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# Hybrid Electric Vehicle with Boost Converter Utilizing Renewable Energy

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**ABSTRACT**: A holistic approach to a multi-input, dual-output boost converter for any kind of hybrid electric car. Using a multi-input, dual-output boost converter is a practical way to hybridize an electric vehicle. It also creates the possibility of using other natural renewable energy sources and other electric potential energy in place of the most popular but wasteful internal combustion engine fuel.

**KEYWORDS**: Natural renewable energy sources, hybrid power systems, multi-input/dual-output hybrid electric vehicles, and DC-DC boost converters

## I. INTRODUCTION

In the modern world, one of the most contentious topics among climatologists is climate change, the result of the greenhouse effect. The needs for fuel, natural resources, and other energy resources are growing along with the population, which is constantly growing. As a result, these resources are running out at an erratic rate. CO2 is the primary cause of the greenhouse effect, with over 50% of conventional cars emitting it.In addition to using clean, renewable energy sources to provide environmentally friendly transportation, hybrid electric vehicles are becoming well-known as an appealing option for the traffic system in the modern world [1-3]. Multi-input sources are included in this type of vehicle to improve the input system's dependability, effectiveness, and environmental friendliness. Environmentally friendly fuel cells, solar power, plug-in AC voltage, and other regenerative energy sources are examples of inputs. In order to store extra energy and supply energy in case other sources aren't available, batteries are used in a bidirectional fashion. A multi-level input and output conversion system is required to efficiently manage power between input and output and to supply a certain voltage level [4]. In this paper, a multi-input-dual-output DC-DC boost converter is thus presented and studied. Plug-in AC voltage is injected into the multi-input process. The AC sinusoidal voltage is rectified into DC voltage using a rectifier, and the DC-DC buck converter provides the necessary voltage to charge the battery. Charging batteries and converting AC to DC are two processes that controlled operated via manual , push-button switches and operational switches. Next up is the fuel cell, a cutting-edge and highly promising technology that employs clean energy and can effectively fulfill future demand. Our goal should be to use it as little as possible because it is quite expensive.

## II. RELATED WORK

In essence, a hybrid electric vehicle is a contemporary form of electric car that uses less gasoline, is better for the environment, and emits nearly no harmful gas emissions. A hybrid vehicle needs input from multiple sources in order to efficiently produce enough voltage at the output. A multi-input, multi-output DC-DC boost converter has already been presented to maintain the necessary high peak voltage in the output despite variations in the low peak voltage in the input. This research proposes a new multi-level DC-DC boost converter model that uses four different types of inputs to give power to the dual outputs[5,6].

The four distinct input sources and two distinct outputs of the proposed multi-input dual-output DC-DC boost converter are depicted in Figure 1. Among these, a rectifier consisting of diodes D1, D2, D3, and D4 converts Plugging in an AC voltage source will convert it into DC voltage. Resistor R1 is crossed by the output DC voltage, which is lessened by capacitor C1.To charge the 9-volt DC battery, a buck converter consisting of operational switch Op_Sw1, diode D5,

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inductor L1, and capacitor C2 converts high peaked DC power to 9-volt DC. You can locate the converted output across resistor R2.Plugin AC's primary purpose is to simply charge the battery. Next is fuel cells, an extremely promising technology that adds a second input source of 9 volts to the circuit. The battery that comes in third is charged by both a solar cell and an AC energy source that plugs in. Once charged, the battery provides the circuit with the required voltage. The circuit and other sources are shielded from the battery's reverse current by diode D6. At last, the solar cell that generates 9 volts may simultaneously charge the 9 volt battery that is empty and supply the required voltage to the car that is operating.

## III. METHODOLOGY

The Three primary types of modes exist: the full stop mode, the partial active mode, which only activates 24 voltage, and the fully active mode, which activates both 24 and 72 voltage outputs. When operating in various modes, a hybrid electric vehicle may encounter a variety of scenarios. Here are some key scenarios explained. This is sometimes referred to as the battery charging mode. In this mode, the input source switches are turned on in case the battery needs to be charged while the other switches stay off. The dual outputs are rendered inactive via switches Sw6 and Sw7. The wire for charging batteries is on. The other components are shielded from battery reverse current by diode D6 and switch Sw5. In this instance, switch Sw6 is the sole one with an active 24-volt output, and switch Op_Sw_2 is the operational switch. Certain input source switches are turned on while the others are left off. An inductor is used to raise voltage from 9 volts to 24 volts.

Switches Sw6 and Sw7 in this mode enable dual outputs, while operational switches Op_Sw_2 and Op_Sw_3 are also active. In this mode, case-wise input source switches are turned on while the others stay off. Using inductor L2, diode D8, capacitor C3, and inductor L3, diode D10, capacitor C4, the 24-volt and 72-volt boost up processes from 9-volts are accomplished, respectively.

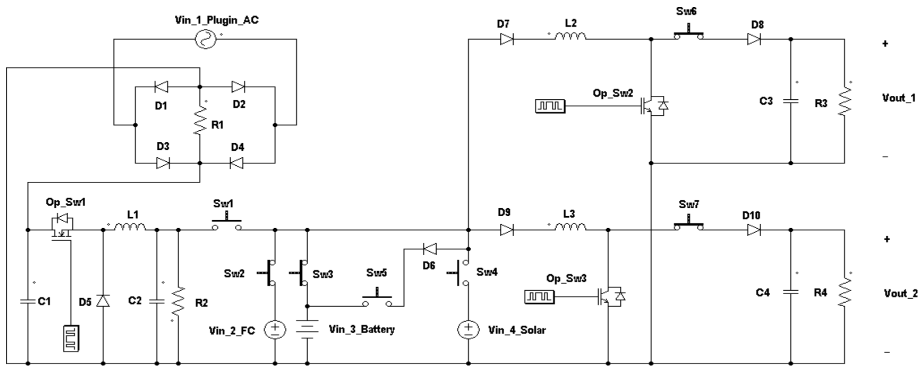


Fig. 1. Multi-input dual-output DC-DC boost converter.

- Case 1: When fuel cells, batteries, electricity, and solar panels are all accessible, the solar cell powers the output via switch Sw4.

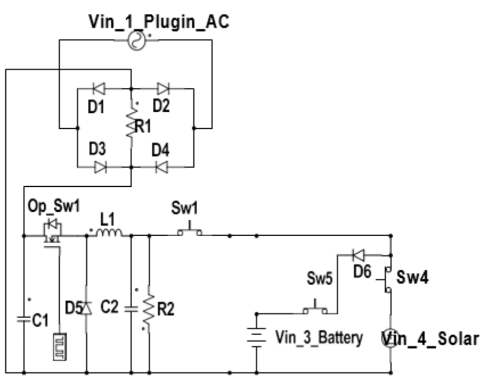


Fig. 2. The battery is getting charged by electricity and solar.

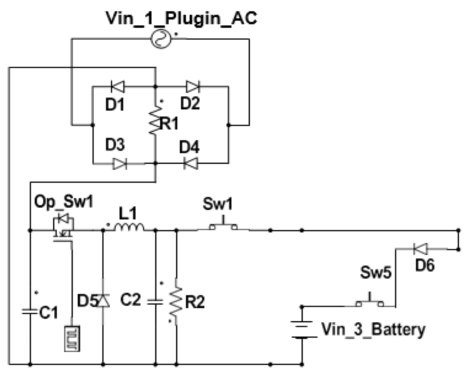


Fig. 3. Battery is charged by electricity.

- Case 2: All that needs to be done to charge the battery when fuel cells and electricity are available is to plug in AC

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voltage through switch Sw5. Figure 3 shows the suggested circuit. When both a battery and a fuel cell are present, the battery powers the output via switch Sw3. In this mode, a battery powers the output at 24 volts. Fig. 5 shows the proposed circuit.

- In this instance, switch Sw6 is the sole one with an active 24-volt output, and switch Op_Sw_2 is the operational switch. Certain input source switches are turned on while the others are left off. An inductor is used to raise voltage from 9 volts to 24 volts.
- Switches Sw6 and Sw7 in this mode enable dual outputs, while operational switches Op_Sw_2 and Op_Sw_3 are also active. In this mode, case-wise input source switches are turned on while the others stay off. Using inductor L2, diode D8, capacitor C3, and inductor L3, diode D10, capacitor C4, the 24-volt and 72-volt boost up processes from 9-volts are accomplished, respectively.

- Case 1: When Switch Sw_4 allows the solar cell to power the outputs when the battery, solar, and fuel cell are available. The suggested circuit is shown in Figure 6.

- Case 2: When a battery is empty and both solar and fuel cells are available, the outputs are powered by the solar cell and the battery is charged via switches Sw4 and Sw5. After charging, battery switch Sw5 is turned off, and switch Sw4 allows solar cells to power the outputs. The suggested circuit is shown in Figure 7.

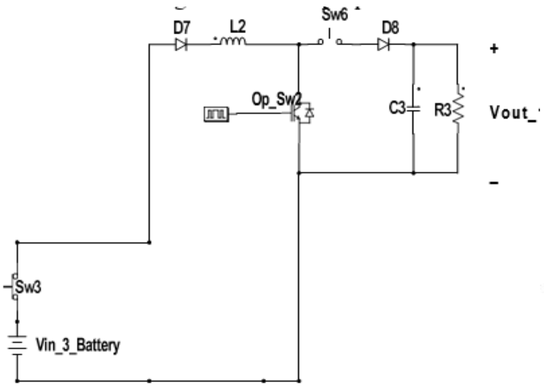



Fig. 5. Output is powered by battery

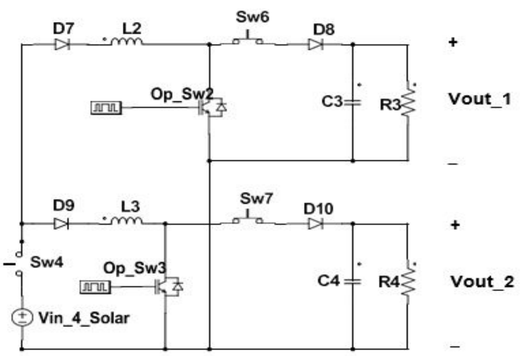
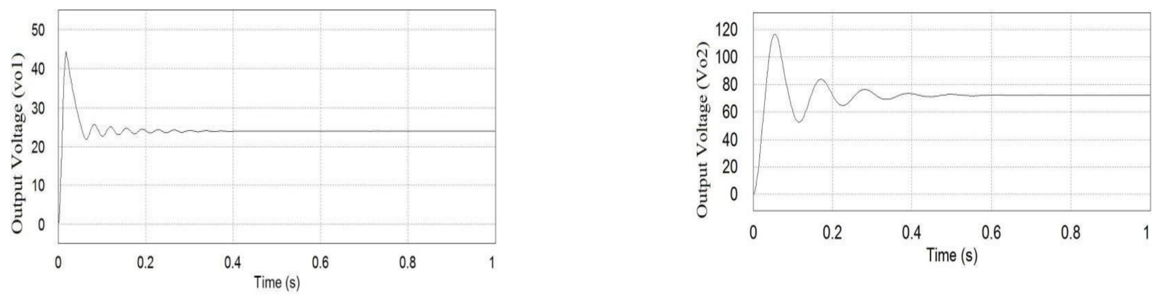



Fig. 6. Outputs are powered by solar cell.

## IV. EXPERIMENTAL RESULTS

In order to verify the performance of the proposed converter simulation have been done for the fully active mode with the battery is fully charged and solar and fuel cells are available by PSIM software. The input solar voltage is considered as 9 volt and outputs are desired to be 24 volt and 48 volt. Switches Sw4, Sw6 and Sw7 are operational switches Op_Sw_2 and Op_Sw_3 are the only ones that are in operation mode. Figure 8 displays the output voltage and current curves, and Table II provides information on the performance parameters of both outputs.
The potential research directions that warrant further investigation are the early investigations on the three mode hybrid vehicle converter configuration, the renewable hybrid power system for raising power backup system, and the use of PSIM to simulate complex hybrid vehicle converter design



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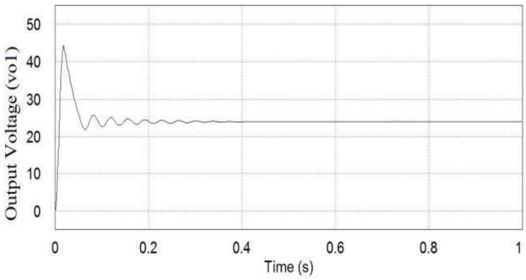


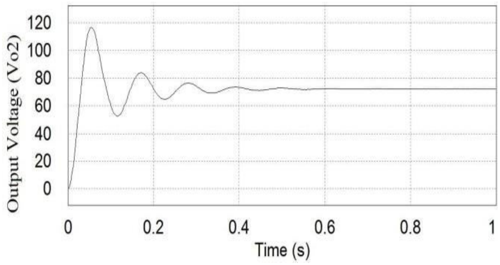


## V. CONCLUSION

The efficiency of the converter plays a major role in why HEV design is superior to conventional vehicle design. As a result, the development of new hand depends upon simulation based analysis of vehicle performance. Currently, vehicle simulations technologies are limited to extremely narrow applications and cannot provide modeling and analysis of all vehicle design choices .To provide more capable and trustworthy converter Modeling simulation, a lot of work is required hybrid vehicles greatly benefits. A work proposes the usage of a multi-input-dual-output DC-DC boost converter for hybridizing the input power source and also for energy transfer across various energy resources like electricity, fuel cell, solar, and energy storage system like battery. Both an energy storage system and a power source are employed in batteries. Both single input single output and multi-input multi-output DC-DC boost converters can be utilized with this converter. Full stop mode, partial active mode (24 voltage is active), and completely active mode (both 24 and 72 voltage are active) are the three primary operating modes of the converter. A microcontroller sensor is observed to function in various scenarios where resources are insufficient to provide a sufficient voltage for the input.

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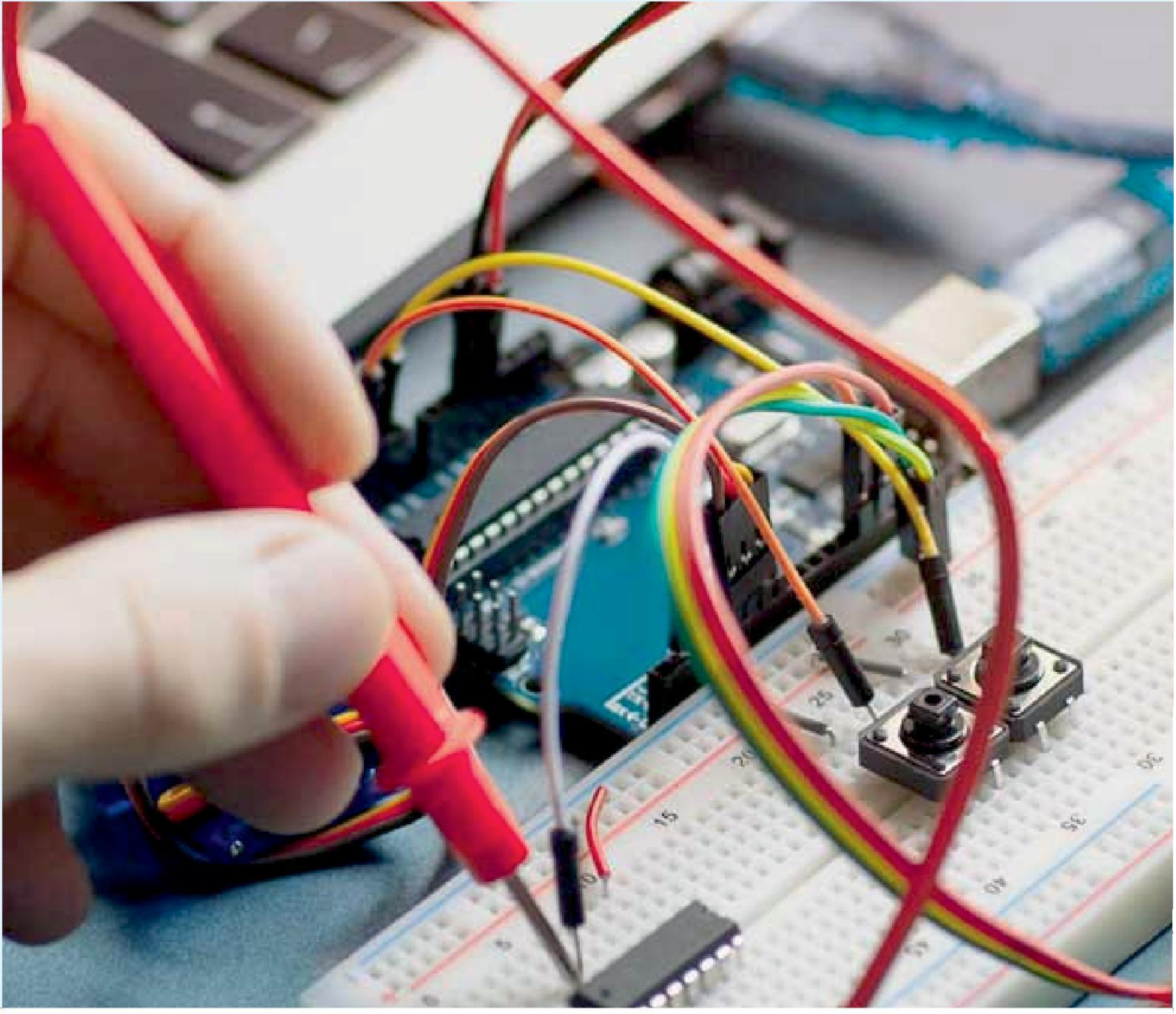



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