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Performance Improvement of Hybrid Renewable Source Fed Hybrid Power Generation System

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Abstract: This project preferred the maximum power production to the load with Photovoltaic/Fuel cell system by increasing the efficiency of the interleaved boost converter. PV PANEL/Hydrogen is a renewable energy and clean which gets more attention from all over world to avoid air pollution and oil shortage of transportation. In order to avoid frequent change in battery, fuel cell control systems build. This paper describe the development of a regular technique of an independent PV/FC system composed of Photovoltaic cell, Hydrogen storage tank, Interleaved boost converter, fuel cell. The efficiency of the fuel cell is 40%-60% generally or up to 85%.The main aim of this paper is to increase the efficiency and output voltage of the PV and fuel cell hybrid power generate system without battery.

Key words: PV cell · Fuel cell · Interleaved DC-DC boost converter · Buck converter · Inverter

INTRODUCTION

Renewable energy plays important role nowadays because it provides energy for future generation and environmental benefits. Usually renewable energy is defined as the energy comes from resources such as sunlight, wind, rain, tides, waves and geothermal heat. Today there is 6.4% of total use of renewable energy sources. In this paper solar energy is taken as a main source. Several stand alone power systems installed around the world. The majority of these power systems are based on fossil power generation. When the diesel generators and batteries are replaced by fuel cells which is running on hydrogen, produced locally with renewable energy improves the environmental standards and reduces the operation and maintenance cost. The conventional Photovoltaic/Fuel cell Hybrid power system consists of four components. They are - the PV generator, the electrolyzer, hydrogen storage tanks and fuel cell. PV panel which converts light energy into electrical energy. Boost converter is used to step up the DC voltage produced by PV panel. Then the stepped up DC voltage is converted into AC voltage with desired frequency and magnitude by using inverter. Produced AC voltage is given to the load demand. When the electrical energy produced by PV panel is excess, that energy is stored by using Electrolyser and Fuel cell for a future use which is shown in the Fig 1.1. To increase the efficiency of the boost converter interleaved boost converter is used. H2 generation is proportional to the water electrolysis. The Electrolyser is operated in between the 20% to 100% power range, because of varying output if the PV system.

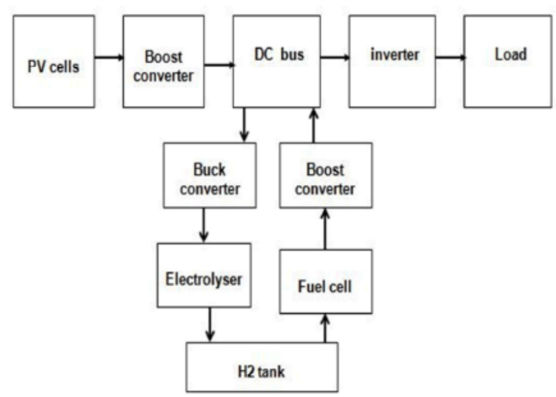

Fig. 1.1: Basic block diagram of conventional circuit

PV Cells are used to convert solar radiation into electricity. In proposed system, interleaved boost converter is used instead of normal converter to increase the duty cycle and output of the entire system, here MOSFET is acting as a switch in interleaved electrolyser with a DC to DC [1] step down converter for H2

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production, a compressor that compresses H2 production, fuel cells with a DC/DC boost converter for H2 utilization, and a DC/AC inverter for load demand. PV system converts solar irradiations into electricity. For the increase of overall system efficiency, the DC/DC boost converter with MPPT [2] enables the P V system to work at the maximum power point in the highly fluctuated environment. For an electrolyser, the H2 generation rate is proportional to the current into the water electrolysis. Due to the varying nature of the PV output, the electrolyser designed to operate between the power ranges from 20%–100% of nominal power depending in the manufacture.

Principle of Operation: This section introduces the topology of proposed high efficiency interleaved boost converter, buck converter, boost converter, inverter as illustrated in Fig. 2. The interleaved boost converter is composed of two main switches S1&S2, Inductor L1&L2, Diode D1&D2 and Capacitor C1 to increase the voltage of the PV panel. Buck converter consists of Switch S3, Diode D3, Inductor L3 and Capacitor C2 to step down the voltage of the interleaved boost converter which is the input to the electrolyser when the water added with the electrolyser produces the hydrogen, which is the input to the fuel cell stores the energy for the future use. Again boost converter is used to step up the voltage of the fuel cell. Inverter is used to convert DC to AC which consists of four switches S5, S6, S7 and S8.output of the inverter is given to the load demand R0 [3].

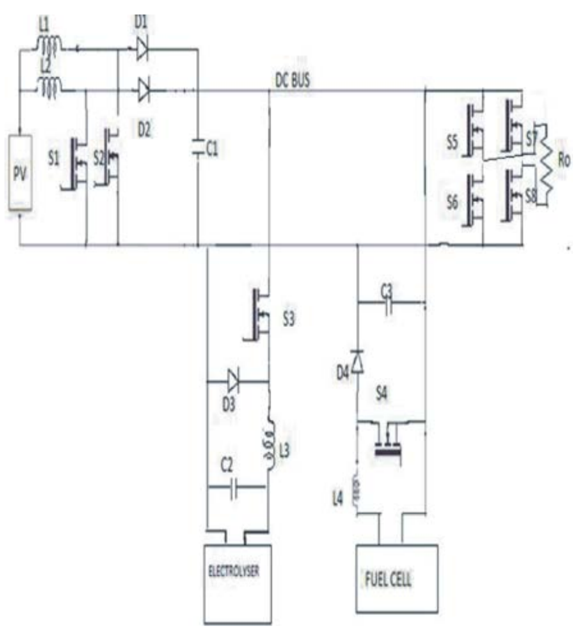

Fig. 2.1: Circuit Diagram

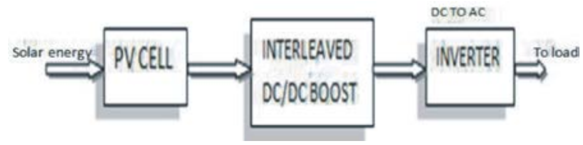

Fig. 2.2: When the solar irradiation of PV is equal to load demand

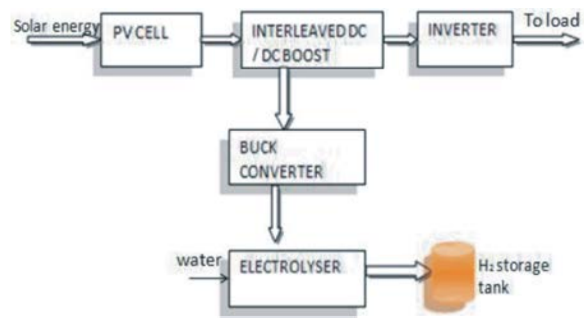

Fig. 2.3: When the irradiation is greater than load demand

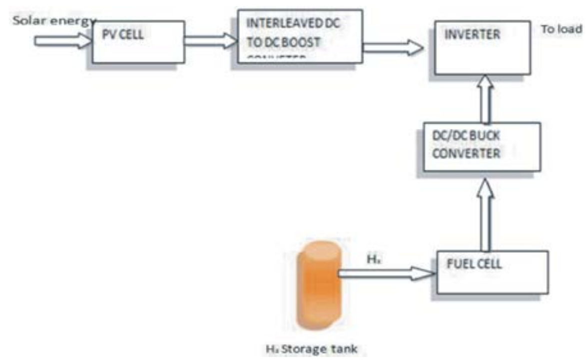

Fig. 2.4: When the solar irradiation is lesser than load demand

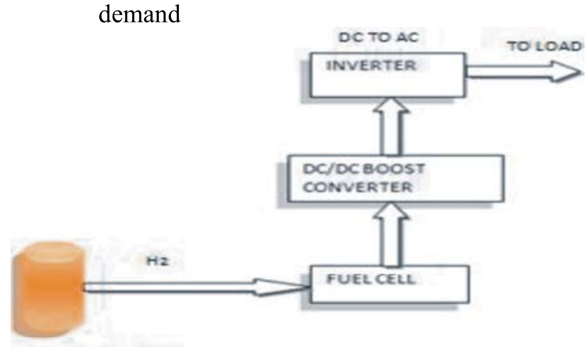

Fig. 2.5: When there is no solar irradiation

Modes of Operation

Mode 1: When the photovoltaic electrical energy is equal to the load mode 1 is utilized to transmit the electrical energy from PV Cell to the load. In this mode interleaved converter switch S1and S2, inverter switch S5, S6, S7and S6 is used. Each switch will turn on at the interval of 60 degree.

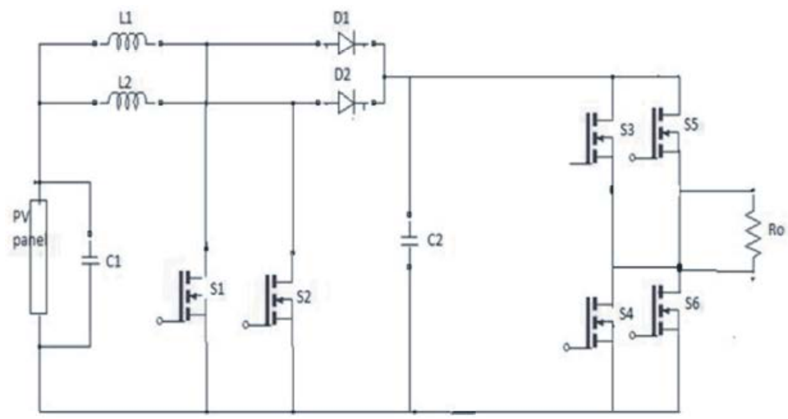

Fig. 3.1: Circuit diagram of mode1

Mode 2: When the photovoltaic electrical energy over reaches the loads demand, mode 2 is utilized to transfer the energy from photovoltaic cell to the load demand. The excess energy from PV cell is stepped down and given to the electrolyser, where electrical energy is converted into chemical energy (H2). Produced H2 is compressed and stored in H2 storage. In this mode interleaved boost converter switch S1 and S2; buck converter switch S3, inverter switch S5, S6, S7 and S8 is used.

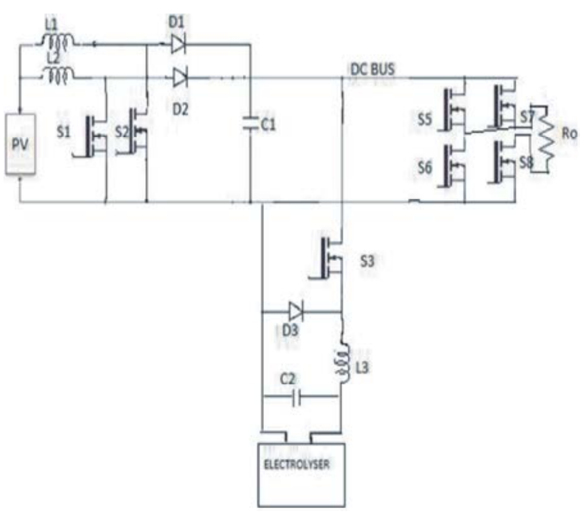

Fig. 3.2: Circuit diagram of Mode2

Mode 3: When the photovoltaic electrical energy is lesser than the load demand mode 3 is utilized to transfer the energy from photovoltaic cell to load demand. The stored H2 energy is given to the fuel cell where the chemical energy is converted into electrical energy. The electricl energy is boosted up by boost converter using the switch s4 and the DC is converted into AC by using Invereter which consist of S5, S6, S7 and S8 switches.

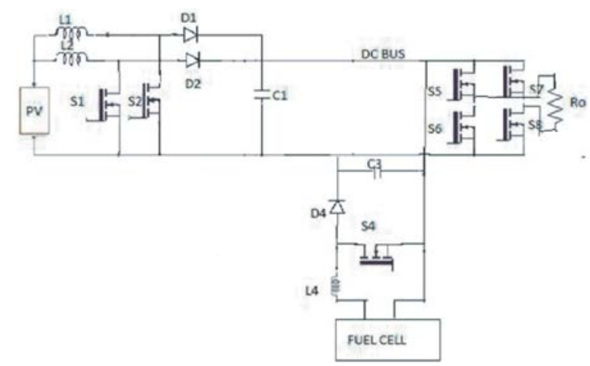

Fig. 3.4: Circuit diagram of Mode 3

Mode 4: When there is no solar radiation, mode 4 is utilized to transfer the energy from fuel cell to the load demand. Where the boost converter switch S4, inverter switch S5, S6, S7 and S8 is used.

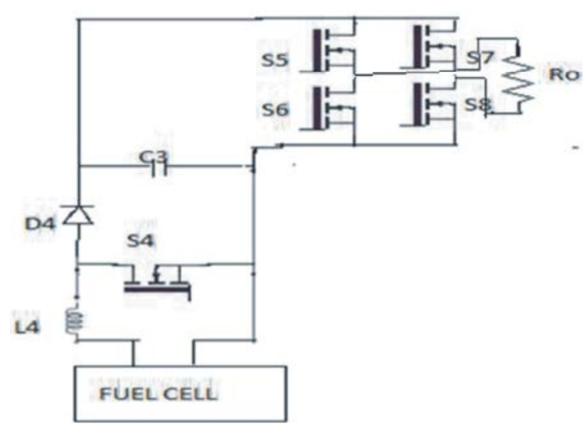

Fig. 3.4: Circuit diagram of Mode 4

Simulation Result: Simulation has become a very powerful tool on the industry application as well as in academics, nowadays. It is no essential for an electrical engineer to understand the concept of simulation and learn its use in various applications. Without simulation it is quiet impossible to proceed further. However computer simulation must not be considered as a substitute for hardware prototype. The objective of this chapter is to describe simulation of impedance source inverter with R, R-L and RLE loads using MATLAB tool. MATLAB is a high-performance language for technical computing. It integrates computation, visualization and programming in an easy-to-use environment where problems and solutions are expressed in familiar mathematical notation.. This allows you to solve many technical computing problems, especially those with matrix and vector formulations, in a fraction of the time it would take to write a program in a scalar non interactive language such as C or.

Fortran: Here the input voltages are measured when the PV is used, c2ombination of PV and Fuel cell, Fuel cell alone, Which is shown in the below figure(Fig(4.2) to Fig(4.5)). The simulation diagram of the proposed system is shown in the Fig (4.1).

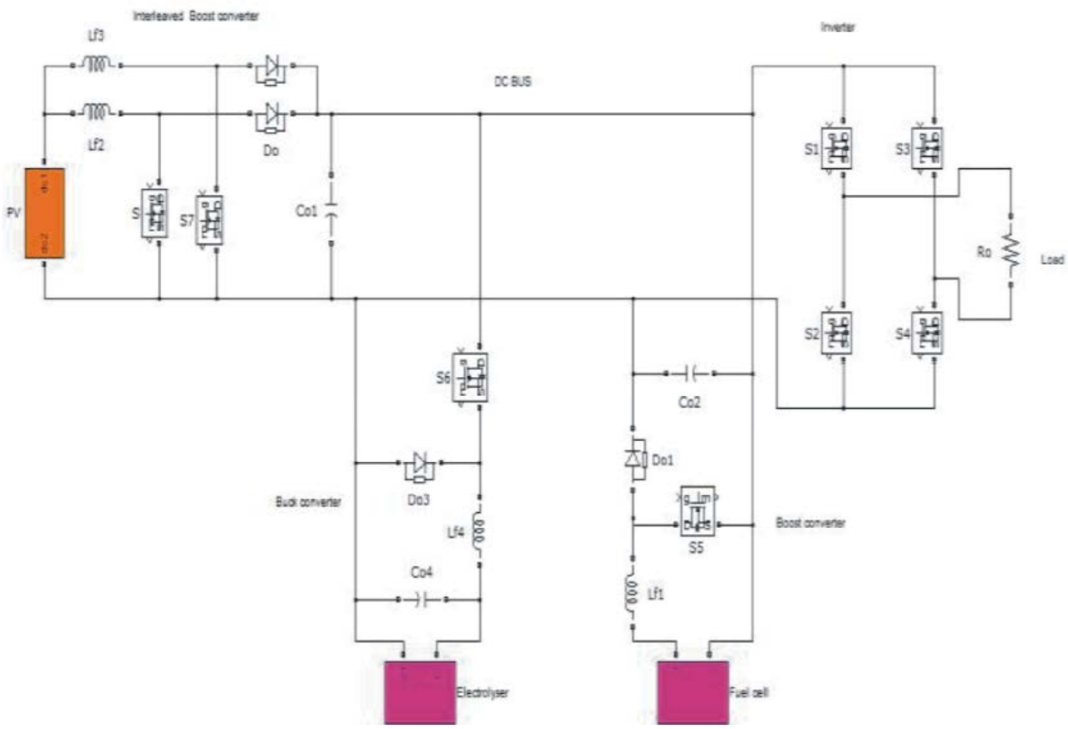

Fig. 4.1: Simulation diagram of proposed system

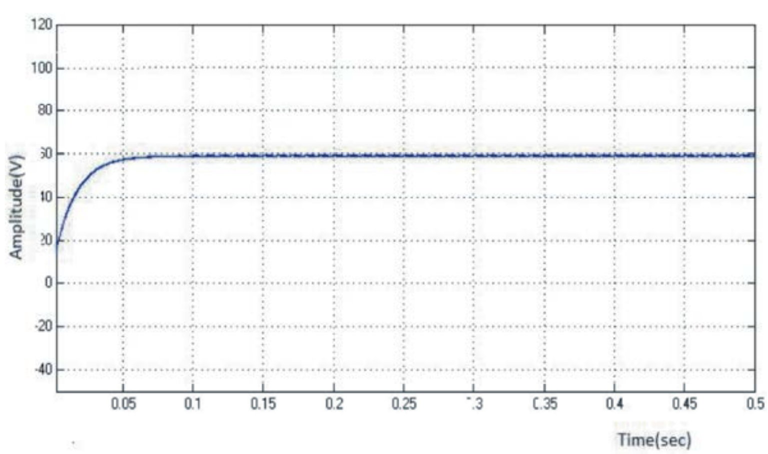

Fig. 4.2: Input Voltage of the PV/FC system

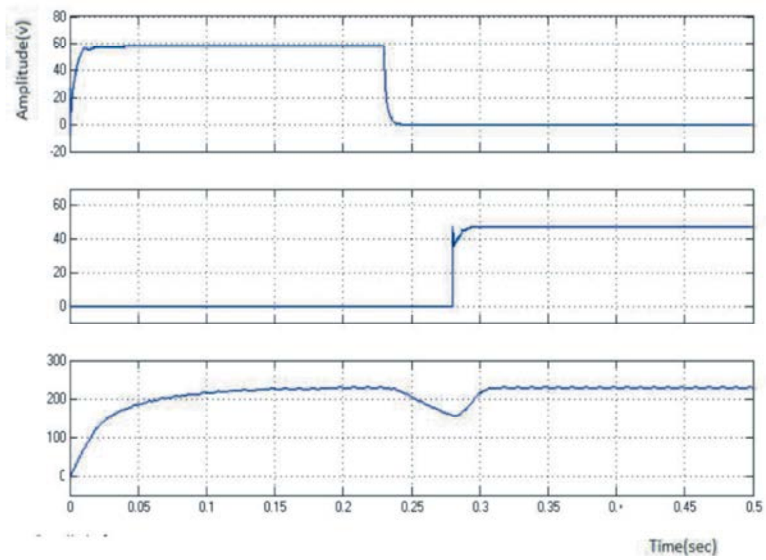

Fig. 4.3: Input voltage when the PV and Fuel cell is used.

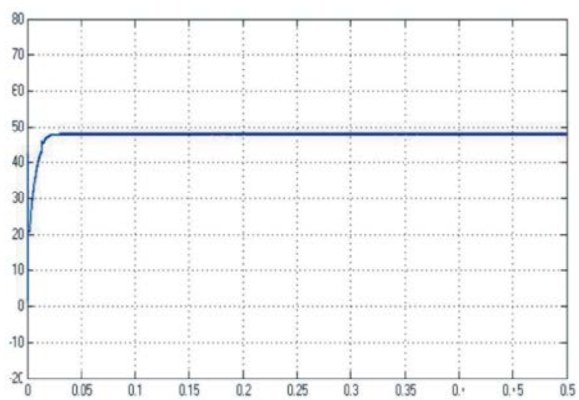

Fig. 4.4: Input voltage when the fuel cell is used

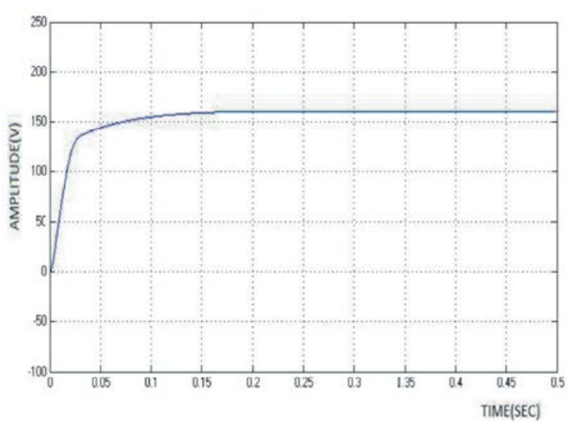

Fig. 4.5: Output voltage of PV/FC system

CONCLUSION

The PEM fuel cells are a viable alternative to diesel engine generators as renewable, clean, safe energy and high efficiency for the next century. PV/FC hybrid power system is proposed to increase the output of the system and efficiency using interleaved boost converter. Computer program and control strategies have been developed to coordinate the optimal design and operation of the PV/FC hybrid power system components.

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