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RENEWABLE ENERGY SOURCE BASED BOOST CONVERTER FED BLDC MOTOR

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***Abstract*---The demand for electrical energy is growing rapidly; therefore it is necessary to enhance power producing capacity. As non-renewable fuels are going to extinguish, that's why we are focused toward renewable energy which is the best option now a days. There are so many options to produce electrical energy using renewable energy such as solar, wind and tidal, etc. from this the best form of energy is solar energy. Solar energy is available in abundant form and free in nature. But renewable energy is irregular because of its output and efficiency as compared to non-renewable energy. So we have provided the proposed method to increase the renewable energy i.e. solar energy by means of boost converted (BC). The boost converter, over the various common DC-DC converters, offers many advantages in SPV based applications. To show the application of BC here BLDC motor is used whose speed is controlled by using ESC and micro controller**

Keywords--- Solar Panel; Energy; Battery Management; Boost Converter; Electronic Speed Controller

I. INTRODUCTION

The demand for power generation capacity is increasing day by day; so to meet this demand, without harming the environment can be done by means of renewable energy source due to their effective operation and no pollution. Since the output of renewable energy i.e solar energy is less we cannot fulfill the demand. If we want to fulfill the demand then more number of panels are required, a large area is required for installation, complexity is increased in operation and cost also increases which ultimately make it uneconomical to install in commercial and domestic level. Hence to fulfill this demand and overcome above disadvantages, by connecting an boost converter to the solar panels. The solar energy gives output voltage and the boost converter will boost up this output voltage level and efficiency is also increased

Brush less DC (BLDC) motors have developed in popularity over the years as a result of advantages such as high efficiency, high power density, small size, minimal maintenance needs, and immunity to electromagnetic interference (EMI).

A three-phase synchronous motor with torque-speed characteristics similar to a DC motor is known as a BLDC motor. The stator incorporates three phase windings that are activated by a voltage source inverter (VSI), while the rotor includes permanent magnets. It uses an electronic commutation system based on the rotor position as measured by Hall Effect position sensors, rather using brushes and commentators. As a result, issues like sparking, brush wear and tear, EMI, and noise interference are avoided with BLDC motor.

II. THEORETCAL ANALYSIS

Solar power systems are getting progressively in style thanks to increased energy demand and worries concerning environmental degradation throughout the world. An usual PV module's open-circuit voltage is roughly twenty one volts, whereas the most electric receptacle (MPP) is around sixteen volts. The traditional gadget requires sizable range of PV modules to be linked in collection; with a PV array voltage of 150 to 450 V and a system power of extra than 500 W. It is a variable in this suggested model as a DC-DC boost converter. The boost converter steps-up the input voltage from the solar panel and provides it to the Battery Management System(BMS).Where three batteries of 4V are connected in series resulting in the voltage range of 12V and the battery gets charged through the boost converter. When the BC switch is ON the battery will feed 12V supply to the Electrical Speed Controller. Now, an electronic speed control adjusts the switching rate of a network of field effect transistors in response to a speed reference signal (taken from a throttle lever, joystick, or other manual input) (FETs). Transistors can be switched on and off according to their duty cycle. The speed of the motor is also changed.

A. Boost Converter--

Figure 1 depicts the DC-DC conventional boost converter's basic functioning. The diode gets reverse biased as soon as the switch is flipped, isolating the load stage. The inductor stores energy from the input source. When the power switch is turned off, the load stage receives energy from both the inductor and the source, resulting in a load voltage larger than the source voltage. The traditional boost converter has a basic circuit and is inexpensive

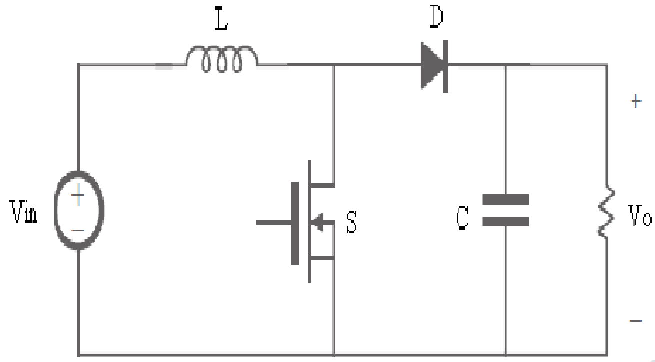

Fig. 1. General configuration of a boost converetr

Assume the average inductor current to be during ON and OFF. When switch is ON let the
Voltage across L=V. Therefore,

Energy stored in L=VI (T_{ON})

When the switch is OFF let the energy supplied by the inductor to the load be

$$V_L = V_0 - V$$

$$E_L = (V_0 - V) I\, T_{OFF}$$

Neglecting the losses let us consider,

Energy stored in L = Energy supplied by L

$$V\, I\, T_{ON} = (V_0 - V)\, I\, T_{OFF}$$

$$V\, I\, T_{ON} = V_0\, I\, T_{OFF} - V\, I\, T_{OFF}$$

$$V_0 = V \left[\frac{TON + TOFF}{T\, OFF}\right]$$

$$= V \left[\frac{T}{TOFF}\right]$$

$$= V \left[\frac{T}{T - TON}\right]$$

$$= V \left[\frac{1}{1 - \frac{TON}{T}}\right]$$

Expression for output voltage, $V_0 = V \left[\frac{1}{1-d}\right]$

B. ESC and BLDC Motor--

Brushless DC motors (also known as BLDC motors) are electrically commutated DC motors without brushes. The clockwise and counter clockwise commutation sequences for BLDC motors are synchronised with Hall effect position sensors. The synchronous motor's speed and torque are controlled by the Electronic Speed Controller, which sends current pulses to the motor windings.

An Electronic Speed Controller (ESC) can be built from three key components: a voltage regulator, a processor, and FETs for switching. The voltage regulator separates the electronic speed control from the power transmission back to your receiver and then to the servos. This also has a secondary function, including when the motor is powered by a battery, the motor receives its lowest voltage, and the voltage regulator keeps some power for flight control in critical circumstances, ensuring that the motor does not burn the entire battery's power. The processor is now confined entirely within just a single Si semiconductor chip. The main objective of this processor is to decode data from the model's receiver and to manage the power to the motor using FETs. This transistor is crucial in an ESC since it performs all of the tasks. It monitors the motor's total current and voltage, and also a battery. This transistor acts as a switch, controlling the current flow and allowing the electric motor to be throttled.

Fig. 2. BLDC Motor

III. BLOCK DIAGRAM AND WORKING

To have an operating solar power generator, you would like 2 main components. A collector and a storage unit are the two components. We need a battery storage unit because solar energy is not constant; sometimes only a small amount of radiation is received. We must also have a backup power supply. Here, we use 3 Li-ion batteries which are rechargeable. During the charging and discharging there is a chance for over-voltage and under-voltage respectively. Therefore, we use Battery Management System (BMS) which

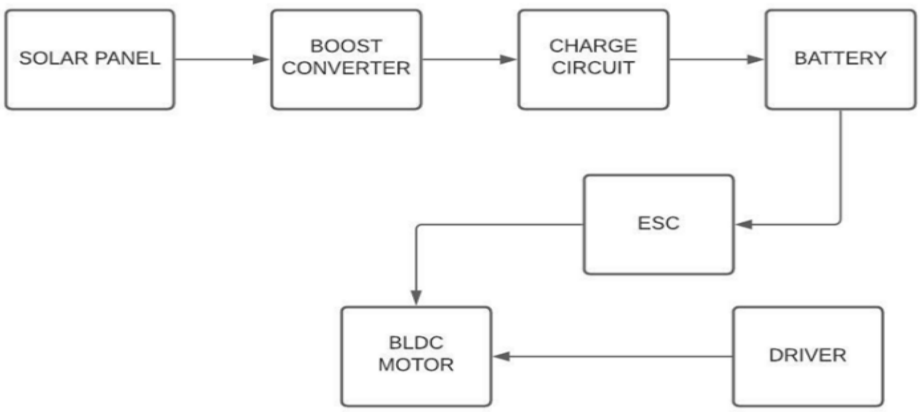

Fig. 3. Block diagram of renewable energy source based boost converter fed BLDC motor

protects the battery from the unfavorable conditions. A boost converter (BC) boosts the output voltage of a solar panel by using the panel's output as an input.

ESC includes regulating the switching frequency of the inverter switches to control the BLDC motor's speed.BLDC motors are also called electronically commutated motors. These motors are powered by a DC electric source that is converted to an AC electric signal by an inbuilt inverter or a switching power supply. Permanent magnets on the rotor are used in the stator windings to maintain a nearly constant flux density in the air gap.Here we use a 2200KV BLDC motor which cannot be driven because of the less than 24 volt boost converter output. The battery will first be charged, and then discharged. The motor will be powered by battery power when the voltage is above 24 volts. The voltage applied to the winding of the BLDC engine stator is determined by the position of the rotor.

Fig. 4. Electronic speed controller

Name of the Component	Specifications
Solar Panel	O/P :6V-3W
BLDC Motor	O/P : 2200KV(rpm/V)
Boost Converter	I/P : 3V-32V, O/P : 5V-35V(adjustable)
Battery Management System	Overcharge protection voltage : 4.25-4.35V, Over discharge protection voltage : 2.32-2.35V
Li-ion Battery	O/P : 12V
ESC	DC : 5.5V-12.6V, BEC : 5V/2A
Servo Motor Tester	OP : 4.8-6V O/P Current : >15mA
Hardware	Solar Panel, BLDC Motor, Boost Converter, Battery Management System, Li-ion Battery, Electronic Speed Controller (ESC), Servo Motor Tester.

Table. 1. Specifications of the System

IV. RESULTS AND DISCUSSION

Solar panel with rating 6V,and 3W will provide a 500mAmp which is fed to the boost converter and it is set to 12 volts in order to match with the lithium ion a battery management system is employed to manipulate and shield batteries which are connected in series each of 4 volts adding up to 12 volts. A are being charged and discharged. The BMS will protect the batteries from burning out in case if there are any uninterrupted causes in the circuit. The BLDC motor is controlled using a microcontroller with a 555 timer and a potentiometer which can control the speed of the BLDC motor.

A. Case: 1

When the boost converter's input voltage is supplied by a solar panel, it may vary depending on the availability of the sun or solar energy, but the boost converter's output voltage remains constant. The boost converter can decreases up to minimum of 3 volts and beyond that Boost converter cannot decrease.

S. No	Input Voltage	Output Voltage
1	12.2V	12.1V
2	10.3V	12.1V
3	8.2V	12.1V
4	6.1V	12.1V
5	5.3V	12.1V

Table 2. For different values of input voltage, boost converter's output voltage is given

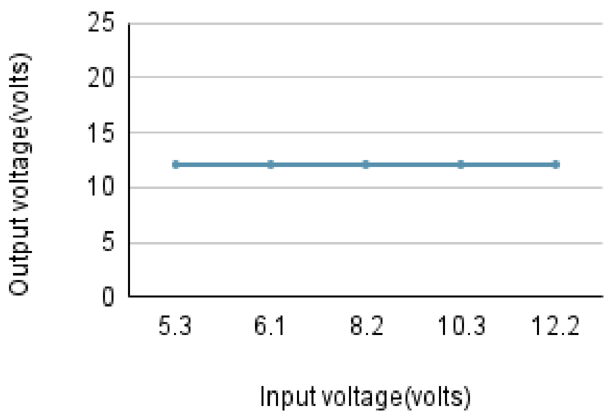

Fig. 5. Graphical representation of input voltage versus output voltage

B. **Case: 2**

When the boost converter receives its input voltage from a solar panel, it may rise or fall depending on the availability of the sun or solar energy. As the boost converter's output voltage rises, so does the input voltage. The boost converter may boost the voltage to a maximum of 30 volts.

S. No	Input Voltage	Output Voltage
1	5.0V	5.1V
2	7.0V	7.2V
3	9.0V	9.3V
4	11.2V	11.0V
5	12.5V	12.3V

Table 3. For different values of input voltage, boost converter's output voltage is given

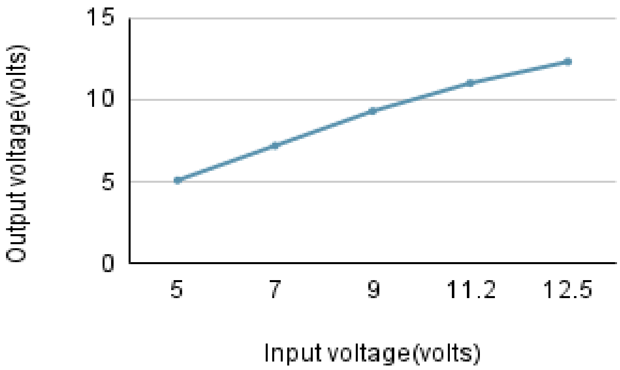

Fig. 6. Graphical representation of input voltage versus output voltage

We observed the speed by using a tachometer and we noted it down in the form of a tabular column 4 and we plotted a graph so that we can observe the speed of the BLDC motor is increased by increasing the pulse width modulation of the servo motor control.

S. No	Pulse Width	Speed in rpm
1	1 ms	500
2	2ms	1500
3	3ms	3000
4	4ms	7000
5	5ms	12000

Table 4. Speed of BLDC motor is increased by varying the pulse width.

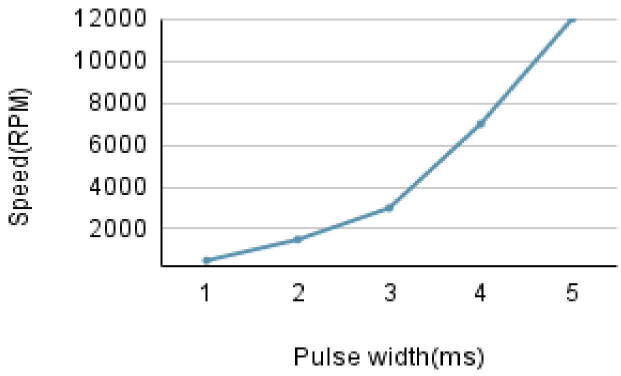

Fig. 7. Graphical representation of pulse width(ms) versus speed in RPM.

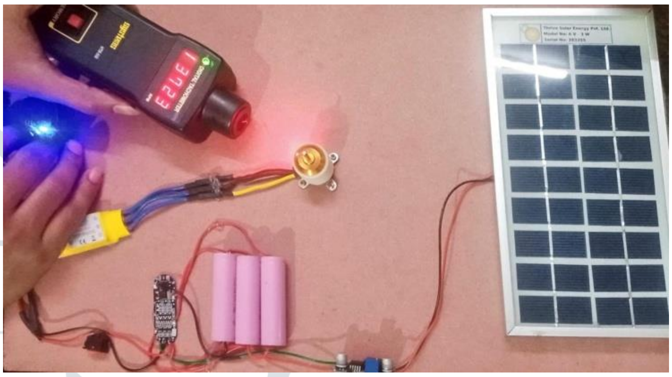

Fig. 8. Hardware implementation of renewable energy source based boost converter fed BLDC motor

V. CONCLUSION

The project work shows the application of a boost converter for increasing the power and efficiency of solar panels and the application of it is shown by running BLDC motors. The IBC is more advantageous than conventional boost converters like improved efficiency, less ripple, peak current, improved reliability, good current sharing characteristics, higher boosting capacity etc. The BLDC motors speed is controlled by ESC with the help of a micro controller and potentiometer. The graph obtained between output voltage and efficiency is a straight line. Hence from the result it is found that though the input voltage is less but output voltage is more.

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