INNOVATION OF NEW TECHNOLOGY FOR ELECTRICAL VEHICLE

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***Abstract* — In world more than 60% petroleum is consumed by vehicles, Electric Vehicles (EVs) segment has gained importance in world. Every nation is looking into alternative options of energy efficient transportation solutions. This segment has gained importance because it is an environment friendly, non-polluting means of transport. Electric vehicles powered by energy stored in batteries. EVs are still facing many issues like how to maximally extend the driving range of EV with a fixed amount of power stored in batteries, how to satisfy the energy requirements of the EVs in running. This paper is based on the concepts of charging the batteries of an electric vehicle when it is in running condition. Energy can be generated in EVs by regenerative breaking, photovoltaic solar cells, wind turbines, vehicle suspension. It will also save the charging time of battery and voltage level of the battery to a great extent.**

Index: Terms–Electric Vehicle, environment friendly, regenerative breaking photovoltaic solar cells, wind turbines, vehicle suspension.

I. INTRODUCTION

In order to increase the driving range of EV with a fixed amount of saved power, other approaches should be developed to generate power in running vehicles. Electric vehicles (EVs) include electric trains, electric buses, electric aircrafts, electric boats, electric motorcycles or even electric spacecrafts etc. This paper attempts to explain innovative methods of generating clean energy in a fast moving electric cars, electric bus, electric motorcycles and also equally applicable for all type of hybrid electric vehicle.

There are numbers of electrical loads in electric vehicles (EVs) [1], as tabulated below:-

TABLE I

ELECTRIC VEHICLE'S TOTAL LOAD ESTIMATION

	Four wheelers	**Two wheelers**
Drive with motor	800W-1.5KW	250W-800W
Head light	230W	35W
Parking lights and indicators	50W	20W
Horn, music system, speaker	100W	10W
Power window	350W	-
Wiper	60W	-
Other	500W	10W

If other sources are found to support the charging of batteries to run any of above mention electrical system by some other source it will improve the range of EVs. It can significantly observe that the instantaneous power required is highly vary during uphill and downhill path or vehicle going through speed breaker or improper road[2]. There are various methods to generate the electricity in running EVs such. This paper is going to deal with some of the methods such as regenerative breaking, photovoltaic solar cells, wind turbines, vehicle suspension. Condition for implementing any technology to generate electricity in EV is addition of initial cost and maintenance cost always should be less then cost saved after implementing technology.

The first section gives the introductory idea about the paper. The second section of the paper gives ideas about the different approaches to generate electricity in a running electric vehicle. Results of the experiment are discussed in the third section. The final section presents the conclusion.

II. ENERGY GENERATION APPROACHES

A. Solar Powered Electric Vehicle

All pure green energy technologies are able to convert renewable resources into energy and are aimed at replacing fossil fuel energy. Green energy is coming into the spotlight due to domestic overseas changes such as the weakened carbon industry caused by the recent high oil prices and global warming. Currently, renewable green energy is composed of 8 renewable energy fields such as solar, wind power, biological, and geothermal and the 3 new energy fields of hydrogen energy, fuel cells, and coal liquefied gasification. It's a pro-active approach to shift our source of energy to renewable source. Designing a Solar Powered BLDC Motor Driven Electric Vehicle is one of the solutions for the oncoming crisis. The integrated system consisting of the solar module, charge controllers, batteries, boost converter and BLDC motor, henceforth developed into the Solar Powered Electric Vehicle. In order to achieve the required voltage, the Photo Voltaic (PV) Module may be connected either in parallel or series, but it's costlier. Thus to make it cost effective; power converters and batteries are been used. The electrical charge is consolidated from the PV panel and directed to the output terminals to produce low voltage (Direct Current). The charge controllers direct this power acquired from the solar panel to the batteries. The

voltage is then boosted up using the boost power converter, ultimately running the BLDC motor which is used as the drive motor for our vehicle application.

$$I = I_{sc} - I_o\left[e^{q\left(\frac{V+I.R_s}{nkT}\right)} - 1\right] - \left(\frac{V+I.R_s}{R_p}\right)$$

Where
I- is the cell current,
V - Cell voltage.
Q - Electron charge.
K - Boltsmann's constant.
T - Temperature in Kelvin.
I_o - Reverse saturation current of the diode
N - Diode ideality factor and takes the value between one and two.

The 20W solar modules can be connected in parallel or series according to the requirement of the application that to increase the output voltage using two or more solar modules; they must be connected serially. On the other hand, to increase the current rating, it must be connected in parallel. Depending upon the need of the application, the appropriate connections can be made. A combination of serial and parallel connection is also possible to meet the need.

Charge Controller limits the rate at which electric current is added to or drawn from the electric batteries. The prime purpose of using the Charge Controller is to prevent against overcharging and deep discharging of a battery. For the 12V/42Ah battery, 12V/6A solar charge controller is an ideal choice. According to the rating of the battery and solar module the selection of the charge controller is done.

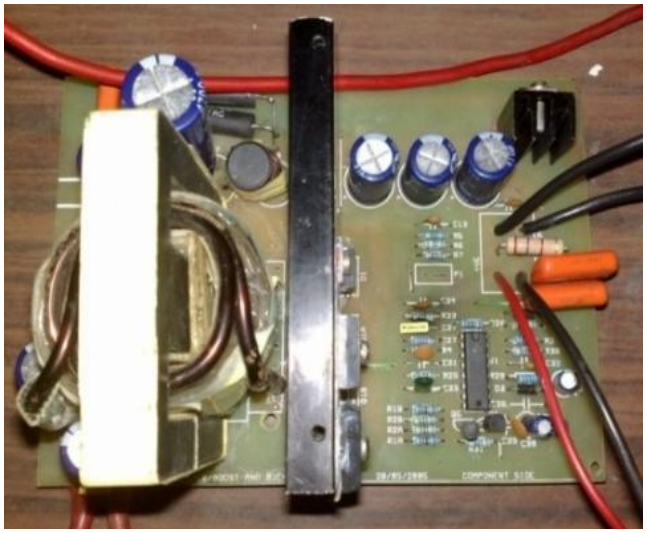

Fig. 1 Boost converter

Two charge controllers are connected between the solar modules and the batteries individually. In the next phase of the work, the power which is stored in the batteries is used in driving the BLDC motor. From the specification it's well understood that the required voltage to run the motor is 48V, while the rated voltage of a single battery is 12V. Thus to achieve the rated voltage of the motor; we are in need of four batteries which when connected in series can satisfy the requirement. In order to make it cost effective, two batteries are connected serially, giving 24V as the output voltage. This 24V from the serially connected batteries are then boosted to 48V using the boost converter.

B. Wind Alternator

If this wind energy is used to extract some power in such a way that it does not create any component of force or thrust opposite to the direction of the propulsion of the vehicle, then this gained energy can be used to produce electricity to charge up the battery of the electric vehicle itself. It is assumed that the vehicle is moving in a calm and steady wind stream with zero wind velocity. If the vehicle is moving at a constant speed of 10 m/s (36 km/h), then we can think a wind stream with15 m/s is flowing around the vehicle. Normally this wind will cause a drag force which is opposite to the direction of the propulsion of the vehicle. At constant speed (zero acceleration) the energy requirements to move the vehicle forward are –To overcome the frictional force (rolling resistance of road) and to overcome wind resistance. At this Condition, if the air stream flowing around the vehicle (which was not interacting with the vehicle previously) is allowed to enter inside and let it flow down to the rear side; then it may be possible to use these air streams to generate power. The vehicle has already interacted with this wind and it deflects the stream of wind at the two sides of it by stagnation at the front. This is the energy that had been lost from the vehicle to overcome the aerodynamic resistant. Now if these stream generated by the interaction of the wind and vehicle is captured within the vehicle in such a way that it would not impose an additional drag at the direction of propulsion of the vehicle, some of the energy can be recovered and fed back to the battery by means of conventional energy conversion processes.

The air flow through the vehicle is given by,

$$Q = C_v A v$$

Where, Q = flow rate in cubic meter per second.
C_v = opening effectiveness
A = Area in square meter

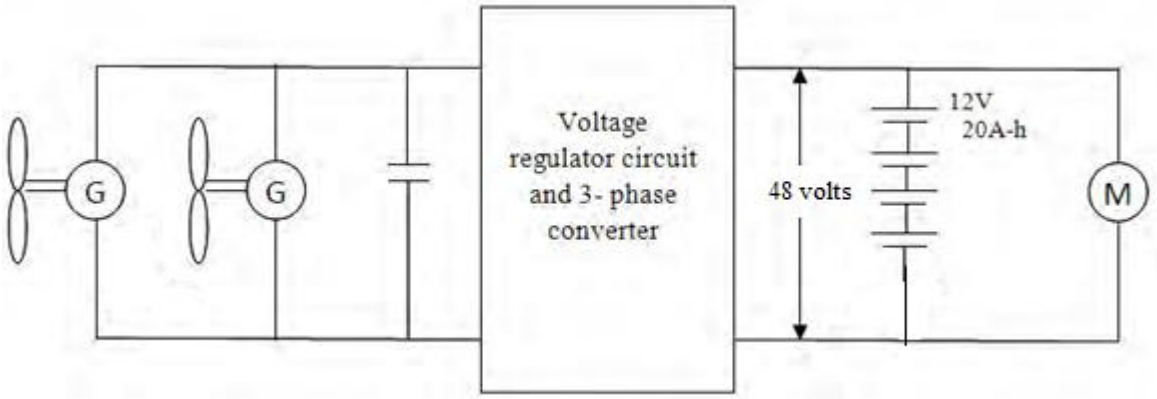

Fig. 2 Wind energy generation

v = air velocity in m/s
This equation (1) will determine the amount of air flow through the vehicle inlet area.

Output power from a wind turbine is given by,

$$P_T = 0.5\, C_p\, \rho\, Q\, v^2$$

Where,
P_T = Power output from the turbine in watt.
C_p = Power co-efficient
(Assuming, C_p = 0.4 for the design)
ρ = air density; 1.225 kg/m^3.
Q = air flow in m^3/s.
v = air velocity in m/s.

C. Regenerative Breaking:-

A pure electric vehicle (EV) contains three major parts: the power battery pack (usually in series as an energy-storage unit), the driving motor and the power converter controller. Among all the driving motors, the brushless direct-current (DC) motor has many advantages over other brush DC motors, IMs and switch reluctance machines. It has the merits of simple structure, high efficiency, electronic commutating device, high starting torque, noiseless operation and high speed range, *etc*. Hence, the brushless DC motor has been widely used in EVs. Conventional EVs use mechanical brakes to increase the friction of the wheel for deceleration purposes. Thus, the braking kinetic energy is wasted. With this problem in mind, this paper will discuss how to convert the kinetic energy into electrical energy that can be recharged to the battery pack. As a result, regenerative braking can realize both electric braking and energy savings. A potential of 30% of brake energy can be recovered with the proposed strategy. Their results demonstrate that highly accurate fault diagnosis is possible with the pattern recognition-based techniques. The capacitor bank's initial and final voltages were recorded in order to assess the amount of energy captured. Mechanical braking was engaged in order to reach a complete stop using an alternate braking lever.

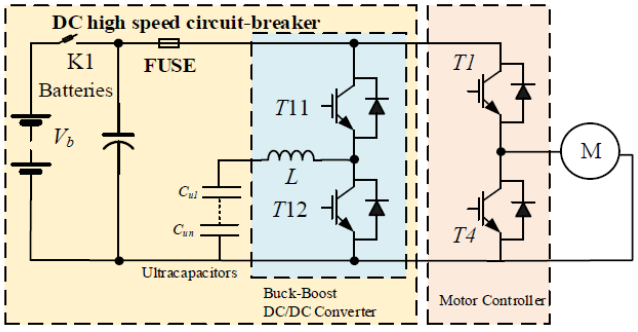

Fig. 3 Regenerative Breaking

Vehicle + driver mass = Total weight
Kinetic Energy: KE = ½ mv2 (m is mass in kg, v is velocity in m/s)
Capacitor Energy: ECAP = ½ CV2 (C is capacitance in Farads, V is capacitor voltage in Volts)
Capacitor Charge: QCAP = CV (C is in Farads, V is in Volts, Q is in Coulombs)

Fig. 4 Super-Capacitor

D. Suspension or Vibration

The electric energy generation process using vibration can be largely divided into 4 kinds; technology using piezoelectric effects, technology using magnetic induction, technology using change of electrostatic capacity, and technology generating electric power by converting vibration into rotational energy in a turbine. The present research tries to generate electric energy through electromagnetic induction of vibration load created by vehicle travel.

Moving vehicles produce vibrations due to transfer (loss) of energy from the rotating parts to the body of the vehicle. These vibrations are generated either when the vehicle is at standstill (when engine is on) or when the vehicle is moving. These vibrations are maximum when the body of vehicle is in resonance with the rotating parts and the vibrations are more in parts of vehicles which are not mechanically fitted. These vibrations that are produced are in 3- dimensions (that is along 3 perpendicular axes x,y,z). The generation of vibrations in vehicles is due to many reasons such as moment of inertia of rotating parts, uneven road surfaces, load on the system. So in order to harness this waste going energy we introduced two methods which uses piezoelectric materials and principle of Electromagnetic Induction for energy conversion respectively.

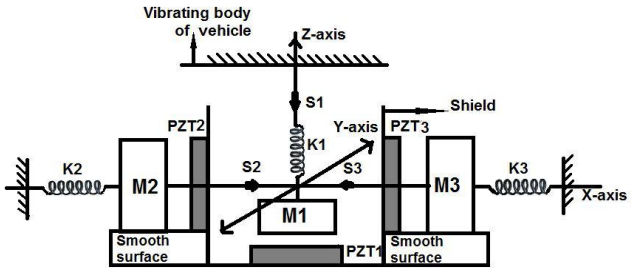

Fig. 5 Top view of 3-Dimensionalmass-spring based PZT energy harvester

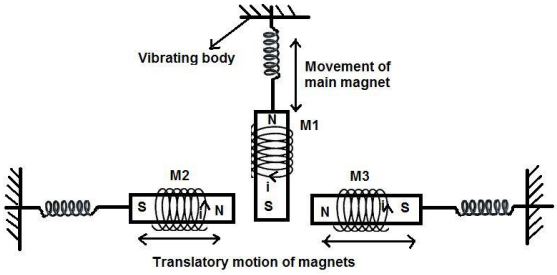

Figure.6.Spring magnet system and translator motion of Magnet

IV. CONCLUSION

In the field of automobile sector, this kind of experiment is new. By implementing this system on an automobile, the fuel efficiency of an automobile increases without hampering environment. Moreover, the cost of the project is low and could be recovered within three years. The concept of placing regenerative breaking, photovoltaic solar cells, wind turbines, vehicle suspension is presented for the very first time by us. We believe it requires more research and elaborate analysis which we expect to continue in future.

REFERENCES

[1]N. S. Hanamapure, Ajit B. Bachche Wind Energy Utilization for Generation of Electricity on an Automobile. International Journal of Engineering and Innovative Technology (IJEIT) Volume 2, Issue 7, January 2013.

[2]Nicolas CHAUVIN LENR Powered Electric Vehicles, ILENRS -12, Williamsburg, USA, July 2012.

[3] Immanuel Alphonse, Dr. S. Hosimin Thilagar, F. Bright Singh, "Design of Solar Powered BLDC Motor Driven Electric Vehicle". INTERNATIONAL JOURNAL of RENEWABLE ENERGY RESEARCH Immanuel Alphonse et al., Vol.2, No.3, 2012

[4] Dakshina M. Bellur and Marian K. Kazimierczuk, DC-DC Converters for Electric Vehicle Applications, 2007 IEEE, pp.286-293.

[5] I Byung-Wan. Jo, Yung-Sung. Lee, Gwang-Won.Yun, Chul. Park, Jang-Wook. Kim Vibration-Induced Energy Harvesting for Green Technology nternational Conference on Chemical, Environment and Civil engineering (ICCECE'2012) Nov. 17-18, 2012 Manila (Philippines)

6] G.jithendra naidu, k.pranay kumar reddy & s.siva Prasad, piezo based electric power generation using 3-Dimensional mechanical vibrations produced in Vehicles.international journal of electrical and electronics

engineering (*IJEEE*) issn (*print*): 2231 – 5284, vol-2, iss-1, 2012

[7] Jia, J.; Wang, J.; Cham, Y.T.; Wang, Y.; Han, M. Electrical characteristic study of a hybrid PEMFC and ultracapacitor system. *IEEE Trans. Ind. Electron.* **2010**, *57*, 1945–1953.