Integrated Multi Input CUK Converter Used Standalone System for WECS and PV

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Abstract-The contribution of a renewable power source to the total power generation becomes more and more important. Wind and photovoltaic (PV) power generation are two of the most promising renewable energy technologies. These systems help in reducing the cost as well as emissions. Stand alone or of grid systems are mostly commonly used to power a building or a remote location. Along with the renewable energy sources these systems also use battery in order to ensure a continuous reliable supply. This particular thesis focuses on the Solar-Wind hybrid power solutions, which uses a single multi input CUK converter instead of individual converters. Multi input converters help in reducing the complexity of circuit as well as reduces the control section. In this project, the simulation of hybrid system has been done using MATLAB and the multi input CUK converter has been designed.

Index Terms- Micro grid1, Hybrid System2, Multi Input Converters3.

1. INTRODUCTION

Electricity is one the most essential needs for humans in the present. Conversion of renewable energy into electricity not only improves generation of electricity but also reduces pollution due to fossil fuels [1]. Due to the fossil fuel exhaustion and the environmental problems caused by the conventional power generation such as gasoline, coal, etc renewable energy sources and among them photo voltaic panels and wind-generators are now widely used [2]. Significant progress has been made over the last few years in the research and development of renewable energy systems such as wind, sea wave and solar energy systems.

The scarcity of conventional energy resources, rise in the fuel prices and concern for the environment from the burning of fossil fuels has made power generation from conventional energy sources unsustainable and nonviable. It is envisaged that supply-demand gap will continue to rise exponentially unless it is met by some other means of power generation. Inaccessibility of the grid power to the remote places and the lack of rural electrification have prompted for alternative sources of energy. The non-conventional energy resources, such as water, wind, sun, and biomass, have become better alternatives for conventional energy resources[3]. From socioeconomic and environmental view points, exploitation of renewable energy enhances supply security, provides local solutions, lowers environmental impacts, offers sustainable energy development and provides job opportunities. In developing country like India, most of the population lives in isolated rural areas and electrification in decentralized mode by nearby available renewable energy resources will benefit the overall development of these areas.

The locally available renewable energy resources in remote rural areas mainly include micro hydro power (MHP), biomass, wind and solar photo voltaic (SPV).

2. HYBRID SYSTEM

Studies shows that hybrid system have more advantages [4]. Renewable energy are mainly used in hybrid system as the energy source. Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides and geothermal heat. These resources are renewable and can be naturally replenished. Therefore, for all practical purposes, these resources can be considered to be inexhaustible, unlike dwindling conventional fossil fuels. The global energy crunch has provided a renewed impetus to the growth and development of Clean and Renewable Energy sources. Clean Development Mechanisms (CDMs) are being adopted by organizations all across the globe. Apart from the rapidly decreasing reserves of fossil fuels in the world, another major factor working against fossil fuels is the pollution associated with their combustion. Contrastingly, renewable energy sources are known to be much cleaner and produce energy without the harmful effects of pollution unlike their conventional counterparts.

2.1. *Stand Alone System*

More than 200 million people, live in rural areas without access to grid connected power. In India, over 80,000 villages remain to be un electrified and about 400 villages (with 63tribes) are difficult to supply electricity due to inherent problems of

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location and economy [5]. The costs to install and service the distribution lines are considerably high for remote areas. Also there will be a substantial increase in transmission line losses in addition to poor power supply reliability. Like several other developing countries, India is characterized by severe energy deficit. In most of the remote and non-electrified sites, extension of utility grid lines experiences a number of problems such as high capital investment, high lead time, low load factor, poor voltage regulation and frequent power supply interruptions. There is a growing interest in harnessing renewable energy sources since they are naturally available, pollution free and inexhaustible. At present, standalone solar photo voltaic and wind systems have been promoted around the globe on a comparatively larger scale. These independent systems cannot provide continuous source of energy, as they are seasonal. For. example, standalone solar photo voltaic energy system cannot provide reliable power during non-sunny days. The standalone wind system cannot satisfy constant load demands due to significant fluctuations in the magnitude of wind speeds from hour to hour throughout the year. Therefore, energy storage systems will be required for each of these systems in order to satisfy the power demands. Usually storage system is expensive and the size has to be reduced to a minimum possible for the renewable energy system to be cost effective[5]. Hybrid power systems can be used to reduce energy storage requirements.

2.2. PV System

Photo voltaic (PV) is the name of a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photo voltaic effect, a phenomenon commonly studied in physics, photo chemistry and electrochemistry. A photo voltaic system employs solar panels composed of a number of solar cells to supply usable solar power. Power generation from solar PV has long been seen as a clean sustainable energy technology which draws upon the planet's most plentiful and widely distributed renewable energy source the sun. The direct conversion of sunlight to electricity occurs without any moving parts or environmental emissions during operation. It is well proven, as photo voltaic systems have now been used for fifty years in specialized applications, and grid-connected PV systems have been in use for over twenty years. Photovoltaics (PV) is the name of a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect, a phenomenon commonly studied in physics, photochemistry and electrochemistry. A

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Solar system energy is the most important renewable and sustainable energy system. Solar-electric-energy system has grown consistently and become a popular resource of energy. The main reasons for this huge attention are;

(1) increase in efficiency of solar cells
(2) recent technological improvements
(3) green and environmental friendship

Typical applications of solar energy are supply the residential loads and far off electrical installations. It also has a major role in distributed generation network. Right now solar cell efficiency is relatively low around 12 to 20%,[3] it means that PV panel can harvest a little amount of sunlight energy.

2.3. *Maximum Power Point Tracking*

The recent change in the environmental conditions such as global warming and the rapid increase in the demand for electricity led to a need for a new source of energy that is cheaper and sustainable with less carbon emissions. Solar energy has offered promising results in the quest of finding the solution to the problem. If used in a proper way then it has the capacity to fulfill numerous energy needs of the world. That is why researchers are more inclined towards this area. A photovoltaic system converts sunlight into electricity by photovoltaic effect. Photovoltaic (PV) electrical energy generation provides several advantages with respect to other energy sources like it uses the inexhaustible world-wide available sunlight as a source of energy, it does not generate environmental pollutants and also the PV panels used requires minimum maintenance. However, the major challenges in such type of system includes the high cost of PV panel and also the solar energy is a dilute source of energy and its availability varies widely with time and with different atmospheric condition[6]. So, it is very necessary to make a complete utilization of solar energy in such available conditions and for this maximum power point tracking controller is essential for the PV

system to extract maximum power at given atmospheric condition.

In photovoltaic system generates electrical energy from sunlight. At unique point on P-V or I-V curve of PV system, The PV cell generates maximum power, called Maximum Power Point. Due change in radiation and temperature the current generation from PV modules also changes. Voltage current a curve of PV modules shows non linearity for different temperature and radiation conditions an optimum load which extracts the maximum energy from PV cells [5].

There are different approaches for PV module MPPT. A PV array is by nature a nonlinear power source, which under constant uniform irradiance has a current-voltage (I-V) characteristic like that shown in Fig.1.
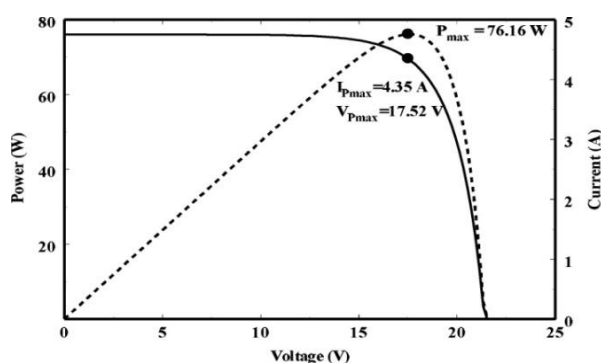
Fig 1: PV array I V and PV characteristics

There is a unique point on the curve, called the maximum power point (MPP), at which the array operates with maximum efficiency and produces maximum output power. As it is well known, the MPP of a PV power generation system depends on array temperature, solar insolation, shading conditions, and PV cells aging, So it is necessary to constantly track the MPP of the solar array. A switch-mode power converter, called a maximum power point tracker (MPPT), can be used to maintain the PV arrays operating point at the MPP. The MPPT does this by controlling the PV arrays voltage or current independently of those of the load. If properly controlled by an MPPT algorithm, the MPPT can locate and track the MPP of the PV array [7]. However, the location of the MPP in the IV plane is not known a priory.

2.4. *Wind Turbine*

Wind-powered machines have been used by humans for thousands of years. Until the 20th century wind power was used to provide mechanical power to pump water or to grind grain. The earliest recorded windmills are vertical-axis mills and were used in Afghanistan in the seventh

century BC. Horizontal-axis windmills are found in historical documents from Persia, Tibet and China around 1000 AD. From Persia and the Middle-East, the horizontal-axis windmill spread across Europe in the 12th century, where windmill performance was constantly improved; by the 19th century a considerable part of the power used in the industry in Europe was based on wind energy. Industrialization then led to a gradual decline in windmills, as the use of un fluctuating wind energy was substituted by fossil fuel fired engines which provided a more consistent power source .

A wind turbine is a machine for converting the kinetic energy in the wind into mechanical energy. If the mechanical energy is used directly by machinery, such as a pump or grinding stones, the machine is called a windmill. If the mechanical energy is then converted to electricity, the machine is called a wind generator. Utility-scale turbines range in size from 100 kilowatts to several megawatts.

2.5. *Converters*

DC-to-DC regulators are also known as Switching Regulators which uses power switches like an inductor, a capacitor and a diode to transfer power from input to output. The switches are generally passive or Active type. Passive switches consist of a diode, whereas the active switches are like MOSFET transistor. MOSFET transistors are an efficient and fast way to allow a pulse width modulation (PWM) signal to control the frequency and duty cycle of the ON and OFF time of the switch. More power is transferred from input to output when Duty cycle is high. One of the advantages of the PWM is that the signal remains digital from the source i.e. from the Microcontroller to the MOSFETs so that any analog-to-digital signals conversion is no more needed. Digital signals are very rarely affected from outside noise, unless the noise is large to change the signal from one to zero or vice versa. There are many DC-to-DC converters so far studied. Some are like Buck, Boost, Buck-Boost, CUK, and SEPIC. These regulators do not produce power. In fact some of the input power according to their efficiency is consumed by these Regulators. Therefore considering ideal case to maintain the same power level the adjusted voltage level affects the current level. Since current and voltage are both directly proportional to power therefore in buck mode the voltage is reduced as the current increases. While in boost mode the voltage is increased as the current decreases. The Solar Charge controller consists of various components like Dc-Dc Converter, Microcontroller, LCD, Temperature sensors, Voltage sensors, Current sensors, Irradiance

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Sensors [7]. The Dc- Dc Converter is one among the major component of the controller which receives the input voltage from the PV panel and converts the voltage without use of transformer and gives the desired output as that required for various charging stages of Battery.

3. CONVERTER TOPOLOGIE

Since most DG technologies inherently produce dc power, there are two basic families of converters that can be used to integrate these local generation units into a common main system bus to form a dc micro grid. One, exemplified in Fig.2 is the conventional approach of using SICs. The other, exemplified in Fig.3 is to use MICs. MICs are typically realized by taking a conventional SIC and
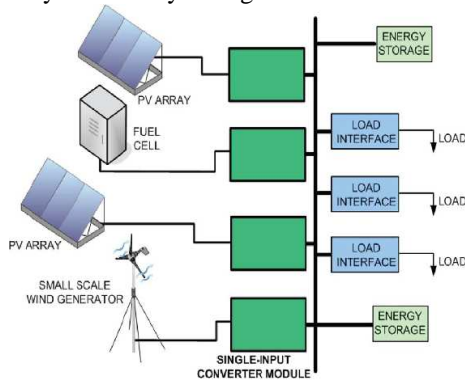
Fig.2. Possible dc micro grid architecture with

SICs

Splitting its circuit into a common output stage and an input stage that is replicated in order to produce one input for each replicated original input stage. Hence, MICs tend to facilitate integrating various sources. Some of the past studies that describe alternative ways of realizing MICs [8]. Although some previous works on MICs claim without proof that they can achieve higher reliability ,it is not clear how this characteristic can be verified considering that the common output stage may act as a single point of failure for all sources connected to that same MIC module, thus, negating the advantage of having diverse inputs. For this reason, it is relevant to quantitatively evaluate how MIC design affects micro grids availability.
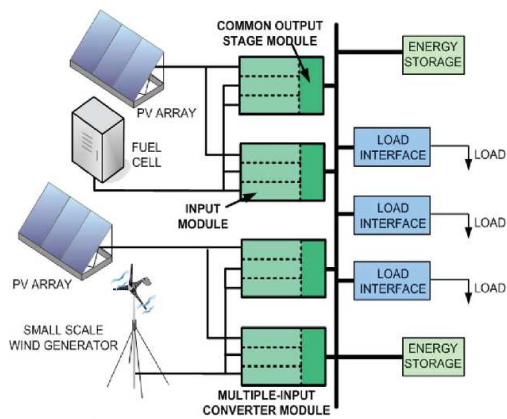

Fig.3. Possible dc micro grid architecture with MICs

Fig.4, 5 and 6 shows three of the most general ways in which MICs can be realized depending on the connection point among input modules and one example of a representative circuit topology for each case. The simplest approach is to make all inputs to share only the output capacitor, as in the MI boost. Yet, this approach, shown in Fig. 4, is only arguably a MIC because it can also be considered a parallel connection of boost converters in which the output capacitor of each boost converter is replaced by a single capacitor. Another option is to link all inputs magnetically at a common magnetic core, as shown in the MI CSHB in Fig.5.

The third option, displayed in Fig. 6 and exemplified with a MI ISEPIC , is to make the input modules to share at least one uncontrolled switch and a capacitor and possibly an inductor or coupled inductors. Since these three dc-dc converter topologies boost, ISEPIC, and CSHB are representative of most other
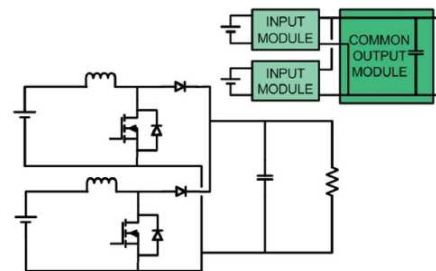

Fig.4.Boost Converter

realizable circuit topologies, they were chosen as benchmark cases for the analysis. Most other likely chosen topologies for micro grids, including, but not limited to buck boost, fly back, Cuk, push pull, or half bridge, have similar number of components and arrangement than one of the three reference circuits, so difference in reliability calculations with

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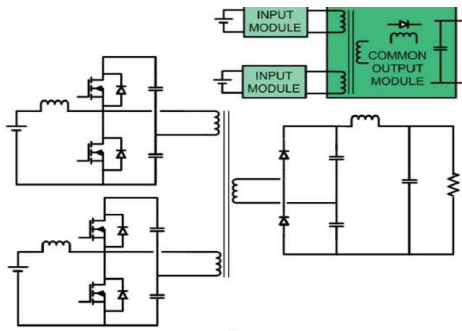the corresponding similar topology of these other converters are negligible.

Fig.5. CSHB

The three chosen topologies have some subtle differences that make them, from a practical perspective, slightly more likely to be chosen for micro-grid interfaces. All three, boost, ISEPIC, and CSHB converters, have a current source interface, which makes them suitable to all type of sources, particularly to those, such as fuel cells, that require
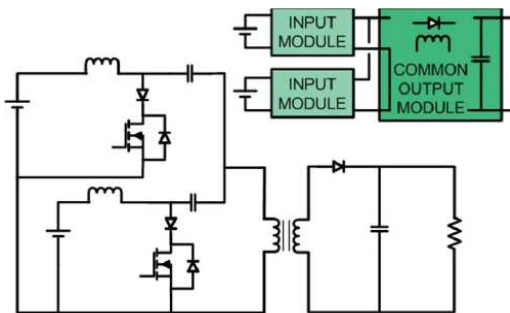
Fig.6. ISEPIC

relatively continuous current output. In addition to provide universal source compatibility and avoid affecting fuel cells life with discontinuous currents, current source interface converters facilitates maximum power point tracking (MPPT) and almost eliminate current ripple that may reduce MPPT algorithms efficacy. Moreover, contrary to the boost converter, the ISEPIC can be controlled to both increase and decrease the DG unit voltage, so the entire output characteristic of the source can be tracked in search for a maximum power point of operation. Furthermore, the ISEPIC and CSHB may have high-voltage step-up conversion ratios, so sources with inherently low voltages, such as PV modules and fuel cells, can be easily integrated without compromising reliability by connecting many power generation cells in series.

4. HYBRID SYSTEM WITH MI CUK CONVERTER

Fig.7 shows the overall architecture of the proposed micro grid with wind and PV resources. Its main energy sources, wind and solar radiation, are transformed in a wind generator and PV modules. In order to combine these energy sources, a CSI MIC, such as an MI Cuk converter or an MI SEPIC converter with a dc bus system, is used because a CSI MIC is more effective for maximum power point (MPP) tracking in PV modules and for the input current control method used in this micro grid. MICs were chosen because they provide a cost effective and flexible method to interface various renewable energy sources. In addition, a dc power distribution system is chosen because dc power systems may achieve higher availability and energy efficiency in a simpler way than equivalent ac power systems . A voltage level of 380 V is considered to be the main dc bus voltage in this power system because it is more suitable for bidirectional power flow between the intended power system and the utility grid and because it is the likely voltage to be chosen in a future standard for industrial applications with dc distribution, such as in data centers. However, a three-phase rectifier in the wind generator may be required for this dc distribution system because the output voltage of the wind generator is usually ac. As depicted in Fig.7 an energy storage system (ESS) is also connected to the main dc bus in order to overcome the intermittent properties of renewable energy sources and to support local power production in an islanded mode particularly during blackouts or natural disasters.

Depending on applications, the various voltage levels of local dc loads such as 60 V telecommunication power systems or plug-in electric vehicles can be accommodated through an additional dc-dc converter as described in Fig.7. The local ac loads whose line-to-line voltage level is in this micro grid can also be connected with a PWM inverter.
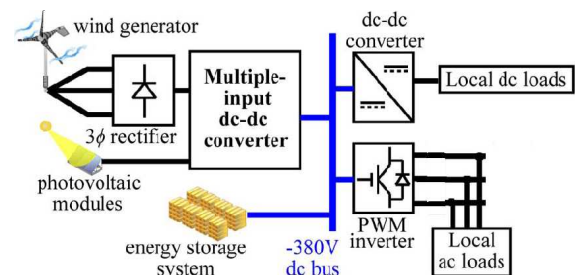

Fig.7. Overall architecture of the proposed sustainable microgrid

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4.1. *Wind Turbine Model*

A wind turbine in the proposed micro grid simulation study is modeled by an aerodynamic input torque which drives a wind generator. In order to explain the wind turbine model here, the mechanical power captured by the blades of a wind turbine is described as follows.

$$P_m = \frac{1}{2} C_p(\lambda, \beta) \rho \prod R^2 V^3 \qquad (1)$$

where is a rotor power coefficient C_p, is a blade pitch angle, is a tip-speed ratio (TSR), λ is an air density, R is the radius of a wind turbine blade, and V is a wind speed. The rotor power coefficient is defined by the fraction of the available wind power that can be transformed to the mechanical power by a rotor . This rotor power coefficient (C_p) depends on the blade aerodynamics, which is the function (β) of a blade pitch angle and a TSR (λ). The type of a wind turbine rotor may also be another factor affecting the rotor power coefficient (C_p). However, the C_p of in which a general blade type was assumed is used in this study for the sake of simplicity

$$C_p = (0.44 - 0.0167\beta)\sin(\frac{\prod(\lambda - 2)}{13 - 0.3\beta}) \qquad (2)$$

Table 1.Parameters and specification of the wind turbine model

Parameter Name	Value	Unit
rated power	20	kW
rated wind speed	12	m/s
rated rotor speed	27.5413	rad/s
blade radius	3.7	m
blade pitch angle	0	degree
air density	1.225	kg/ m^3

The TSR (λ) can be defined as the function of a wind speed written as

$$\lambda = \frac{\omega_m R}{V_{wind}} \qquad (3)$$

where ω_m is the rotor speed of a wind turbine. Then, from (1), (3), and considering that

$$T_m = \frac{P_m}{\omega_m} \qquad (4)$$

The aerodynamic input torque T_m by which a wind generator is driven can be obtained as follows

$$T_m = \frac{C_p(\beta, \lambda)\rho \prod R^5}{2\lambda^3} \omega_m^3 \qquad (5)$$

The wind turbine in the simulation study is modeled by (5) in which the input variables are the wind turbine rotor speed and the TSR that can be calculated with (3). The parameters of the investigated wind turbine model in this paper are shown in Table 1. According to (4) and (5), the aerodynamic torque is maximized at a given wind speed when the pitch angle of a blade is 0.

4.2. *Direct-Driven PMSG*

The wind generator considered here is a gearless direct- driven PSMG. This PMSG does not require frequent mechanical maintenance because it does not use gears between wind blades and the generator. Another advantage of the direct driven PMSG is that a permanent magnet eliminates the dc excitation circuit that may complicate the control hardware. Table 2 shows the specifications of the direct driven PMSG model used in the simulation study. For the simulation study, the internal model of a PMSG in MATLAB Simulink/Sim power systems is used with the specifications provided in Table 2.

Table 2: Specification of the Direct Driven PMSG Model

Parameter Name	Value	Unit
rated power	20	kW
rated line voltage	519.6	V$_{rms}$
Stator phase inductance	8.5	mH
Stator phase resistance	.35	Ω
No: of poles	12	
Rated mechanical speed	263	rpm

4.3. *PV System Model*

This study uses the PV model that is depicted in Fig.8 and was proposed in Table 3 because it is suitable for simulating practical PV systems which are composed of numerous PV modules and because it only requires a few parameters, such as the number of PV modules, PV array open-circuit voltage and short-circuit current. Moreover, this model can represent solar irradiance and temperature changes which may happen commonly during the day. The detailed discussions of this PV model are out of the scope of this paper; however, a reader may refer to for explanation of such model derivations .The rated power of the PV system in this paper is 250W.
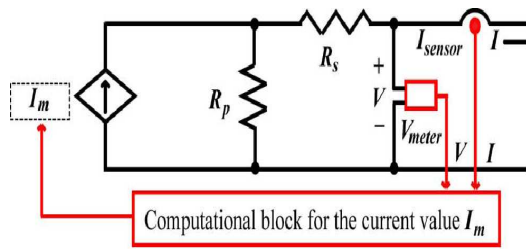
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Fig.8. Circuit-based PV model used in the

simulation study

4.4. *MI CSI Converter*

Among MIC topologies MI CSI converters such as an MI Cuk converter and an MI SEPIC converter can be used in this micro grid. These MI CSI converters provide nearly continuous input current waveforms due to their CSI input legs. Hence, these converters provide more operational flexibility than an MI buck-boost converter because they allow the integration of input sources that require a relatively constant current, such as the input current control that is used in this power plant. An MI Cuk converter is similar to an MI SEPIC converter except for the output voltage inversion. However, since there are more past works focusing exclusively on the MI SEPIC, the analysis here focuses on the MI Cuk converter shown in Fig.9.
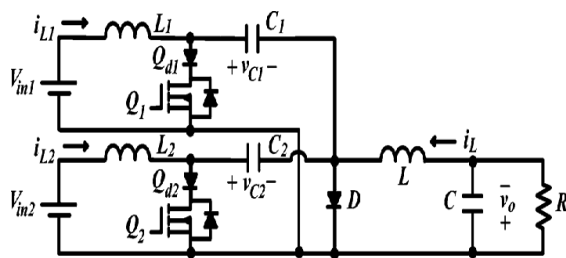
Fig.9. MI Cuk dc-dc converter
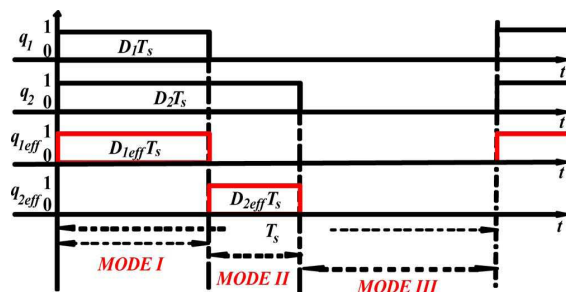
Fig.10. Switching diagram of the MI Cuk dc-dc converter

Fig.10. illustrates the switching diagram of an MI cuk converter. If it is assumed to be operated in a continuous conduction mode, circuit operation in a steady state can be described based on the following three operational modes.

1. Mode 1 (Fig.11 (a); $0 < t < D_1 T_s$): It is assumed that the voltage level of the first input source (V_{in1}) is higher than that of the second input source (V_{in2}) .Although active switches Q_1 and Q_2 are turned on in this mode is depicted in Fig.11(a), only Q_1 conducts current since the diode Q_{d2} is reverse biased due to the assumption that V_{in1} is greater than V_{in2}. The diode D at the common output stage is also reverse-biased.

2. Mode 2 (see Fig.11(b); $D_1 T_s < t < D_2 T_s$): Only an active switch Q_2 is turned on and conducts current in this mode since the diode Q_{d2} is also turned on. The diode D at the common output stage is still reverse-biased.

3. Mode 3 (see Fig.11(c); $D_2 T_s < t < T_s$): All switches except the diode D are turned off in this mode. Therefore, the diode D only conducts current.
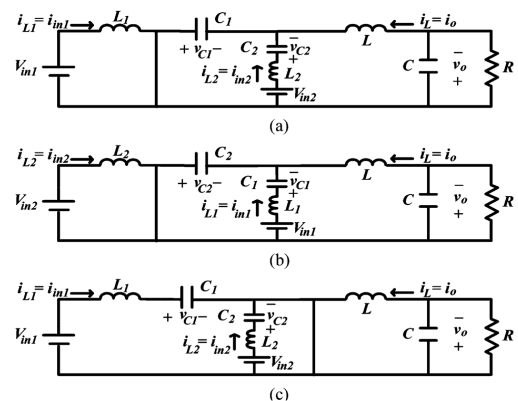

Fig.11.Operational modes of the MI Cuk dc-dc converter.(a) Mode I (only Q_1 conducts current). (b) Mode II (only Q_2 conducts current) (c) Mode III (only diode D conducts current)

5. SIMULATION STUDIES AND DESIGN

Here the simulation studies of the proposed system are analyzed and the curves were plotted. The simulation software used in modeling is MATLAB.

5.1. *Design of Multi Input Cuk Converter*

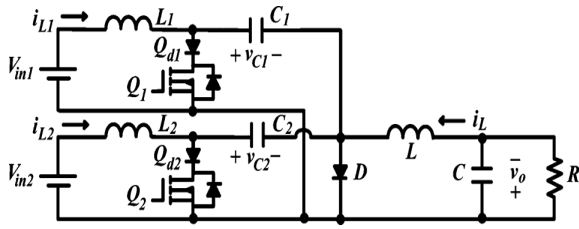Design of multi input cuk converter is shown below. Here converter have 3 modes of operation.

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Fig.12. MI Cuk dc-dc converter

5.1.1. Capacitor

1. Mode 1: $(0 - D_1T_s) \Longrightarrow q_1(t)$

$$i_{C1} = -(i_{L0} + i_{L2})$$ (6)

$$i_{C2} = i_{L2}$$ (7)

$$i_{C0} = i_{L0} - \frac{V_0}{R}$$ (8)

2. Mode 2: $(D_1T_s - D_2T_s)) \Longrightarrow q_{2eff}(t)$

$$i_{C1} = i_{L1}$$ (9)

$$i_{C2} = -(i_{L0} + i_{L1})$$ (10)

$$i_{C0} = i_{L0} - \frac{V_0}{R}$$ (11)

3. Mode 3: $(D_2T_s - T_s) \Longrightarrow (1 - q_{2eff}(t))$

$$i_{C1} = i_{L1}$$ (12)

$$i_{C2} = i_{L2}$$ (13)

$$i_{C0} = i_{L0} - \frac{V_0}{R}$$ (14)

Expand and rearrange equations:

$$i_{L0} = \frac{P_0(1 - D_2)}{(D_1 V_{in1} + D_{2eff} V_{in2})}$$ (15)

$$i_{L1} = \frac{D_1 i_{L0}}{1 - D_2}$$ (16)

$$i_{L2} = \frac{D_{2eff} i_{L0}}{1 - D_2}$$ (17)

5.1.2 Inductor

1. Mode 1: $(0 - D_1T_s) \Longrightarrow q_1(t)$

$$V_{L1} = V_{in1}$$ (18)

$$V_{L2} = V_{c1} - V_{c2} + V_{in2}$$ (19)

$$V_{L0} = V_{c1} - V_0$$ (20)

2. Mode 2: $(D_1T_s - D_2T_s) \Longrightarrow q_{2eff}(t)$

$$V_{L2} = V_{in2}$$ (21)

$$V_{L1} = V_{c2} - V_{c1} + V_{in1}$$ (22)

$$V_{L0} = V_{c2} - V_0$$ (23)

3. Mode 3: $(D_2T_s - T_s) \Longrightarrow (1 - q_2(t))$

$$V_{in1} - V_{L1} - V_{c1} + V_{c2} + V_{L2} - V_{in2} = 0$$ (24)

$$V_{L2} = V_{in2} - V_{L2}$$ (25)

$$V_{L0} = V_0$$ (26)

Expand and rearrange equations:

$$V_{c1} = \frac{(1 - D_{2eff})V_{in1} + D_{2eff}V_{in2}}{1 - D_2}$$ (27)

$$V_{c2} = \frac{(1 - D_1)V_{in2} + D_1 V_{in1}}{1 - D_2}$$ (28)

$$V_0 = \frac{D_{2eff}V_{in2} + D_1 V_{in1}}{1 - D_2}$$ (29)

5.2. Simulation of PV panel with MPPT

A circuit based simulation model for a PV cell for estimating the IV and PV characteristic curves of photovoltaic panel with respect to changes on environmental parameters of irradiance. Here also used MPPT algorithm for improving efficiency.

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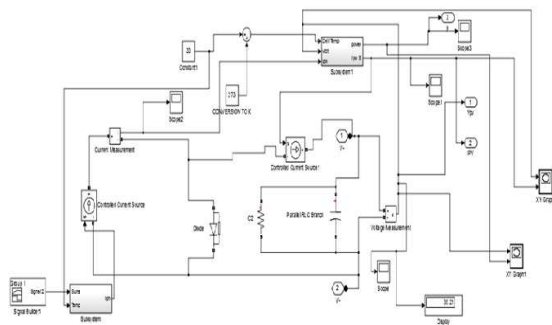*Available online at www.ijrat.org*

Fig.13. Simulation of PV panel

Using a Shockley diode equation, an accurate simulink PV panel model is developed. 250W Solarex MSX230 PV panel is chosen for evaluating the developed model.

5.3. *I-V and P-V characteristics of 230W system*

The following Fig.14 shows the current voltage characteristics of the 230W system From the I-V characteristics it is clear that the open circuit voltage,V_{oc} is 43.2 V (approximately as three panels are connected in series)and the short circuit current is 7.3A(approximately as eight strings are
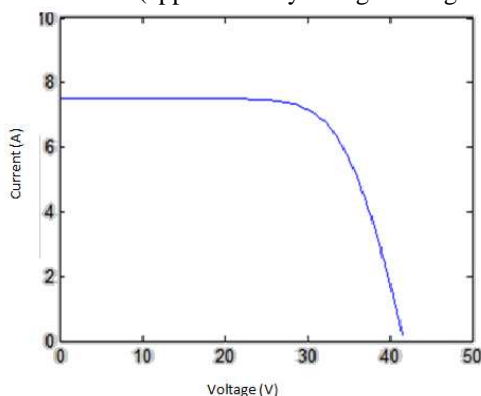
Fig.14. IV curve of solar panel

connected in parallel). Fig.15 shows the P-V curve of the 230W system From the P-V characteristics, the power is approximately 230W.
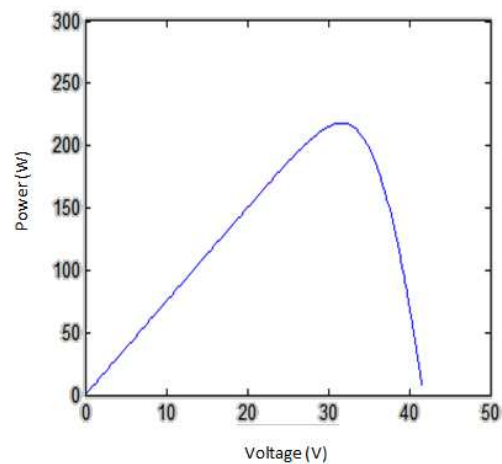
Fig.15. PV curve of solar panel
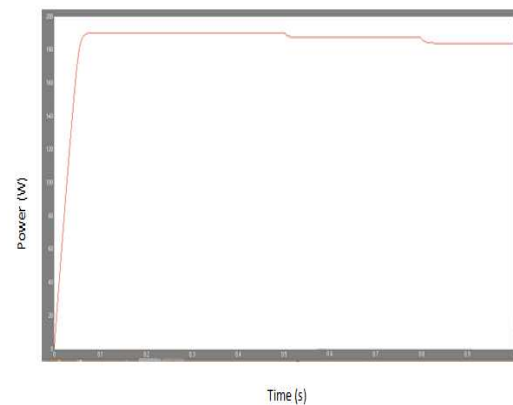

Fig.16. Panel output power

5.4. *Wind Energy Conversion System*

The following Fig.17 shows the simulation of wind energy conversion system. Ratings are equal to the proposed system ratings. When the generator speed reaches to 27pu that time only wind turbine starts to working.
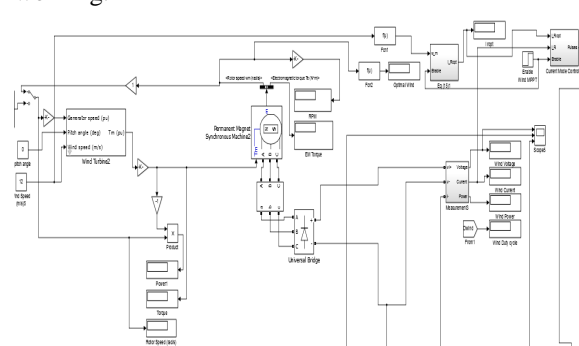
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Fig.17. Simulation of Wind Energy Conversion

System

5.5. *Energy Storage System*

Energy storage system contains the main parts are battery and energy storage control section. This control section has mainly 3 functions.

1. Check bus voltage level and select the work: buck or boost
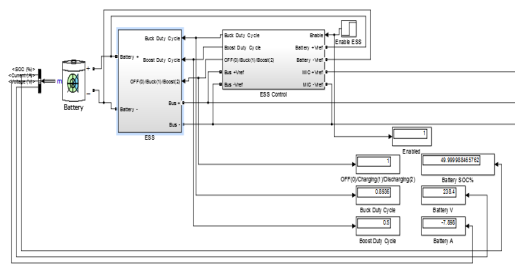2. Provide gate pulse for buck action
3. Provide gate pulse for boost action
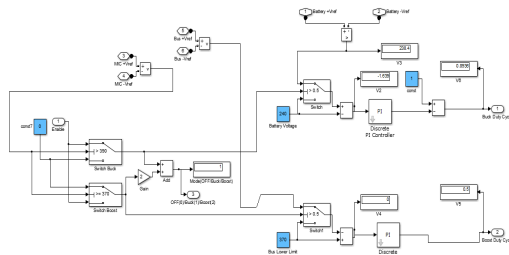

Fig.18. Energy storage system

Fig.19. Energy storage system Control

5.6. *Multi Input CUK Converter*

This CUK converter combines more than one input and provides a single output. Multi Input CUK Converter as shown below
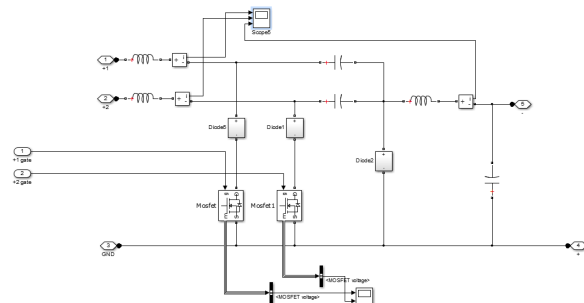

Fig.20. Multi Input Cuk Converter

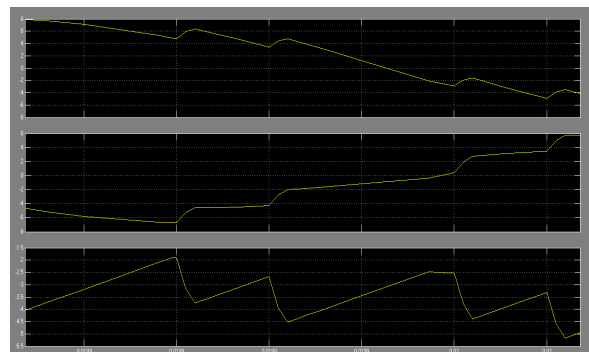The current waveform of MI Cuk Converter as shown below

Fig.21. Current Waveform of Multi Input Cuk Converter

Final output as shown below. MI Cuk converter output always in the range of 370 to 390.
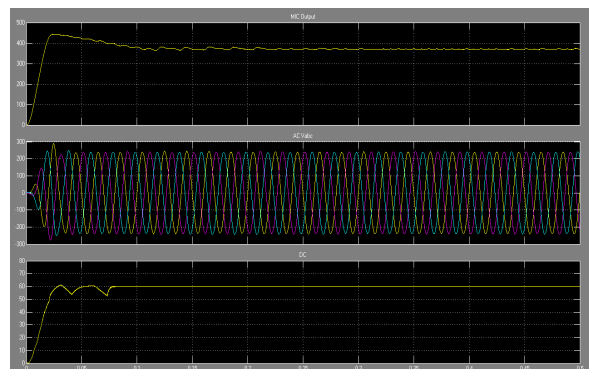

Fig.22. Waveform of Bus voltage, DC load voltage and Ac load voltage

6. CONCLUSION

In most of the remote and non-electrified sites, extension of utility grid lines experiences a number of problems such as high capital investment, high lead time, low load factor, poor voltage regulation and frequent power supply interruptions. There is a growing interest in harnessing renewable energy sources since they are naturally available, pollution free and inexhaustible. At present, standalone solar photovoltaic and wind systems have been promoted around the globe on a comparatively larger scale. Its hybrid system has more advantages than individual usage of renewable source.

The principal objective of work is to provide centralized control architecture in input section of hybrid system. For this purpose used a MI Cuk Converter. The Cuk converter has been designed and studied.

The simulation of PV panel, wind energy conversion system, MI CUK converter using MATLAB was completed and it compare with references. At last overall system simulation was

done using MATLAB and attains the conditions for meeting a particular load.

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