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Hybrid Energy Management System for DC Micro-Grid Using Renewable Energy Sources

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ABSTRACT

Energy demand is ever increasing in the world, searching for fossil fuel is done on priority basis. These fuels are not sustainable, they pollute the environment. Shortage of fossil fuels resources and adverse environment affects made use of Renewable Energy Sources (RES) as Solar energy and Wind energy essential. Solar energy and Wind energy combined to form Solar-Wind Hybrid Power System (SWHPS), which will enhance the qualities of each other and another. To reduce the power demand on the conventional power generation sector, the optimized utilization of these natural resources is essential to produce power.

This work proposes the open loop DC Micro-Grid containing renewable energy sources, storage elements and loads are presented. The controller ensures hybrid energy power balance and grid stability even when some devices are not controllable in terms of their power output, and environmental conditions and load vary in time. Open loop DC micro-grid system framework with disturbance, DMG frameworks are formed; shown and simulated using Simulink in MATLAB and their results are presented. Assessment is done regarding settling time and steady state error. The assessments exhibit the unmatched execution of controlled DC-MGS framework. The proposed framework has tendency like minimising the consonant substance and quick reaction.

KEYWORDS: Renewable Energy Sources1, Solar-Wind Hybrid Power System 2,DC Microgrid 3

1. INTRODUCTION

Renewable energy got attention due to the depletion of fossil fuels and global warming. Due to this, the use of DC/DC converters is rapidly increasing in a vast amount of applications such as wind turbines, photovoltaic systems, electric vehicles, energy storage systems, and in such applications, where different voltage levels loads are connected. The block diagram of DC MG is expressed in Fig. 1.1. DC MG mainly includes renewable energy sources (RES) such as solar and wind, energy storage system (ESS), and DC load. Every RES and ESS is connected with the bus through a power electronic interface (PEI). It is therefore necessary to have effective control for the PEIs.

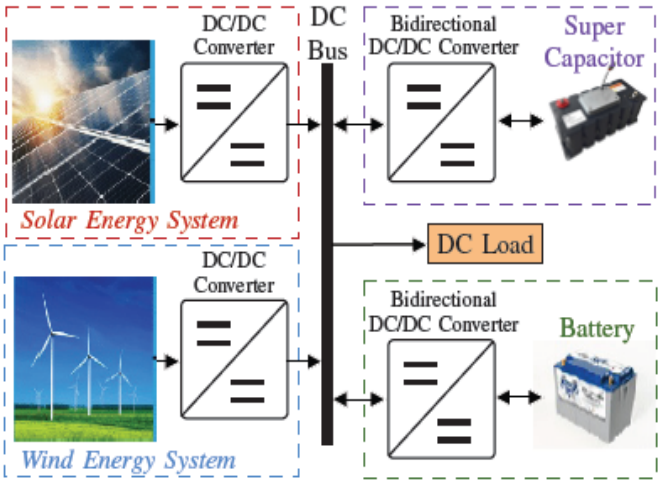

Fig 1.1Possible structure of single bus DC MG, including renewable energy sources such as solar and wind, energy storage systems, and DC load.

In recent years the number of technological developments on the design of prototypes for energy electricity by using energy sources not conventional, such as solar, wind, hydro, biomass and bio fuels, geothermal, cells fuels. Renewable energy sources such as Solar Energy and Wind energy are the sources that energy captured and stored by nature. A generating system with a single power source non-conventional energy does not supply electricity required [1]. Due to global warming new energy sources need to be used such as solar and wind energy. Renewable energy is becoming more important. Solar and Wind energy is pollution free and inexhaustible. All regions of the world have renewable resources of one type or another. Thus a study on renewable energies focuses more and more attention. Use of renewable energy sources for power generation many studies have been carried out. Due to their unpredictable nature, the solar and wind energy systems are highly unreliable [2]. Other energy source can compensate for the difference, when a source is unavailable or insufficient in meeting the load demands.

Due to the rapid growth of power electronics techniques applications with photovoltaic (PV) energy and wind energy have been increased significantly. Basically solar radiation and wind speed are complementary profiles. The communities outside the urban centers have problems for installation, wiring because the public does not arrive to their homes. In these cases, these energy sources are a highly feasible alternative. Hybrid system is a high performance compared to unconventional source. As considering these two energy resources, the output is not certain due to environmental or day and night situations. That is the output of Solar-Wind system is not certain one might give more power and other might give less power or no power. So it required to stabilize output voltage from this system. These two systems are connected parallel to each other, that if one source is not available, then the other one can balance the system. Thus, these two systems can work individually and simultaneously too.

2. SOLAR HYBRID WIND SYSTEM

The electric system that combines solar energy and wind energy is named as hybrid power system, which offers several advantages over either single system. In much of the areas, wind speeds are low in the summer when the sun shine brightest and longest. In winters less sunlight is available and wind is stronger. Hybrid systems produce power when it will be needed. The peak operating time for wind and solar occurs at different times of day and year [11]. Many hybrid power systems are stand alone systems which are not connected to an electricity distribution system [6]. When neither the wind nor the solar system is generating power, the hybrid system provides power through batteries. The engine generator can provide power and recharge batteries, when batteries run low. Modern electronic controllers can operate hybrid systems automatically, by adding engine generator which makes the system complex [9]. Other components needed for the system should be small in size due to engine generator. During non charging period the storage capacity must be large enough to supply electrical need. The solar energy system output and wind energy system output are added together in parallel because if one source is absent the other one can compensate for it [10]. Solar energy system and wind energy system can work separately and together.

3. ANALYSIS OF QUADRATIC BOOST CONVERTER

Single switch elevated voltage gain quadratic boost converter contain triple diode, couple of inductor &couple of capacitor D1, D2, L1, L2, C1, C2 respectively. Duty cycle (K) controlled in pulse-generator for power MOSFET (M1) where 'K' is approximately chosen as 0.5 & load resistor as 'R'. By assumption 'QBC' operated in continuous conduction mode. 'The circuit diagram of QBC' is delineated in Fig 2.2. In single QBC has a single

switch M1, Two inductors L1 and L2, Two Capacitors C1, C2, Three diodes D1, D2, D3 and load. A QBC same as boost converter but it uses Single switch. It has higher voltage conversion ratio when compared to conventional boost converter and Single QBC. This increases the suitable gain for PV, Wind energy systems and in micro grid applications.

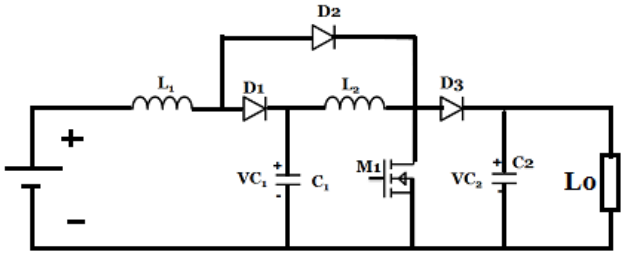

Fig.2. Circuit diagram of Quadratic Boost Converter

4. SIMULATION RESULTS AND DISCUSSION

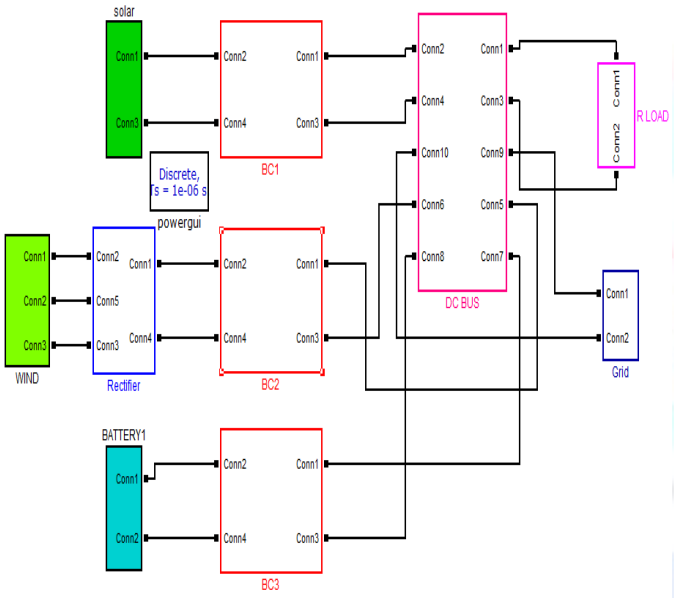

Fig.3 Circuit diagram of boost converter based hybird DC microgrid

Circuit diagram of boost converter based hybird DC microgrid is shown in fig 3. Voltage across PV is shown in fig 4 and its value is 15V. Voltage across wind generator is shown in fig 5 and its value is 15V. Switching pulse of boost converter S1 is shown in fig 6 and its value is 1V. Circuit diagram of boost converter is shown in fig 7.Voltage across R load is shown in fig 8 and its value is 90V. Current through R load is shown in fig 9 and its value is 0.9A. Output Power is shown in fig 10 and its value is 80W.

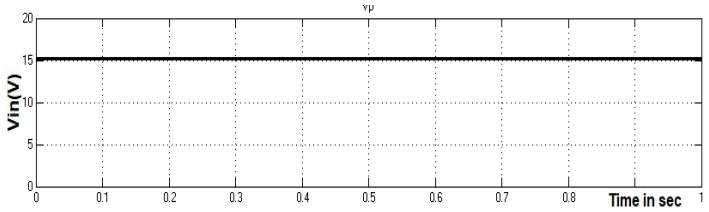

Fig 4 Voltage across PV

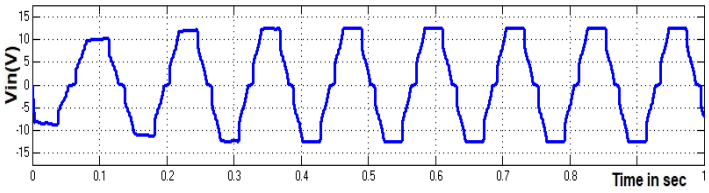

Fig 5 Voltage across wind generator

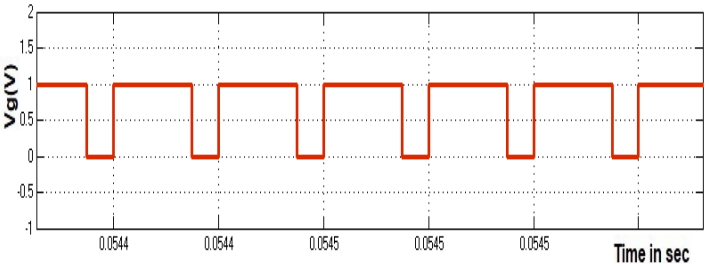

Fig 6 Switching pulse of boost converter S1

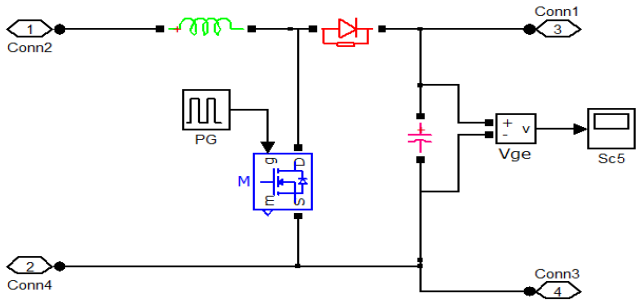

Fig 7 Circuit diagram of boost converter

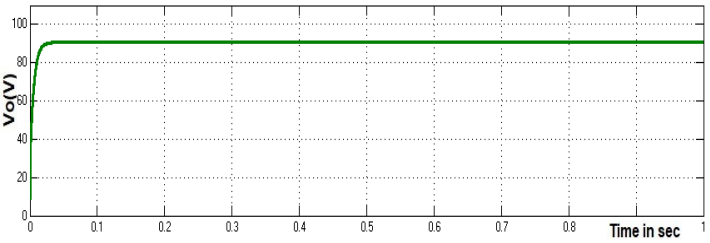

Fig 8 Voltage across R-load

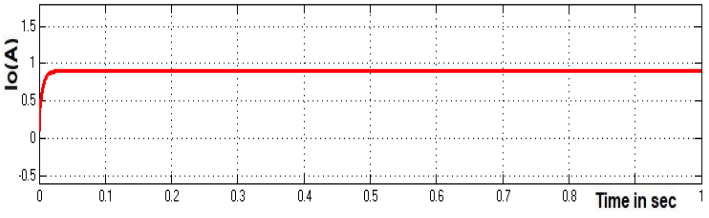

Fig 9 Current through R-load

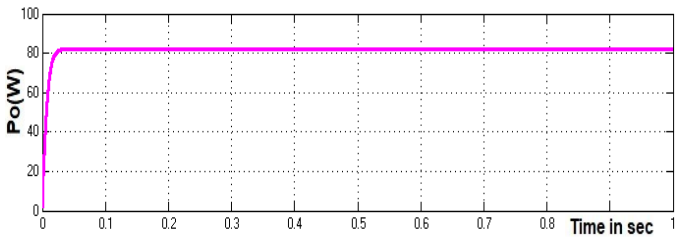

Fig 10 Output power

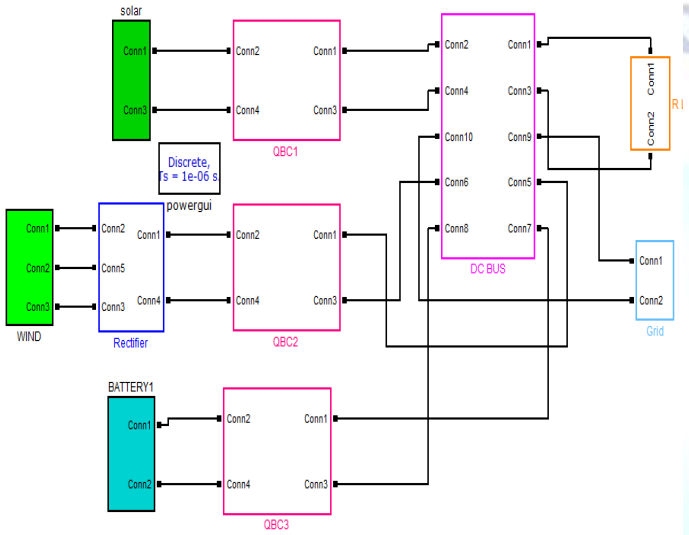

Fig 11 Circuit diagram of quadratic boost converter based hybird DC microgrid

Circuit diagram of quadratic boost converter based hybird DC microgrid is shown in fig 11. Voltage across PV is shown in fig 12 and its value is 15V. Voltage across wind generator is shown in fig 13 and its value is 15V. Circuit diagram of quadratic boost converter is shown in fig 14.Switching pulse of boost converter S1 is shown in fig 15 and its value is 1V. Voltage across R load is shown in fig 16 and its value is 150V. Current through R load is shown in fig 17 and its value is 1.6A. Output Power is shown in fig 18 and its value is 250W.

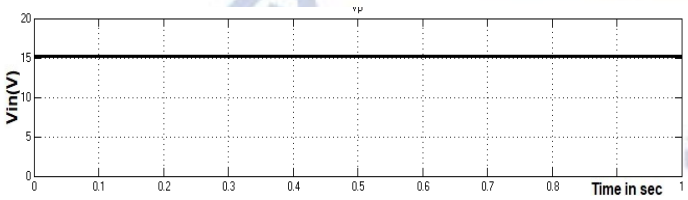

Fig 12 Voltage across PV

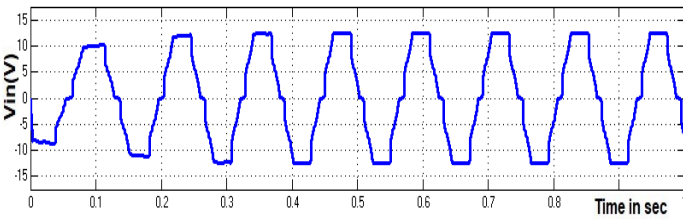

Fig 13 Voltage across wind generator

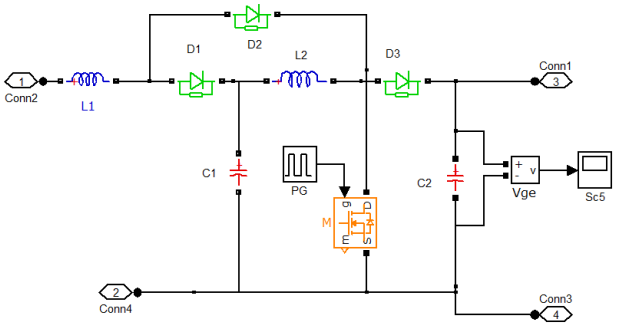

Fig 14 Circuit diagram of quadratic boost converter

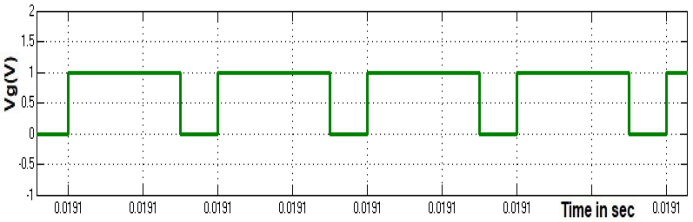

Fig 15 Switching pulse of boost converter S1

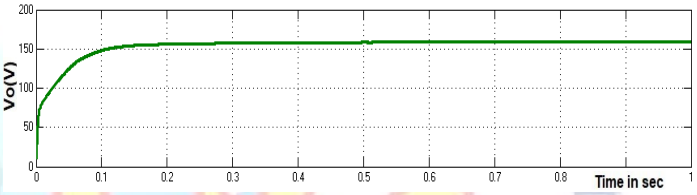

Fig 16 Voltage across R-load

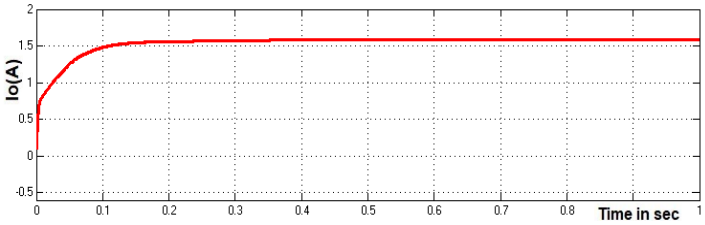

Fig 17 Current through R-load

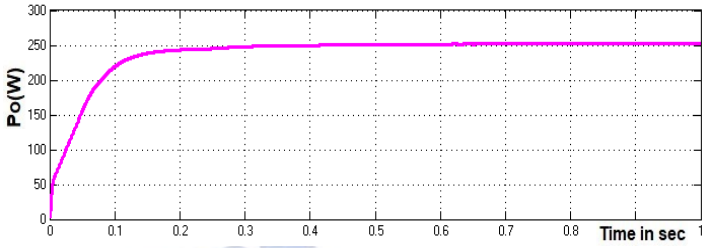

Fig 18 Output power

TABLE 1 COMPARSION OF OUTPUT VOLTAGE AND OUTPUT POWER

Hybrid Converter	Vin(V)	Vo(V)	Po(W)
BC	15	90	80
QBC	15	150	250

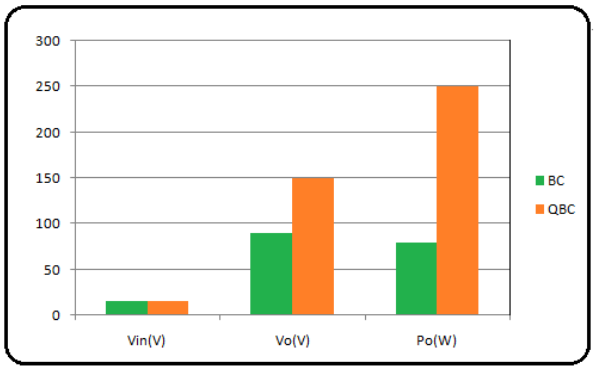

Fig 19 Bar chart comparison of output voltage & output power

The Table 1 gives the Comparsion of output voltage and output power for quadratic boost converter based hybird DC microgrid system. The Fig.19 shows the Bar chart comparison of output voltage and output power for quadratic boost converter based hybird DC microgrid system. Output voltage of Quadratic boost converter is improved from 90V to 150 V; Output power of Quadratic boost converter is improved from 80W to 250W; hence the Quadratic boost converter system has better performance than normal boost converter system.

5. CONCLUSION

Circuit diagram of boost converter based hybrid DC microgrid system is simulated. Circuit diagram of quadratic boost converter based hybrid DC microgrid system is simulated. Above systems are compared. Output voltage of Quadratic boost converter is improved from 90V to 150 V; Output power of Quadratic boost converter is improved from 80W to 250W; hence the Quadratic boost converter system has better performance than normal boost converter system.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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