Cuk-zeta fused converter topology of converters for maximum power point tracking in hybrid PV-wind system

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***Abstract*- A topology of converters is presented in this paper which is fused cuk-zeta topology connected with hybrid PV- wind. It is also connected with MPPT to obtain maximum power from a hybrid PV-wind system. This topology is invented to find the maximum voltage from the system in minimum current. In this system, it is found that a hybrid system with a fused converter is more beneficial than a single-source connected with only one converter. This system also removes the need for passive input filters. P and O algorithm is used in MPPT and for this work, MATLAB software is used.**

Keywords- Fused Converter Topology, Zeta, Cuk Converter, MPPT.

1. INTRODUCTION

By the time population is increasing the need for electricity is also increasing. There are many sources from which energy is extracted. These all are classified into two types of sources which are renewable and nonrenewable energy sources. Because of the harmful emission of fossil fuels and the exhaustible nature of non-renewable sources, our focus is now shifted to renewable sources. It provides a pollution-free environment and it is non exhaustible along with it has no cost of the input source.

Hybridization is a technique from which maximum power can be found. In this paper, a PV-wind hybrid system is presented which gives maximum energy at all times of the day. Whenever PV or wind system gives energy for a limited time when used separately. As PV system gives energy only during daytime or sunny weather and the wind system gives energy in only night or rainy weather. But when both work together these can work all day and all atmospheric conditions. Due to this, a system is made from a combination of both systems called a hybrid system. In this paper, MPPT is used with the P&O algorithm to extract maximum power to the system. In this paper, a fused converter topology is also proposed which has two inputs and single output is found by this. It is used to remove passive input filters because it removes HF current harmonics. By this topology, this system works simultaneously and it overcomes the problem of fluctuating nature of the system and by this, we find a constant load. It also improves the efficiency of the system.

In this paper, a new topology is used for voltage enhancement of the system which is a combination of two dc-dc converters, one is a cuk converter and another one is a zeta converter. This system is invented for finding the maximum voltage from the system.

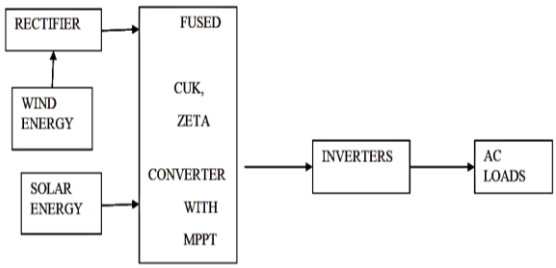


Fig.1. Block diagram of hybrid system connected with fused converter with MPPT

2. MPPT Technique

MPPT stands for maximum power point tracking so it is used to obtain the maximum amount of power from the system whenever an operation is being proceeded. This technique is generally used in PV and wind systems.

In the PV system, it is seen that generation of electricity depends on the amount of light of the sun which receives by PV panel, loads' electrical characteristics, and temperature which solar panel has. When this factor changes the efficiency of power generation is also changes. It can vary from highest to low. To keep efficiency at its peak MPPT technique is used. The work of MPPT is to find a point or can say peak where the highest efficiency is found. It is done to find load characteristics in which the highest efficiency is obtained and maximum power is found.

3. **CONVERTERS**:

To change voltage levels in the system DC-DC converters are used. It is used for step-up and steps down for both purposes. There are electronic devices. In this paper, a fusion of converter is used to find constant load and remove the need for passive input filters. Here two types of converters are fused with is zeta and cuk converters

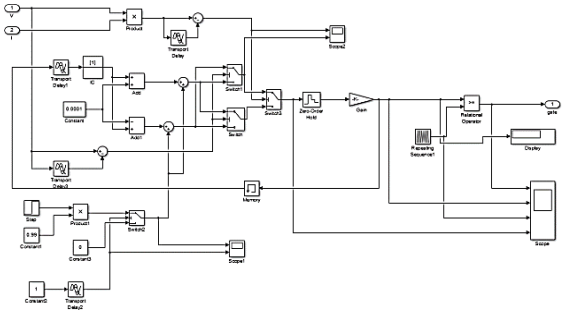


Fig. 2 Mathematical modeling of MPPT

$$M_{cuk} = \frac{Vout}{Vin} = -\frac{ton}{tcw-ton} = -\frac{D}{1-D}$$

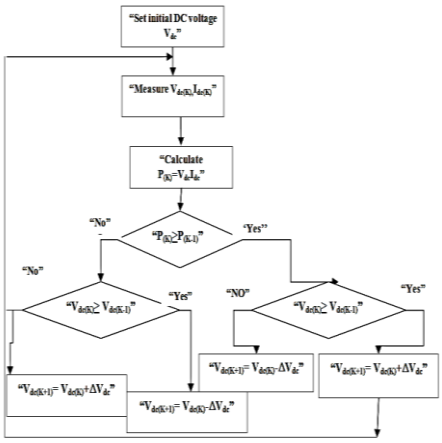


Fig. 3 Flowchart of P&O algorithm

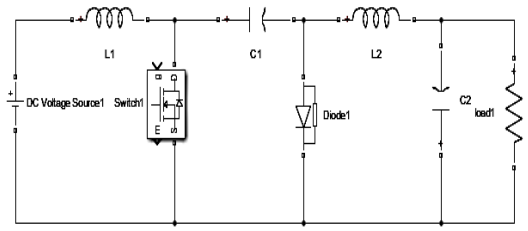


Fig 4. Cuk converter

3.1 Zeta converter:

As a cuk converter, it also proceeds dual technique which is step up and step down of voltage. It has one diode and two inductors in it. Two capacitors are also found in it to store capacity. Zeta converter

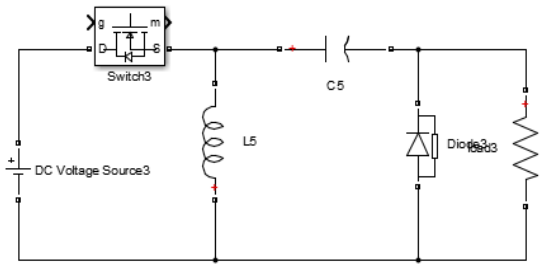


Fig.5 Zeta converter

is used in the proposed hybrid system to make a fusion of converters. In this wind turbine is connected to it for which is the input source for it.

Voltage conversion ratio M_{zeta} of the zeta converter is given by:

$$M_{zeta} = \frac{Vout}{Vin} = \frac{ton}{tcw-ton} = \frac{D}{1-D}$$

$$K_j = 2.4\rho_j V_{s\cdot j}^2(1+\mu_j) \quad (1)$$

3.2 Fused converter topology of converters

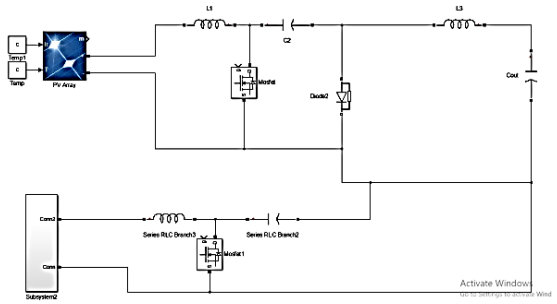
New converter topology has a fusion of two converters which are cuk and zeta converter. For the cuk converter, the input source is the PV system and for the zeta converter, the input source is the wind turbine. This hybrid system gives output voltage which is a combination of two input voltages so from this maximum voltage is found and efficiency is increased.

From the fusion of converters output voltage is found which equation is situated below

$$V_{dc}=\frac{d1}{1-d1}V_{pv}+\frac{d2}{1-d2}$$

A basic circuit diagram of the proposed hybrid system is given below. It has one PV panel and one unit of wind turbine which is connected to cuk and zeta converter respectively. By this, a system is made which has two MOSFETS which are used as switches, three inductors, three capacitors, and a diode. In this model, it is seen that the cuk converter takes input from the PV panel and the zeta converter takes input from the wind turbine. The average power which we will find by this system will be the maximum power generated by the combination of these converters.

Fig.6 Fused converter topology for the hybrid system



4. MODELING OF SYSTEMS

4.1 Modeling of solar panel The solar panel is a type of renewable source. It takes energy from the sun in form of the sun's radiation. Solar cell from which solar panels made is taking this energy for further process. This solar cell is connected in series to make a solar panel.

The below figure shows the basic circuit of the solar cell. It has a diode Id and two types of resistances which are connected in series and in shunt with a diode that has low and high value respectively. In this, a current source is connected in parallel to the diode. The generation of current depends on the radiation of the sun

4.2 Characteristics of PV cell

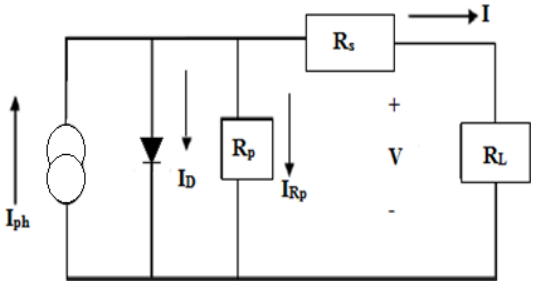


Fig 7 Solar cell characteristic

There are equations related to PV cell charecteristics:

$I = npIph - npIrs[\exp(qv/KTAns) - 1]$
$Irs = Irr(T/Tr)^3[\exp\{qEG/KA(1/Tr - 1/T)\}]$
$EG = EG(0) - \alpha T^2/T+\beta$
$IPh = [Iscr + Ki(T-Tr)]S/100$

Here :

I = current of cell;
I_{ph}= Isolation current;
I_{rs} = reverse saturation current;
I_{rr}=Reverse saturation current of cell
Iscr= Short circuit current of cell(at reference temperature)
q = one electron charge;
V=voltage of cell
k=Boltzman constant ($1.380649*10^{-23}$Joule/Kelvin);
A=Ideality factor
T=Temperature(k);
Tr=Temperature of cell reference
np ,ns=No.of cells in parallel and series respectively;
EG=Semiconductor band gap;
S=Radiation by sun

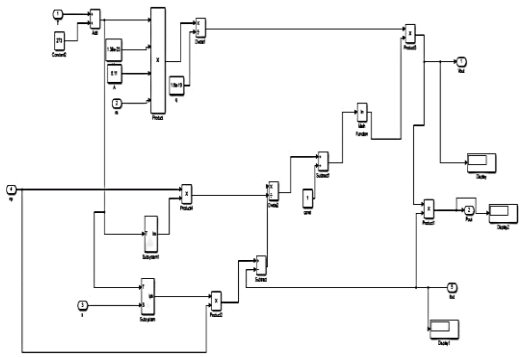


Fig 8 Mathematical modeling of solar panel

Output voltage equation:
$V=(nsKTA/q)\ln\{(np-Iph\ 1/npIrs)+1\}$

By these equations, a mathematical model is proposed in MATLAB software which is given below. By this, we found output voltage, current, and power.

4.3 Modeling of wind turbine

The wind is the source of electricity generation from this electricity is find with no fuel cost. For this wind turbine is made. By blades of this wind is taken in the form of -energy and mechanical energy is obtained by it. A generator is connected with this which converts mechanical energy to electrical energy.IN this system permanent magnet synchronous generator is used.
Power of wind turbine is found by below equation

$P_{wind\ turbine} = 0.5CpAV^3$

Cp = - Pwind turbine Pair(Maximum value of Cp can be defined by the Lanchester-Betz limit);*p* is the air density[1.225 kg/m^3 at 15°C and normal pressure(There is a low-pressure area at the tip of the blade on the pressure surface of the blade. It is mainly caused by the three-dimensional rotation effect at the tip of the blade. In this area, part of the air flows from the pressure surface to the suction surface through the tip of the blade)];
A represents the swept area in (square meter);
V represents the wind velocity without rotor interference (in meter per second)

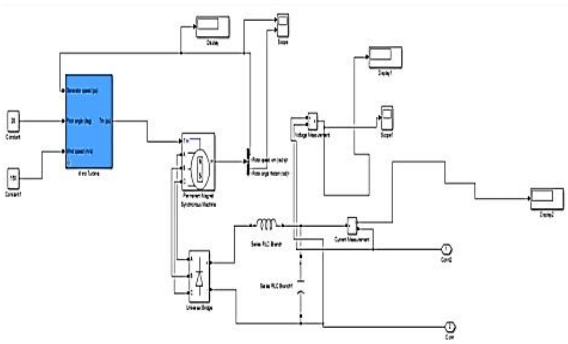


Fig 9 Modeling of wind turbine

Here modeling of the wind turbine takes place in MATLAB software. In this wind turbine is connected to the generator to find electrical energy from the mechanical energy of rotor than rectifier is connected to convert AC to DC than Zeta converter added to step up voltage

5 SIMULATION MODELS

Simulation model of zeta converter fed wind turbine: It is designed to input voltage 40V and output voltage 200V. The below figure shows that the zeta converter fed wind turbine with MPPT. Parameters of zeta converter fed with wind turbine:

Table 1: Zeta converter fed wind turbine

Input Voltage	6v
Output Voltage	40v
Input Current	1.395
Output Current	0.5396
Inductor L1	0.6436mH
InductorL2	0.6436mH
Resistance	300Ω
CapacitorC1	$1*10^6$f
CapacitorC2	$1*10^6$f
Duty Cycle	0.8691
Switching frequency	20kHz

5.1 Cuk converter fed PV panel

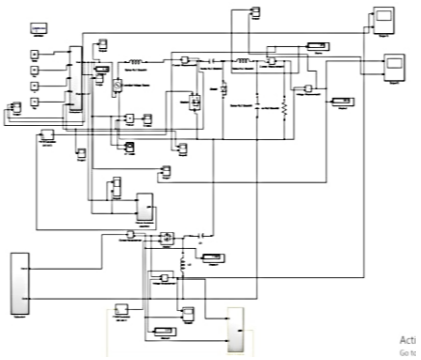


Fig 10 Cuk converter fed with PV panel

Parameters of cuk converter fed PV panel

Table 2: Parameters for cuk converter fed PV panel

Input Voltage	39.33
Output Voltage	269.3
Input Current	7.075
Output Current	0.8977
Inductor L1	0.6436mH
InductorL2	0.6436mH
Resistance	300Ω
CapacitorC1	$2.657*10^6$f
CapacitorC2	$1*10^6$f
Duty Cycle	0.8691
Switching frequency	20kHz

Parameters for sandwich topology

Table 3: Parameters for fused topology

Output voltage	310V
Output current	1.036A
Inductor L1	0.7mH
InductorL2	5.36mH
Resistance	300Ω
CapacitorC1	$2.657*10^6$f
CapacitorC2	$1*10^6$f
Duty Cycle	0.8691
Switching frequency	20kHz

The maximum output voltage is shown in the above table. By this, it is found that the fused converter has output voltage which is the combination of all input voltages.

Simulink model of the proposed system is shown below:

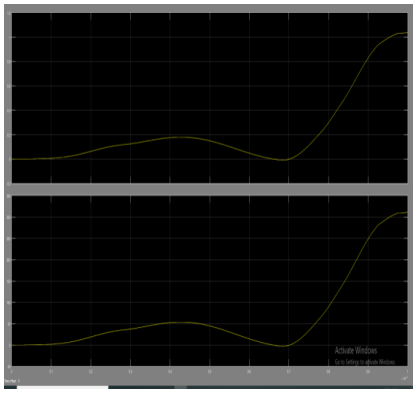


Fig.11 Cuk-zeta fused converter topology for hybrid renewable system

6. RESULT AND DISCUSSION

Simulation result for zeta converter fed wind turbine: This is the waveform of 40Voutput voltage and 0.1356A output current which is found by zeta converter which is fed by wind turbine and connected to MPPT for maximum power point tracking.

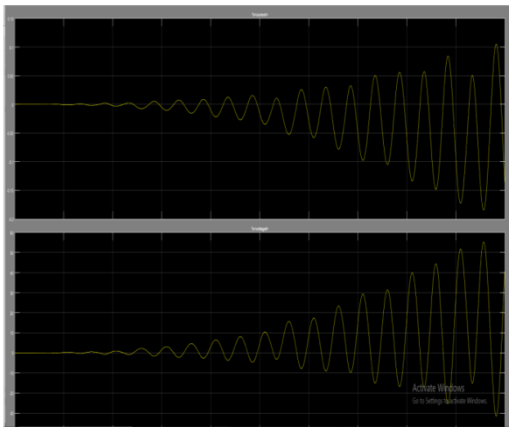


Fig 12. Zeta converter fed wind turbine

Simulation result of Cuk converter fed PV panel: This is the waveform for 0.8977A output current and 270V output voltage of Cuk converter fed PV panel which is connected to MPPT for maximum power point tracking and has switching frequency 20kHZ

Simulation result of proposed hybrid system: The output voltage of the hybrid system is the combination of the output voltage of the PV fed cuk converter and output voltage wind fed zeta converter. It is designed for 310v output voltage and 1.036A input current.

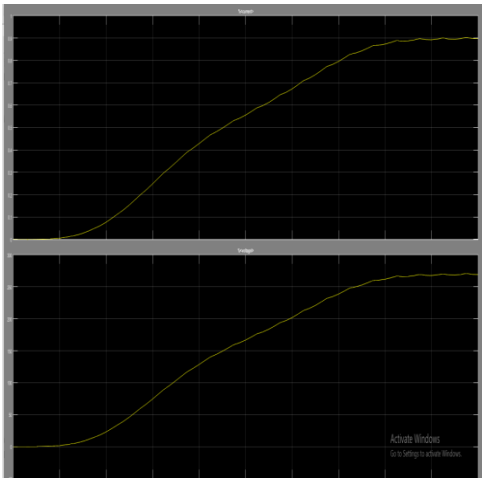


Fig 13 Cuk converter fed with PV panel

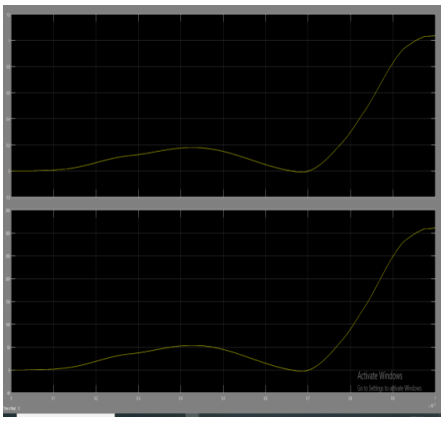


Fig. 14 Simulation result of the proposed hybrid system

6 CONCLUSION

With the increasing demand of population takes demand of electricity along with. To find maximum power from sources this system has been proposed. By this system, the constant load is found. By fusion of converters, it removes the necessity of passive input filters also and by this, it has a low cost. By use of MPPT maximum power is obtained by his system. To take input fuels from solar and wind it generates energy. By this system, it is found that output voltage is a combination of all output voltage which is found separately. By the use of a hybrid system in all atmospheric conditions, energy is obtained.

7 FUTURE SCOPE FOR THIS SYSTEM

In this system, another type of input source is used like hydro, geothermal, etc.Three units can be combined in place of two units Other types of converters can be used

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