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An Innovative Integrated Converter for Electric Vehicles by using Utility Grid and Solar PV Systems

Abstract: - Electric and hybrid electric vehicles represent a paradigm shift in the automotive industry, aiming to reduce carbon emissions, dependence on fossil fuels, and mitigate environmental impact. HEVs combine a gas engine with electric motors, automatically choosing the optimal source and blend of power. Because the hybrid battery recharges on the go through regenerative braking, you never need to plug in. Hybrid electric vehicle (HEV) technology provides excellent solutions to enhance fuel efficiency, performance, and reduce emissions compared to conventional vehicles. Plug-in hybrid electric vehicle (PHEV) is a type of hybrid that can be charged by plugging it into an electrical outlet and has a longer electric range. Plug-in hybrids are equipped with high-capacity batteries that can power the vehicle solely on electricity, allowing for efficient and eco-friendly driving. The battery pack can be recharged using electricity from a nearby power source. This paper suggests a novel integrated converter that can handle both alternating current (AC) and direct current (DC) for the conversion of plug-in hybrid vehicles (PHEV) and hybrid vehicles. The integrated converter can serve as a battery charger and convert electricity between the battery pack and the electric traction machine bus bar pressure. The findings indicate that the combined converter minimizes the number of high-current inductors and current meters, while also ensuring fault current tolerance in PHEV conversion. Controls, DCD/DC converters, electric traction, energy storage, hybrid electric vehicles (HEV), plug-in hybrid electric vehicles (PHEV), power electronics, drive systems.

Keywords:Hybrid electric vehicles (HEV), Plug-in HEV (PHEV), Integrated converter, DC/DC Converters.

I. INTRODUCTION

Since the beginning of the twenty-first century, numerous nations have engaged in discussions regarding the issues of climate change and global warming. A wealth of research has documented the harmful effects of climate change, largely attributable to human activities. The advancement of global civilization and industrial growth has led to a significant rise in fossil fuel consumption in industry, exacerbating air pollution concerns [4]. Additionally, emissions from vehicles, which are equally significant, cannot be ignored [1]. These emissions, primarily consisting of CO2, CO, NOx, as well as particulate matter (PM10 and PM2.5) have been recognized as key factors contributing to the greenhouse gas effect and the proliferation of cancers and other severe health conditions. Approximately 49% of oil resources are consumed by the expanding transportation sector [5]. Based on current consumption trends and crude oil reserves, it is projected that the world's oil supplies may be depleted by 2038. Consequently, it is imperative to replace non-renewable energy sources with renewable alternatives and to adopt effective energy-saving technologies [13-15]. Electric vehicles (EVs) have been thoroughly researched and proposed as a feasible solution to alleviate environmental challenges associated with traffic. When compared to internal combustion engine vehicles (ICEVs), the power source and driving system of EVs [5-6] present significant advantages. Today's society faces the challenge of dwindling automobile fuel resources. There is no doubt that carbon dioxide emissions from vehicle exhaust contribute significantly to the escalating global warming crisis [3]. The hybridization of vehicles offers one of the most promising solutions to these problems. A Hybrid Electric Vehicle (HEV) [7-8]incorporates both an internal combustion engine and an electric power system, enabling it to operate on either power source. Since the gasoline engine in a HEV can be optimized for efficiency, it produces fewer emissions compared to a similarly sized gasoline vehicle. Figure.1 depicts the current development of Hybrid Electric Vehicles [11-12]. The below figure.1 mentions the schematic view of Hybrid Electric Vehicle. In the below figure we are using a DC-DC converter [2] to produce an input voltage for the inverter which in turn operates the propulsion motor of an electric vehicle [18-19].

[1]

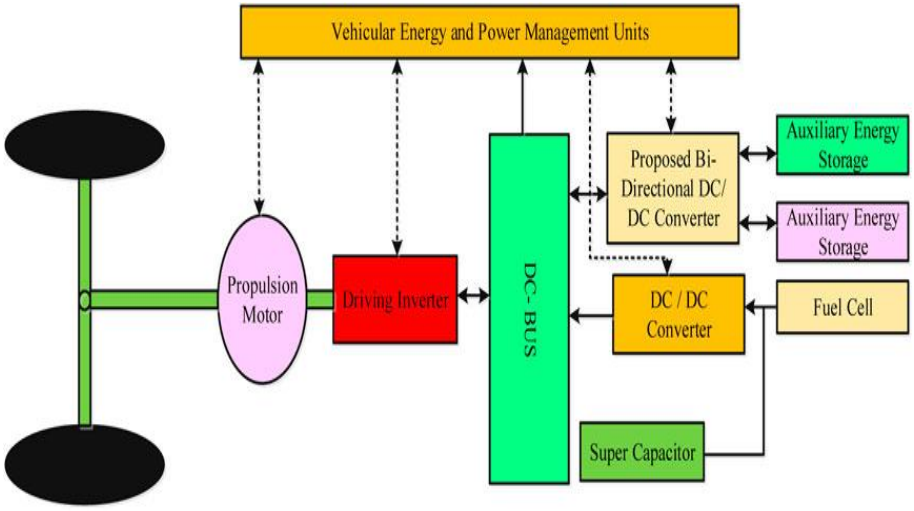

Figure.1Schematic View of Electric vehicle operation

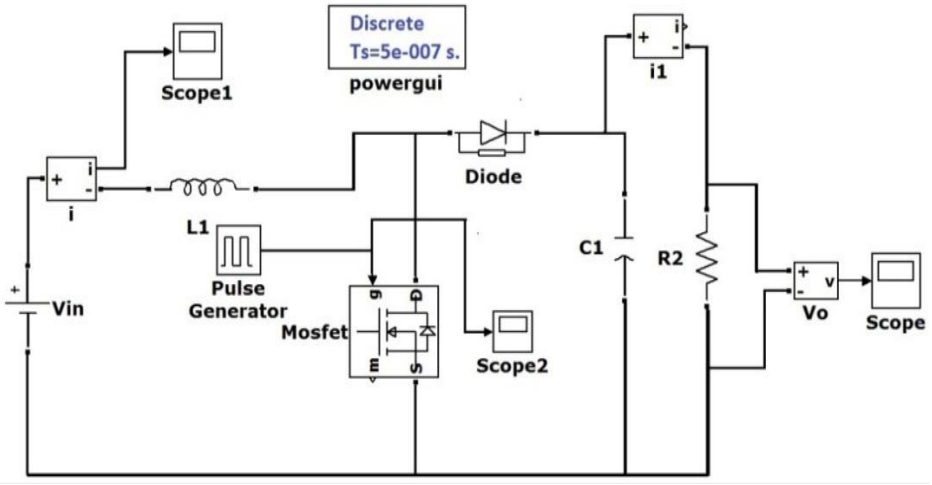

Figure.2Normal PWM based DC-DC converter

Figure.2 depicts the conventional DC-DC converter for hybrid electric vehicle applications. Figure.3 and 4 mentions the corresponding current and voltage waveforms.

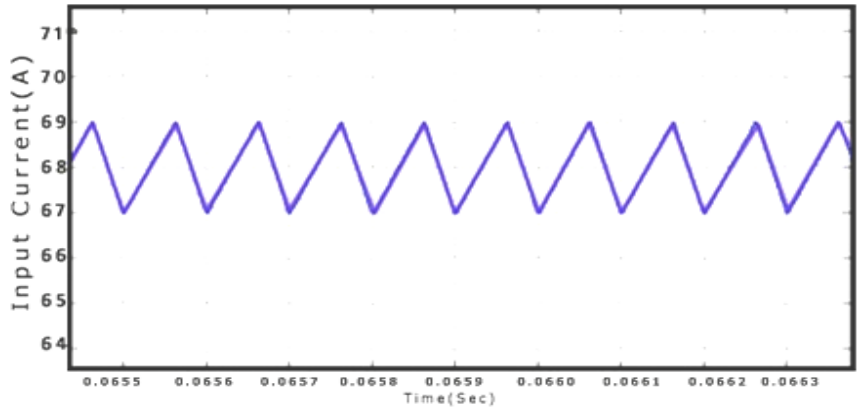

Figure.3 Current wave form for Conventional DC-DC Converter

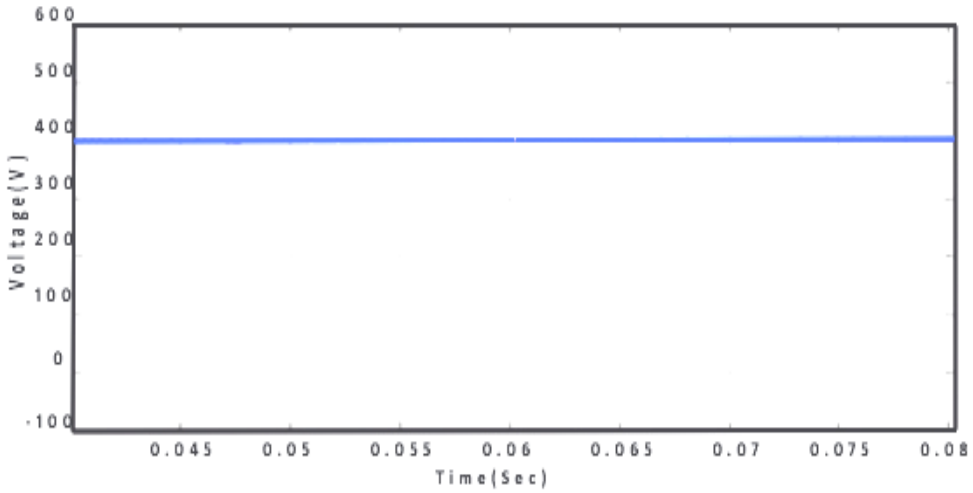

Figure.4Converter DC output voltage Waveform

II. DESIGN AND OPERATION OF A PROPOSED NOVEL DC-DC CONVERTER

Below figure. 5a & 5b and figure.6 depicts the Block diagram of a proposed hybrid vehicle topology with renewable energy sources. The proposed DC-DC converter topology is efficiently useful in both the below configurations to generate better DC voltages which in turn acts as an input to the inverter circuit. Electric vehicles such as battery electric vehicles (BEVs) and hybrid electric vehicles (HEVs) have DC/DC power converters. This converter increases the voltage to the desired level. The power source is DC. Power conversion is required in electric vehicle applications. Using an energy converter in an electric vehicle can reduce the size and cost of the battery. DC/DC converters are designed to convert electricity from a source to a load in one direction. But in this case we are using a bidirectional DC/DC converter. Bidirectional converters can send electricity in both directions. This is a useful application in electric vehicles. Although boost converters provide the best results, we use a power converter to increase the output power of the converter and reduce losses. Usually this is done to control the output voltage, input current, output current or constant power.DC-DC converters play an important role in efficiently distributing electric power in vehicles. With increasing demand for power electronics in electric vehicles, it may be concluded that DC-DC converters will continue to play a major role in the technological advancement of vehicles in the future.

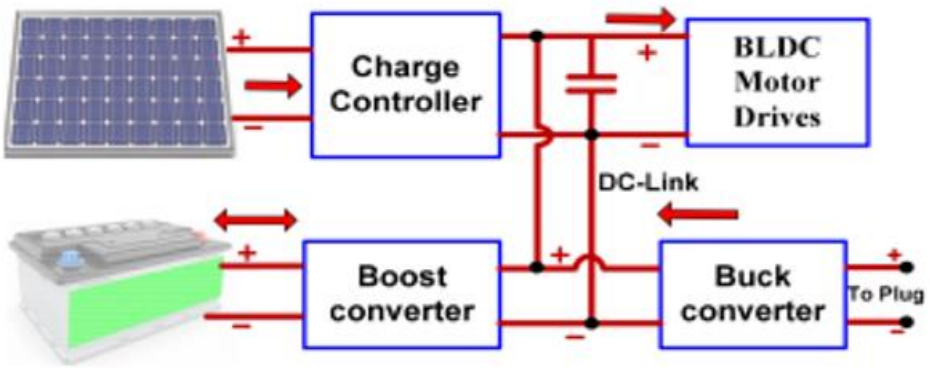

Figure.5a Block diagram of a proposed hybrid vehicle topology

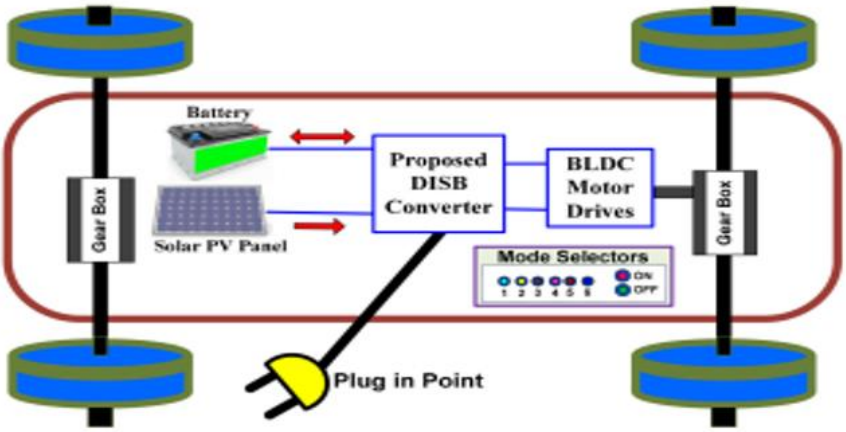

Figure.5 Block diagram of a proposed hybrid vehicle topology

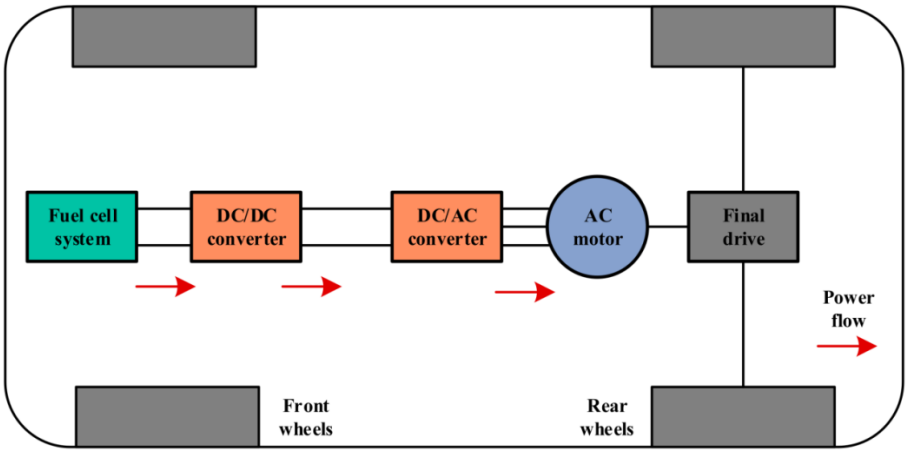

Figure.6 Block diagram of a Fuel cell hybrid vehicle topology

Figure.7 and Figure.8 represents the novel designed topology and the corresponding modes of operations for the DC-DC converter topology and figure.9 depict the output voltage and current waveforms for the mentioned circuit.

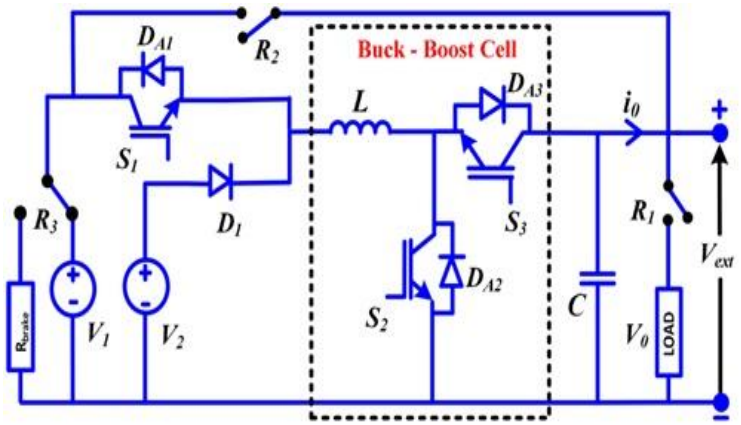

Figure.7 Proposed Buck Boost configuration

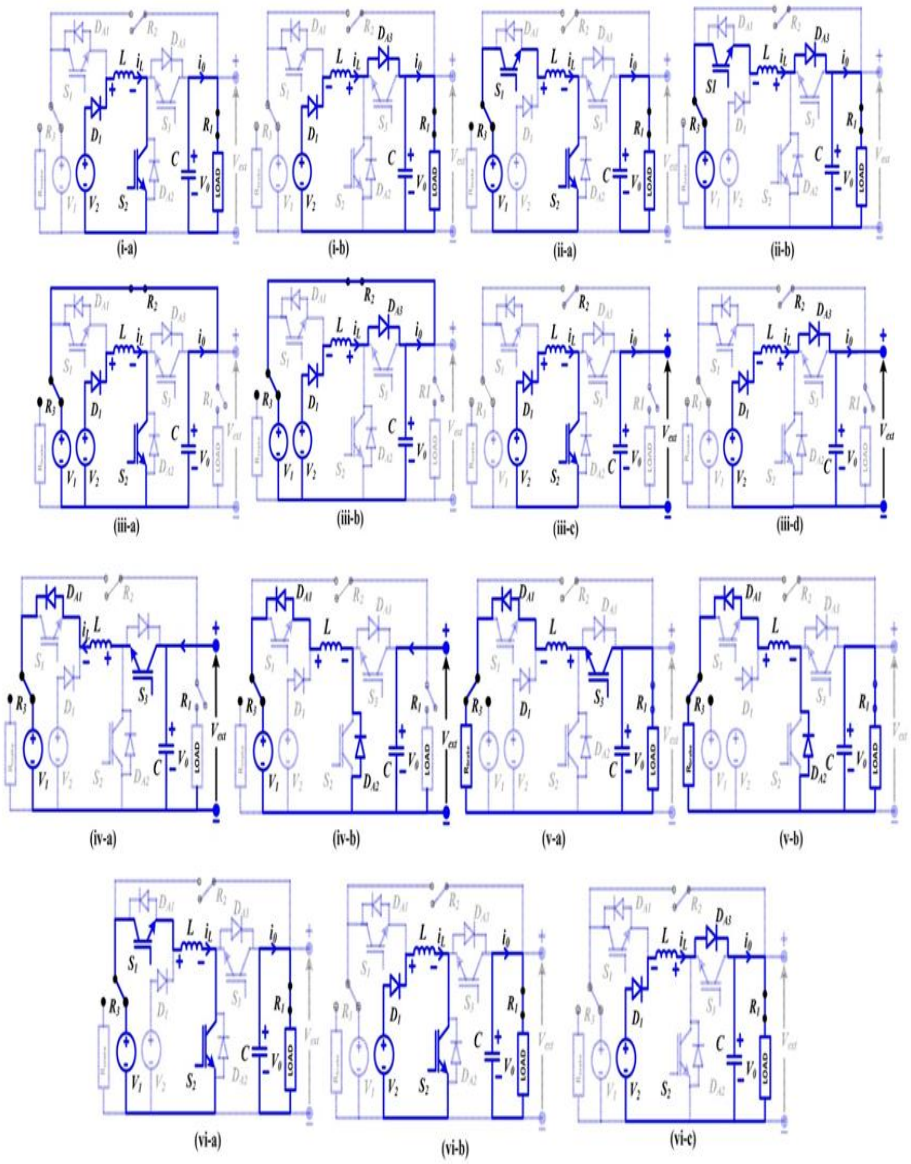

Figure.8 Operating modes of a proposed topology

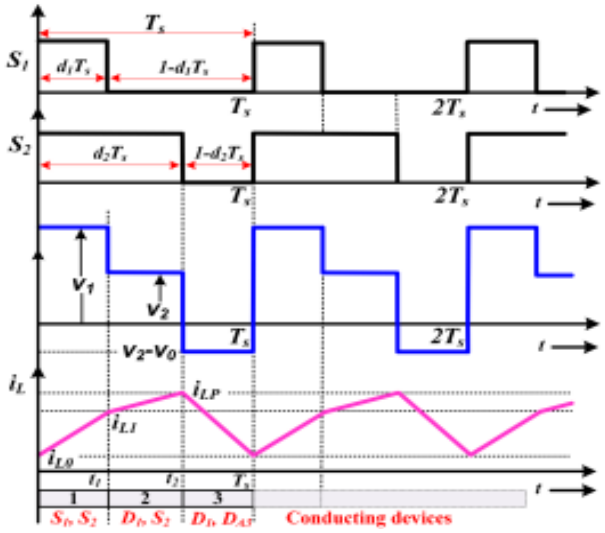

Figure.9Output waveform of a proposed topology

III. MAT LAB/SIMULINK MODELS FOR THE PROPOSED CONFIGURATION

Figure.10 and 11 represents the Mat lab/Simulink model of a conventional DC-Dc converter topology and the corresponding operational characteristics.

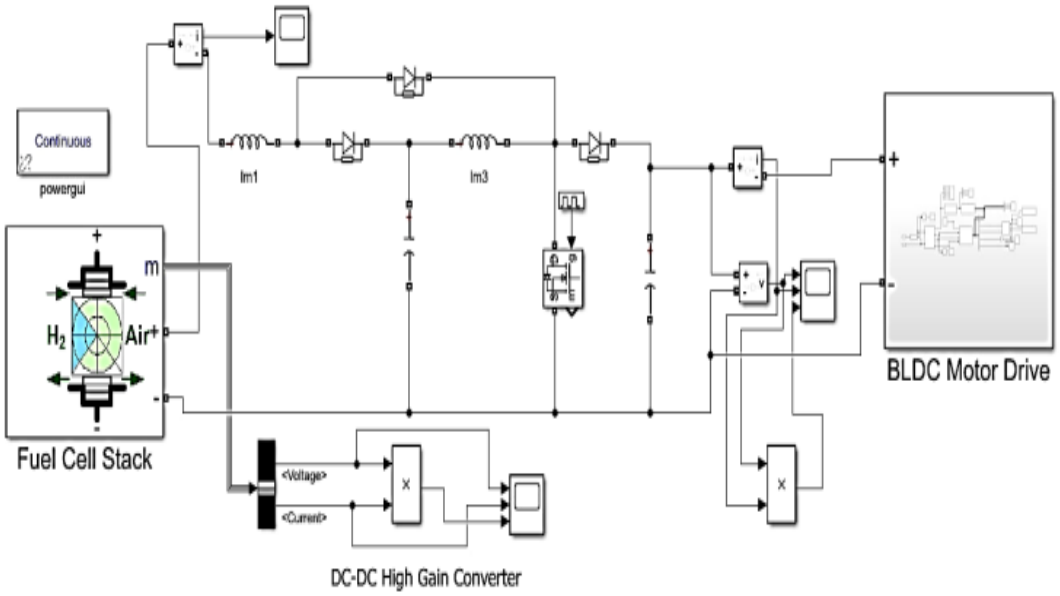

Figure.10Matlab/Simulink model for a Conventional configuration

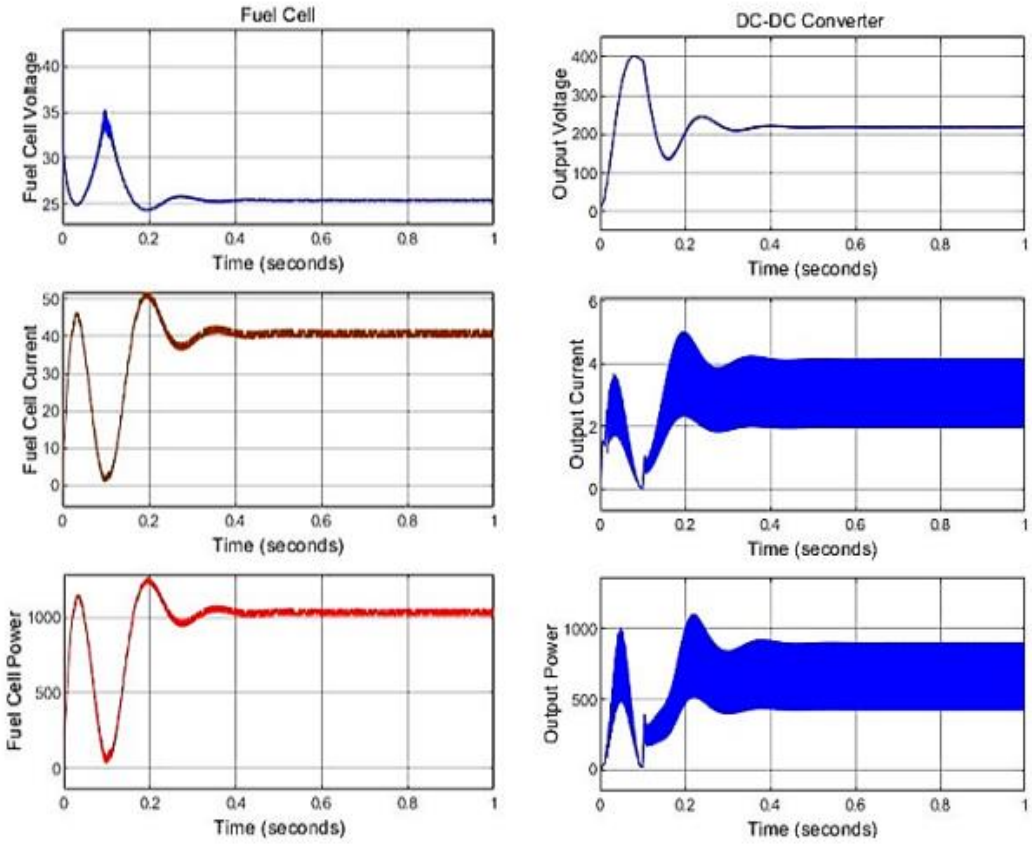

Figure.11 Resultant wave forms for Conventional topology

Figure.12 and 13 represents the Matlab/Simulink model of a proposed DC-Dc converter topology and the corresponding operational characteristics.

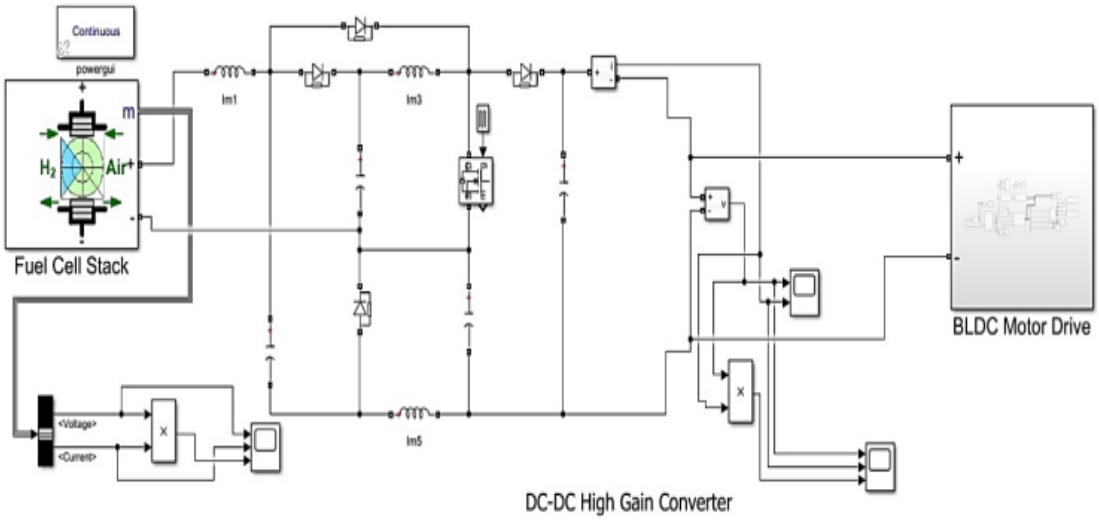

Figure.12Matlab/Simulink model for a proposed configuration

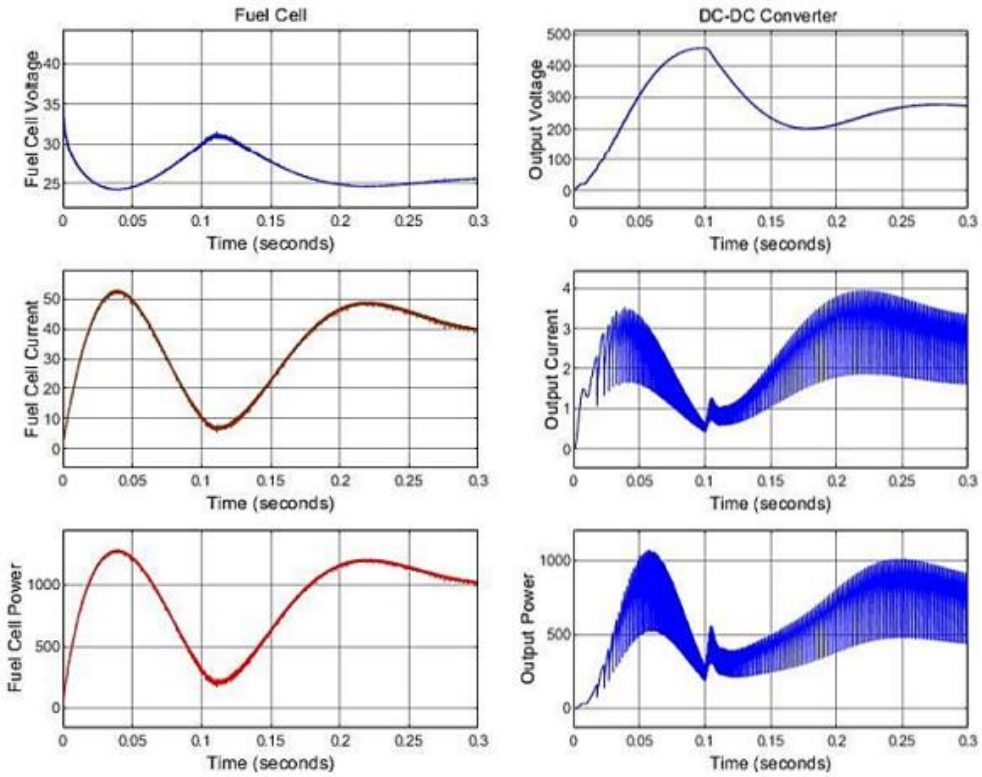

Figure.13 Matlab/Simulink model for a proposed configuration

IV. CONCLUSION

Only renewable energy can provide sufficient energy technologies such as solar photovoltaic (PV) and hydrogen fuel cell (FC). Power converters are essential for use of renewable energy. The study provides an overview of the latest achievements in hybrid electrics vehicle power converter architecture and bidirectional traffic modeling. With the understanding of the previous work, the DC converter can be designed accordingly with the results of the study. To design and implement better converters for electric vehicles, the above ideas can have a significant impact. For academics and automotive engineers, this review can provide clarity concept and information about converter settings, control and optimization. This analysis ultimately serves to pave the way for future expansions of electric cars that are more environmental friendly.

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