

# Regenerative Braking Concept In Powered Hybrid Electric Vehicle Using Solar, Fuel Cell And Battery

S.Hema, A.Anbukani, M.Chithra Devi, D.Shyamu

**Abstract:** Now-a-days Hybrid electric vehicles (HEVs) offer many advantages, such as high fuel economy, low emissions, and silent operation. In this paper, we use three source for the purposes of better performances of the vehicle. There is a bi-directional DC/DC Converter to transfer the energy back and forth and it provides High efficiency, compact size, Lightweight and reliability. In this paper an auxiliary energy storage battery absorbs the Regenerated energy which is obtained during the process of braking and it fed back by the electric machine. In addition, bidirectional dc-dc converter draws power from the other two source to boost the high-voltage during vehicle starting, accelerate and hill climbing. It also has the ability to reverse the direction of current flow, hence the bidirectional dc-dc converters are being increasingly used to achieve power transfer between two dc power sources in either direction.

**Index Terms:** Bidirectional DC/DC converter, battery, fuel cell, regenerative power, solar.

## 1. INTRODUCTION

Integrated electric motor which is used for the motion of the bicycle. There are different types of e-bikes available in worldwide. E-bikes have rechargeable batteries and these battery are the most important part of e-bike. Commonly the batteries of e-bike ranges from 350-500W of power. The electric bike has electric motor which is built in to the hub of the front or back wheel. Electric bike has a concept of regenerative braking in which the power can be stored back in the battery while brake is applied [1].

## 2. DC MOTOR

DC motors are mainly used in large applications, for the smooth running operation, these motors use drives. The advantage of DC motor drives frequent starting, braking and reversing and it is mainly used for good speed regulation [2, 3]. Before enlisting the practical applications of the drives used for DC motors, we will discuss about the different operation of drives for different purpose.

## 3. SOLAR ENERGY

A photovoltaic system will converts light into electrical direct current (DC) by taking advantage of the photoelectric effect. Using solar collector for heating and solar power, we can convert sunlight to electricity directly by using photovoltaic (PV) and indirectly by using concentrated solar power (CPS). To focus a large area of sunlight into a small beam concentrated solar power (CPS) systems use lenses or mirrors and tracking systems [4-6].

## 4. FUEL CELL

A fuel cell is an electrochemical device. It produces electricity by combining hydrogen and oxygen without combustion to

produce water and heat [7-9].

## 5 REGENERATIVE BRAKING

The field flux cannot be increased beyond a rated value, hence the regenerative braking is possible only when the speed of motor goes higher than the rated value. When regenerative braking occurs, the terminal voltage rises and as a result the source is reassured from supplying this amount of power. Due to this the reason loads are connected across the circuit [10, 11].

## 6 BIDIRECTIONAL CONVERTER

In our project, we use more than one source solar, fuel cell, battery and regenerative power also must be stored in battery. For this operation we need to add converter for each every source. So the circuit will be more complex. So we designed and modified the converter from the single inductor converter nearly it will work like a boost converter. But it will be like multiple Input and single output. The non-isolated four-port dc-dc converter is used as the interface circuit of the independent photovoltaic energy storage system [12-14]. The four ports of the converter are photovoltaic cells port, battery port, fuel cell port and load port. It is made more effective by the combination of a three-parallel Boost circuit and a dual output Boost circuit.

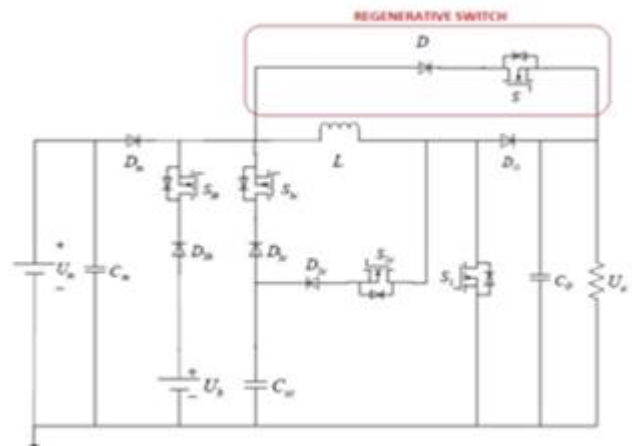


Fig.1. Bidirectional Converter Circuit Diagram

- S.Hema<sup>1</sup>, <sup>1</sup>assistant Professor, Department of Electrical And Electronics Engineering, Vel Tech, Chennai. Email: hema@veltechengg.com
- A.Anbukani<sup>2</sup>, Ug Student, Department Of Electrical And Electronics Engineering, Vel Tech, Chennai.
- M.Chithra Devi<sup>3</sup>, Ug Student, Department Of Electrical And Electronics Engineering, Vel Tech, Chennai.chithraa698@gmail.com
- D.Shyamu<sup>4</sup>ug Student, Department Of Electrical And Electronics Engineering, Vel Tech, Chennai.

## 7 WORKING PRINCIPLE

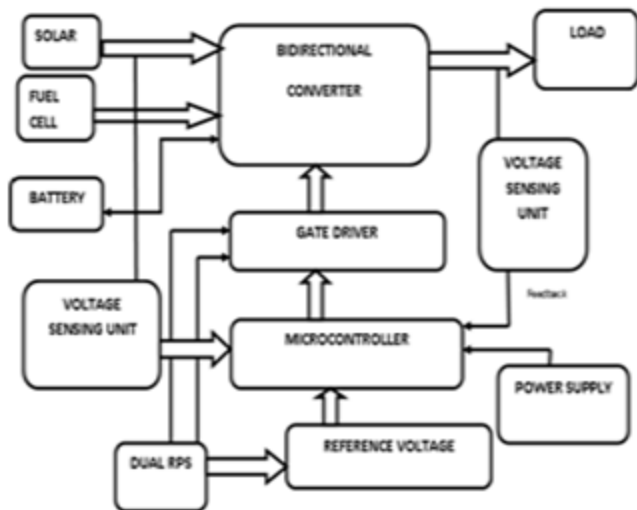


Fig.2. Block Diagram

The hybrid vehicle utilizes the maximum power from renewable energy and should not affect the environment. In order to achieve this solar, fuel cell and battery are used. The first preference is solar if solar achieves required amount of power or more than that, it gives power to motor and excess power is charged to battery. For fuel, the generating power is stored to battery while solar uses to run motor. When solar power is not enough the battery will compensate it. if both power didn't enough means the fuel cell will compensate to run a motor. The battery will store from excess power from fuel cell and solar. While braking, the input power to the motor will cutoff at that time the power will generate by regenerative concept that energy also stored in battery

## 8 Features Of PIC Micro Controller

1. It is small in size and equipped with sufficient output ports without having to use a decoder or multiplexer.
2. It consume low current.
3. It has PWM inside the chip which allow us to vary the duty cycle of DC motor drive.
4. It is very simple but powerful microcontroller. We have to learn only 35 single word instructions to program the chip.
5. It can programmed and reprogrammed easily (up to 10,000,000 cycles) by using the universal programmer in robotics lab.

## 9 SIMULATION

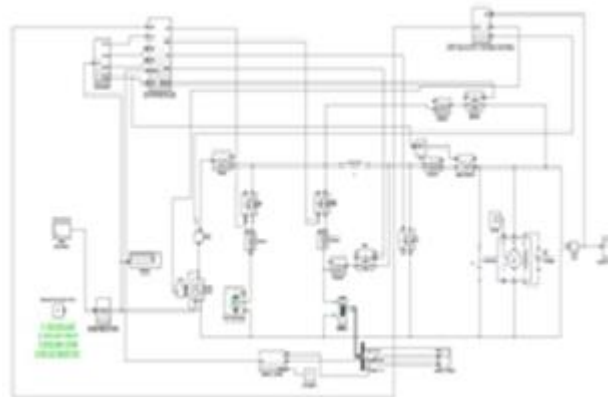


Fig .3. SIMULATION

### 9.1. KEY FEATURES

1. Extensive and expandable libraries of predefined blocks
2. Managing intuitive block diagrams and Interactive graphical editor for assembling
3. It has Ability to manage complex designs by segmenting models into hierarchies of design components
4. Model Explorer to navigate, create, configure, and can search all signals, parameters, properties, and generated code associated with your model

### 9.2. MODES OF OPERATION

1. When solar power is high
2. When solar power is low
3. When there is no solar power
4. Regenerative power

### 9.3. When solar power is high



Fig.4. Mode 1 When Solar Is High

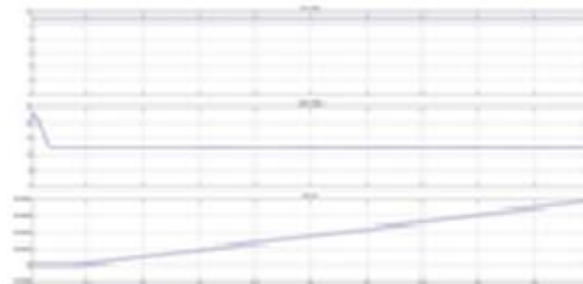
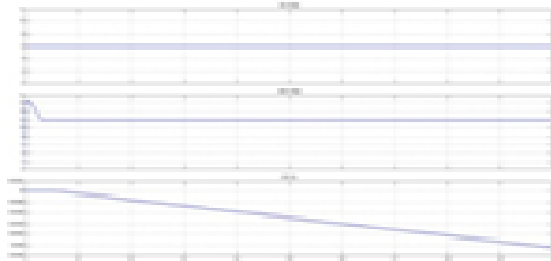
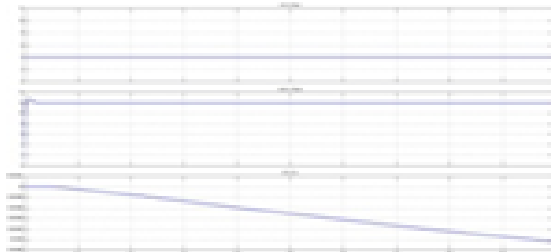
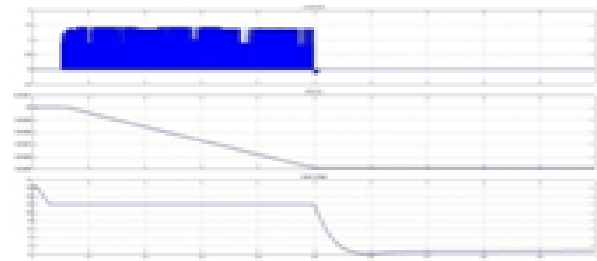


Fig.5. Output

**9.4. When solar power is low:-****Fig.6.** Mode 2 When Solar Is Low**Fig.7.** Output**9.5. When there is no solar power****Fig.8.** Mode 3 When there is no solar**Fig.9.** Output**9.6. REGENERATIVE POWER****Fig.10.** Mode 4 Regenerative Power**Fig.11.** Output**10 LIMITATIONS OF EXISTING SYSTEM**

1. It used more number switches and losses will be high
2. The less amount of energy is transferred to the battery and motor.
3. A duty cycle variation of the converter is high voltage difference.
4. In existing system the solar and battery only used for hybrid vehicle. The generation will be less
5. High inductive and switching loss.

**11 ADVANTAGE OF PROPOSED SYSTEM**

1. Regenerative concept is fully utilized, Forward and Reverse direction control is permitted.
2. We can use three source at a time
3. Simple bidirectional DC-DC converter so no need to go for bulky circuit.
4. Less number of components are required so less switching losses.
5. The proposed converter can also serve as a charger by connecting with AC line directly. It will increase the power availability.
6. The energy developed at the time of braking is not left useless, it is reutilized to store the energy back into battery.
7. Renewable energy is used as input source

**12 APPLICATIONS**

1. This system may be applicable in all types of vehicles like cars, Tempos.
2. Here we used bidirectional converter so it can flow in both direction
3. Three source can be used at a time
4. This system also successfully installed in the heavy vehicles like buses, trucks, trailers, etc.

**13 HARDWARE OUTPUT****Fig.12.** Hardware Output

The proposed system of the hybrid electric vehicle consists of solar, fuel cell and battery. To obtain the energy back from the motor regenerative braking concept is used. LED is used to display the regenerated power from the motor as shown in the above figure. The battery will be charged continuously during the running condition of the motor.

## 14 CONCLUSION

The major objective of this paper is to design and to implement a bi-directional converter in electric bike. Four power switches are just required in the proposed converter, which integrates motor driver and battery charger, not only recycle energy to battery to improve system performance, and reduces the component count to minimize the overall cost. And then, a driving, charging and the electric capacity estimation strategies are all embedded in the system to promote system reliability. A prototype model of the system is developed in laboratory and detailed experimental studies are carried out. It is observed that the experimental results are consistent with the simulation results.

## 15 FUTURE SCOPE

1. All the major automobiles manufacturer are working on hybrid electric vehicle
2. Heavy vehicle like trucks will be use hybrid system in future
3. Efficiency of hybrid electric vehicle will further increase in future
4. Safety features will be add in new generation hybrid vehicle
5. Power of vehicle have to increase in future
6. Price if vehicle will reduce due to increase in production rate of hybrid electric vehicle

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