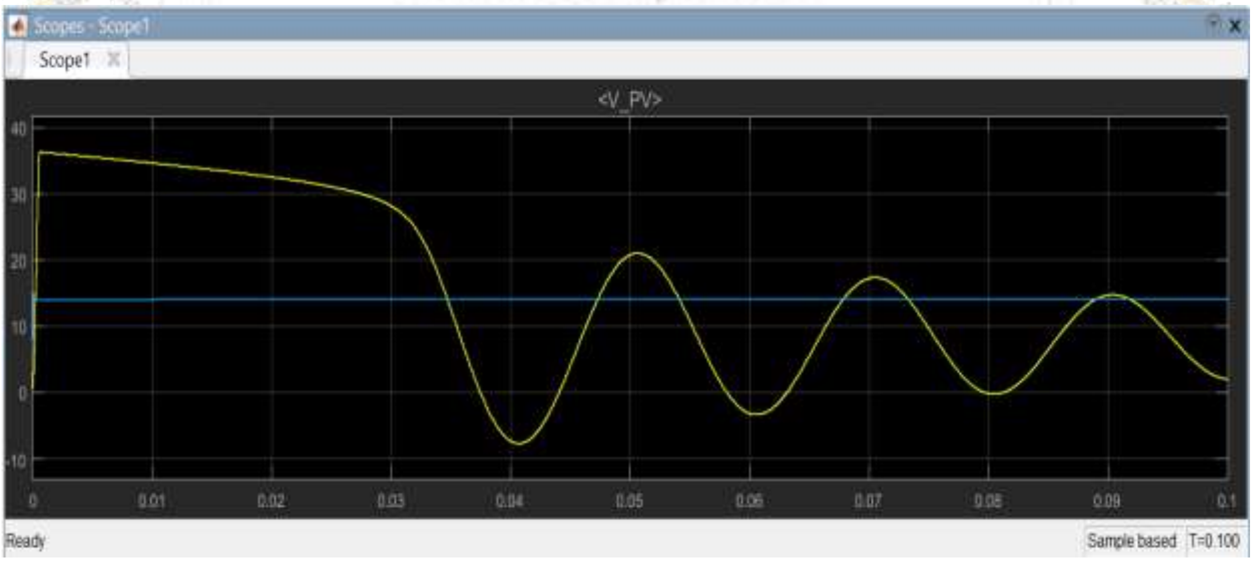

Fig.7 Buck converter simulation of output waveform

(2)Boost converter

When the boost converter having the input of 9V, when the simulation circuit is shown.

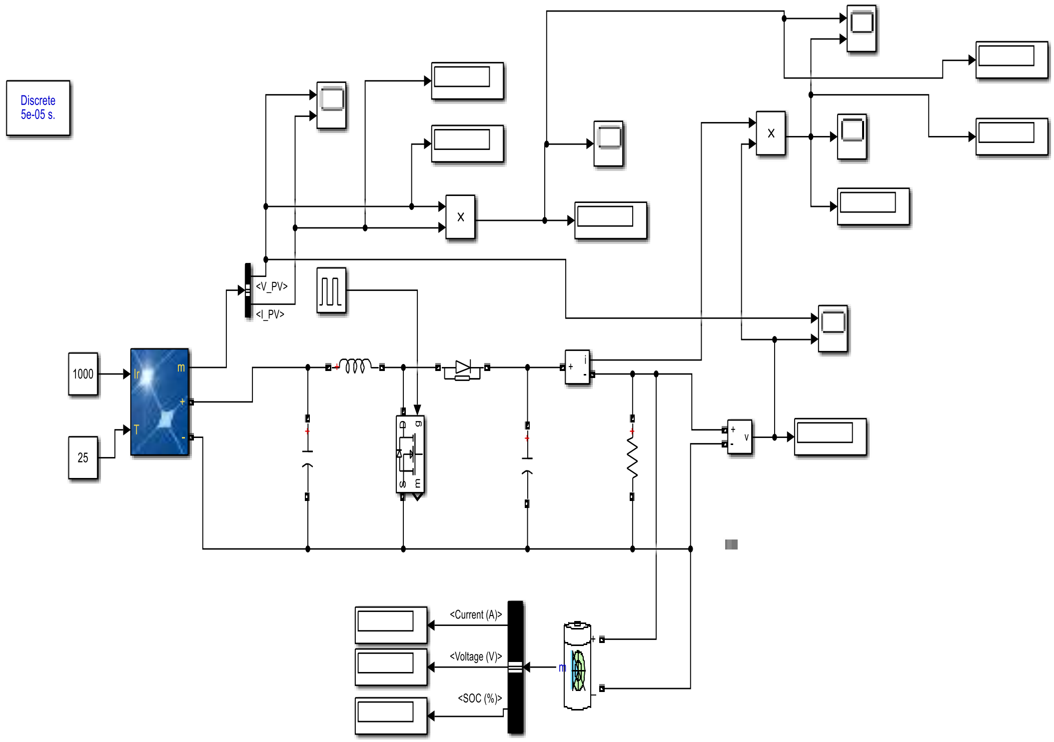

Fig.8: Boost converter simulation model.

The results obtained from the simulation circuit is given in the input values form of output voltage.

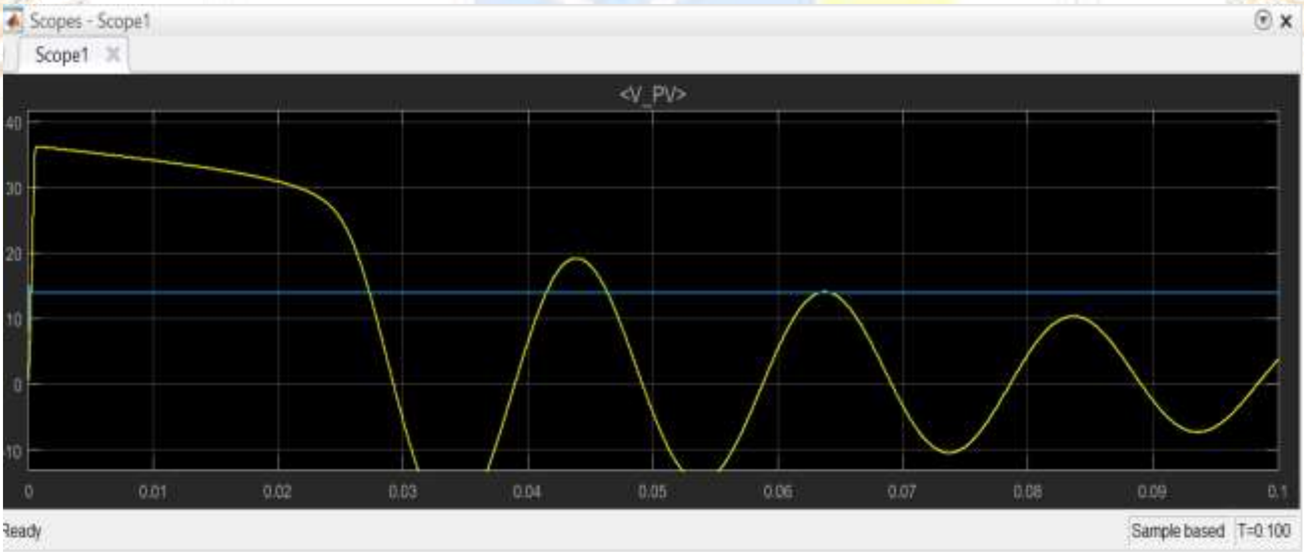

Fig.9: Boost converter simulation of output waveform.

(3)Zeta converter

When the zeta converter having the input of 9V, when the simulation circuit is shown.

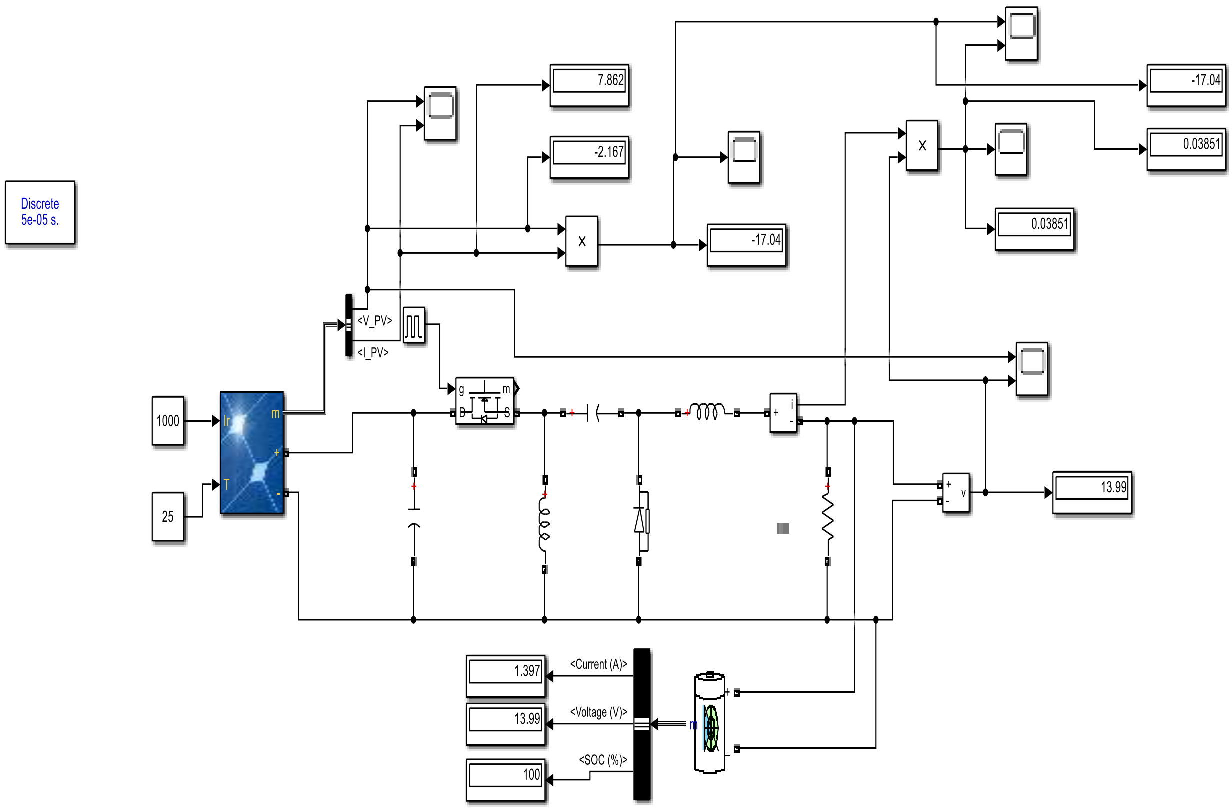

Fig.10: Zeta converter simulation model.

The results obtained from the simulation circuit is given in the input values form of output voltage.

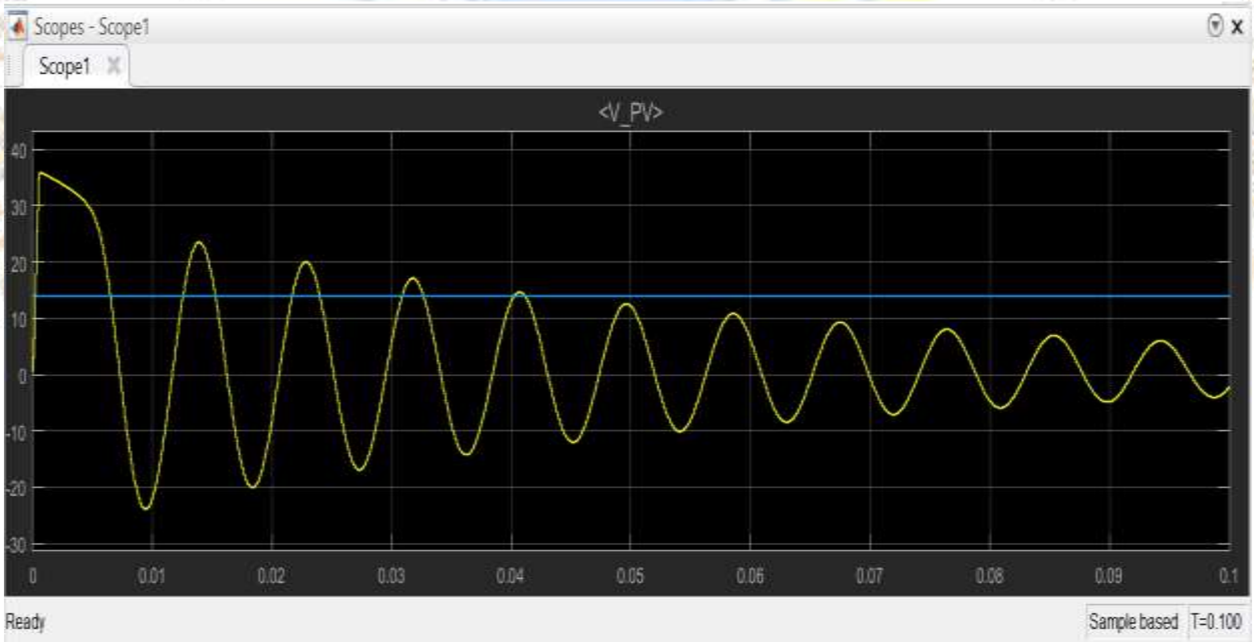

Fig.11: Zeta converter simulation of output waveform.

(4)Sepic converter

When the sepic converter having the input of 9V, when the simulation circuit is shown.

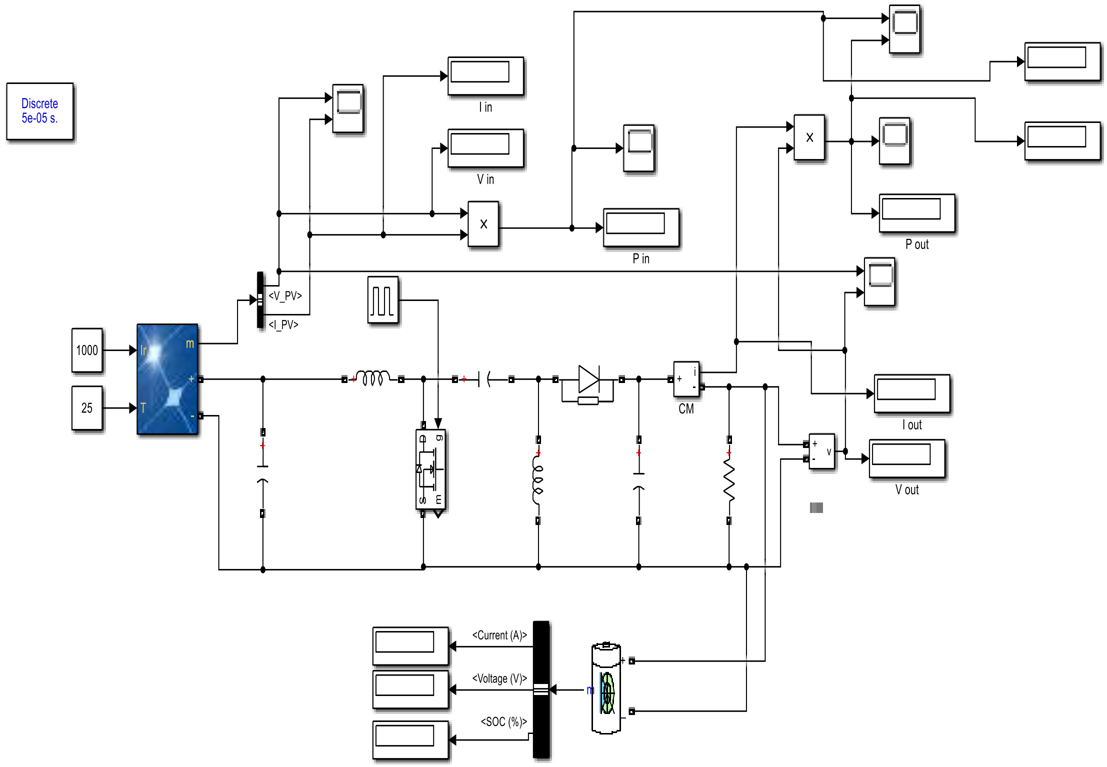

Fig.12: Sepic converter simulation model.

The results obtained from the simulation circuit is given in the input values form of output voltage.

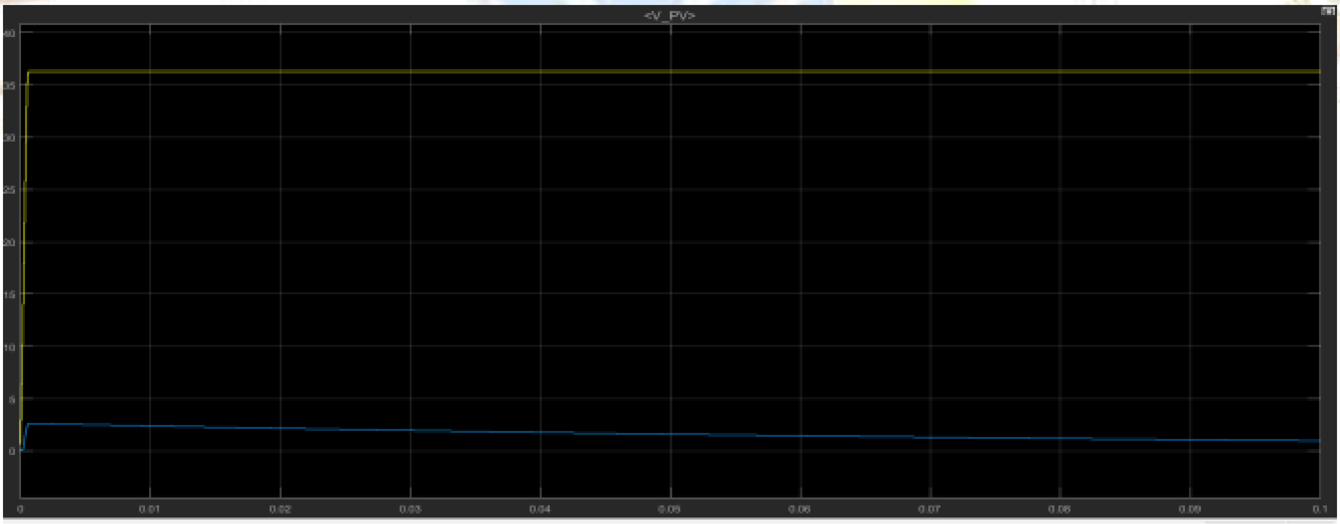

Fig.13: Sepic converter simulation of output waveform.

TABLE 3: Theoretical & Practical comparisons of DC-DC converters

Duty ratio	Converters	input voltage (Vin)	Output voltage(Vo)		voltage gain (Vg)
			Theoretical	**practical**	
0.25	BUCK	9V	2.25	2.134	0.25
	BOOST	9V	12	11.19	0.75
	ZETA	9V	2.197	2.192	0.33
	SEPIC	9V	2.197	3.522	0.33
0.65	BUCK	9V	5.85	5.548	0.65
	BOOST	9V	25.714	23.94	0.35
	ZETA	9V	16.713	14.37	1.857
	SEPIC	9V	16.713	15.23	1.857
0.75	BUCK	9V	6.75	6.52	0.75
	BOOST	9V	36	31.27	0.25
	ZETA	9V	27	16.97	3
	SEPIC	9V	27	23.62	3

These four features explain the quality of the output power of Sepic converter in terms of ripples amplitude as detailed in Fig. 12. This makes Sepic converter a bettercandidate for applications where output power and voltagequality is crucial. This could be very interesting for instance for applications like embedded ones where volumes and densities of passive components have to be very reduced.

V. CONCLUSIONS

In this paper, a comparison study of the performances of four power converters in DC microgrid context is proposed. The first one is a Buck converter and the secondone is the Boost converter and third one is Zeta converter and fourth one is Sepic converter. The study was elaborated in the case where DC/DC converters behave as Constant Power Loads. Sepic converter presents obvious advantages which make it a better choice than basic boost converter. First, output voltage and power reveal lower ripples which provide low conduction losses and reduced stress on components and semiconductors and also better quality compared to the basic boost converter. Experimental results will be subject to future publications to further validate the presented results.

VI. ACKNOWLEDGEMENTS

The authors acknowledge the facilities rendered by the Government Collage of Engineering, Salem For carrying out this work.

VII. REFERENCES

[1] **[1]** M. Jebali Ben Ghorbal, S. Moussa, J. Arbi Ziani & I.Slama Belkhodja, “A comparison study of two DC microgrid controls for a fast and stable DC bus voltage, ” *Mathematics and Computers in Simulation*, available online, 9 March 2020.

[2] S. Bhaskar Mahajan, M. Meraj, A. Iqbal, S. Padmanaban, P. Kiran Maroti & R. Alammari, “High Gain Transformer-Less Double- Duty-Triple-Mode DC/DC Converter for DC Microgrid, ” *IEEE Access* 7, 201

[3] M.Maheshwari, Dr M. Arounassalame Control of Integrated Quadratic Boost Sepic Converter for High Gain Applications. International Conference on Science Technology Engineering and Mathematics (ICONSTEM) 2019.

[4] Pandav Kiran Maroti1, Soroush Esmaeili2, Atif Iqbal1 , Mohammad single switch quadratic modified SEPIC converter

for DC microgrid Applications. IET power electronics 2020.

[5] L. Schmitz, R. F. Coelho Denizar and C. Martins, “High step-up high efficiency dc-dc converter for module-integrated photovoltaic applications, ” *2015 IEEE 13th Brazilian Power Electronics Conference and 1st Southern Power Electronics Conference (COBEP/SPEC)*,2015, Brazil.

[6] K. Manikandan, A. Sivabalan, R. Sundar, P. Surya, “A Study Of Landsman, Sepic And Zeta Converter By Particle Swarm Optimization Technique, ” In *2020 6th International Conference on Advanced Computing and Communication Systems (ICACCS)*, 1035-38, 2020.

[7] H. Chen, X. Hu, Y. Huang, M. Zhang & B. Gao, “Improved DC– DC converter topology for high step-up applications ,” *IET Circuits, Devices Systems* 13, n° 1, 2019.

[8] F. Lima de Sa, C. Dal Agnol, W. Raphael, D. Ruiz Caballero; S. Ahmad Mussa, “A New DC-DC Double Zeta Quadratic Converter,” *2020 IEEE International Conference on Industrial Technology (ICIT),* Consulté le 13 juin 2020.

[9] Ahmed J. Sabzali, EsamH. Ismail, Hussain M. Behbehan,“High voltage step-up integrated double Boost-sepic DC-DC converter for fuel-cell and photovoltaic applications” , Renewable energy, vol. 82, pp44-53, 2015.

[10] Antonio M. S. S. Andrade, Mario L. da S. Martins, “Quadratic-Boost with stacked Zeta converter for High Voltage Gainapplications,” IEEE J. Emerg. Sel. Topics in Power Electron, vol. 5, iss. 4, pp. 1787-1796, 2017.

[11] Tofoli,f.L, Pereira, D.C., de paula, W.J., Junior, D.S.O.: “survey on non-isolated high-voltage step up dc-dc topologies based on the boost converter,” IET Power Electron., 2015, 8, (10) pp. 2044-2057.

[12] Zhao Q Lee FC. High- efficiency, high step-up DC-DC converters. IEEE Trans Power Electron 2003:18(1):65-73.

[13] P. C. M. Bernardo, Z. M. A. Peixoto, L. V. B. Machado Neto, “A high efficient micro-controlled buck converter with maximum power point tracking for photovoltaic systems”, International Conference on Renewable Energies and Power Quality (ICREPQ’09) Spain, April 2009.

[14] M. Veerachary, “Fourth-order buck converter for maximum power point tracking applications,” IEEE Trans. On Aerospace and Electronic Systems, vol. 47, NO. 2, April 2011.

[15] M. H. Rashid, “Power Electronics: Circuits, Devices and Applications”, Prentice-Hall, NJ07458, 2004