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Green Energy driven Car

Utilization of Solar and Wind Energy using*boost converter*

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Abstract: *In today's world we can easily observe the global warming is being increased day by day. There are so many reasons because of which depletion of ozone layer is caused by release of CFC's from vehicle. Hence implementation of renewable energy source driven vehicle should be progressed. This project deals with feature involving like use of solar energy, wind energy for providing the power to the car.Now a day's in electric vehicle the main disadvantage is insufficient amount ofstoring capability of electric energy due to which the vehicle is not able to run for longer duration of time. In comparison ofconventional fuels vehicle to electric vehicle the capacity of battery storing electrical energy is very less. If we analyse in the motor driven vehicles we get much better operation, performance and efficiency than the engine driven vehicle, in electric vehicle one and the most important advantage is of being very environmental friendly. But still according to studies by many researcher's electric vehicle does have lots of advantages over engine vehicles, butdue to one of the most important problem of storing electric energy for long run the clean and green vehicles are lagging behind in the race of automobile industries.*
In this paper details various aspects, how efficiently we can use the renewable energy source and distribution of the renewable energy source (solar and wind) in the vehicle drawing power of different parts of vehicle. In this paper our approach is to use power efficiently and reduces the various energy losses occur due to aerodynamic, mechanical and electric parts of vehicle by selecting designs and various components of vehicle. With the help of better energy efficient electric components, we can minimize the losses in mechanical power transmission and control, by replacing them with electronic and electrical parts for transmission and control as much as possible. For example, wind driven turbine vehicle vanes rotate while it is under operation, or due to enough strong air current, even when the vehicle is not in motion, thus we get benefits from it like mounting generator for continuous recharging of the battery system. The paper provides methods to overcome few drawbacks of the electric vehicle.

Keywords: *Charging Capacity, Wind Turbine, Photovoltaic, Battery Charging, Electric Vehicle,boost converter.*

1. INTRODUCTION

In the year 1970s and 1980s, a need of alternative fuelled vehicles was sensed to reduce the problems of internal combustion engine which runs on petroleum fuel polluting environment and reduce the dependency on crude oil. During the year from 1970s till present many attempts are made to manufacturing of electric vehicles. Vehicleswhich that are driven by fuel other than petroleum fuels (Petrol or Diesel) are commonly known as "ALTERNATIVE FUEL VEHICLE".

For sustainable development in the whole world most efficient way is to use renewable energy in transportation of vehicles to achieve clean and green Earth. In the future, leading automobile industries will be transforming to clean vehicle market {1} and dominate over the petroleum fuel vehicles for example like TESLA has already started manufacturing the electric driven vehicles and China has also started to work on magnetic levitation trains, which will reduce the Green Housing Gas (GHG) emission and reduce the other environmental issues of road transportation {2}, Let us assume when any vehicle is under motion it experiences wind resistance, which can further be classified in two ways such as form drag and frictional drag. Drag which is generated due to viscosity of air is known as frictional drag and drag which is generated by the variation in air pressure at rear side and front side of vehicle is known by form drag {4}.

2. RENEWABLE ENERGY DRIVEN VEHICLE: A LITERATURE PERSPECTIVE

There are many research papers which proposes hybrid types of charging during motion which can be used: plug-in charging uses grid and non-grid power station, and direct renewable energy use for electric vehicle charging. In this design electric vehicle power is generated by the wind turbines and solar cells and are directed to the battery for charging through the inverter to the electric motor for rotational power generation for the differential shaft {5}.

2.1Wind Energy

Wind turbines is placed over the roof of the vehicle so that while moving of vehicle wind enters into the turbine and gets captured in such a way that it passes through vortex shedding region. Normally, a drag force will be generated in the opposite direction of the motion of the vehicle. The energy requirement for moving the vehicle in forward direction at constant speed with zero acceleration are as follows – To overcomewind resistance and to overcome the frictional force i.e. rolling resistance of road.In this condition there is option to use the wind stream for generation of power by wind stream which is flowing around the vehicles allowed to flow inside and let it flow downwards to the rear side which may lead to power generation by air streams.

2.2 Solar Energy

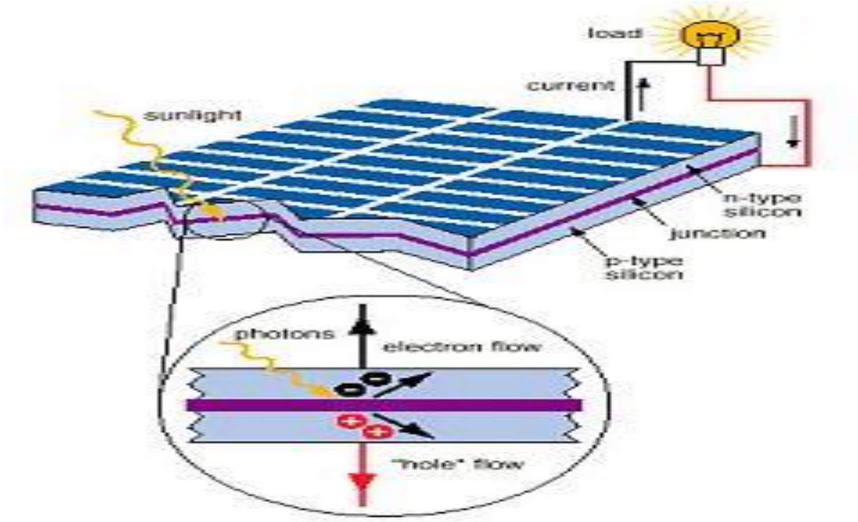

Fig1. Working of a Photovoltaic cell [6]

For electric power vehicle solar panel are the use full source of power generation that is radiated by the sun. Electricity is directly converted by sunlight with the help of PV cells.

2.3 Driving the Motor
The most commonly used motors to drive the vehicles are Brushless DC (BLDC). This type of motor uses feedback directly from the rotor's current and angular position so that the input armature current could be switched among the motor phases in the exact similar synchronization with the rotor motion. Due to itsnoiseless operation, best efficiency, dynamic response of motor and high torque to weight ratio in comparison to other motors BLDC motors are opted at first place. BLDC motor do have stationary electrical magnets on the motor housing and a permanent magnet in the rotor part. The work of motor controller is to convert DC to AC. Its construction is similar to that of brushed motors because it eliminates the complication of transferring the power from the outside of motor to the spinning rotor. Disadvantages of the BLDC motors are more complicated motor speed controllers and high initial cost. There are many advantages of brushless motors which includes little or no maintenance,long life span,and high efficiency.

3. RENEWABLE ENERGY DRIVEN VEHICLE: MATHEMATICAL CALCULATION FOR POWER GENERATED

3.1 Wind Energy
The first stage is analysing the wind speed that occurs at the top and front body of the vehicle, and it is defined in equation [7],
$V = V + V \cos(\varphi)$
Two equations which are basic and would be required to explain the power extraction andair flow. Given below equation determines the air flow through the vehicle [8],
$Q = C_v A v$Where, C_v= opening effectivenessQ = flow of rate in cubic meter per second.[Value of C_v is0.25 – 0.35 for skewed flow and 0.5 - 0.6 for perpendicular flow]
A = Area in square meter,v = air velocity in m/s
In inlet area of the vehicle the amount of air flow will be determined by Q.
Wind turbine will generate the output power as given below [9,]
$P_T = 0.5\, C_p\, \rho\, Q\, v^2$ Here, C_p = Power co-efficient,ρ = air density; 1.225 kg/m^3 Q = air flow in m^3/s,P_T = Output power from the turbine in watt,v = air velocity in m/s.

3.2 Photovoltaic energy

The PV installation at the top of the vehicle is dynamic, does need tracking mechanism to get maximum power at any hour angle. The mathematical analysis of the photovoltaic cell module or array described in given equation [11]. The photocurrent generated by PV cell depends on factor like temperature and radiation, also according to the given equation below [12],

$$I_{ph} = [I_{sc} + K_i(T - 298)]\frac{\beta}{1000}$$

To design the vehicle power need, it needs to know the electrical current and voltage that the panel generates. The current generated by a solar PV module can be approximated by [13],

$$I_{pv} = N_p I_o [exp\frac{q.(V_{ph} + I_{ph}R_s)}{N_s AKT} - 1]$$

Practically, only about 35% of the solar irradiance is potentially available for conversion to electrical power. And the output power from the PV modules can be determined using the equation [14],

$$P_{opv} = I_{pv} V_{opv}$$

4. THE OBJECTIVE AND CHALLENGES

We will be using theBLDC motor of rating 500Watts (48V, 10.5A) in our research application. The other hardware components specification will be chosen according to the rating of the motor. To operate the Brushless DC motor through DC power source, we would require at least four to five battery of rating 12V/42Ah which will be connected in series. This battery connection will increase the cost of vehicle which effect on design. To avoid this, we are using boost power converter, which will boost to the required rating voltage by using half the number of battery which are actually required. So now only two 12V/42Ah battery are to be connected in series which will boost the rated voltage to 48V as per requirement.

5. METHODOLOGIES

5.1 Wind turbine

Following are the features of wind turbine selected for power generation [15]–

- Lift type.
- Two blades.
- Horizontal axis.
- High lift to drag ratio with efficiency ranging from 0.4 to 0.45. They need a relatively high tip speed ratio ($\lambda = \omega R / v_w$). For our design we have chosen $\lambda = 6$. For this value of λ it can be assumed that the value of C_p will be 0.4 to 0.45 [16].
  From $C_p - \lambda$ and $C_F - \lambda$ curve we can see $C_p = 0.4$ and $C_F = 0.055$
  Where,
  C_F = axial thrust co-efficient.
  So, $C_p / C_F \approx 7$

5.2Four –Axis Tracking Mechanisms

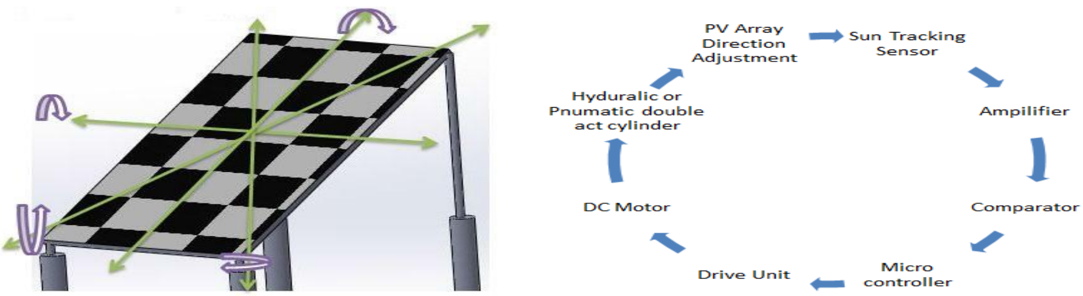

Fig2: Tracking mechanism (a) four-axis (b) block diagram [17]

The vehicle's photovoltaic modules propose to use maximum incident ray tracking mechanism. This tracking system is an automatic system to track the sun ray to extract solar intensity at the optimum angle of incident ray.The PV array tracking mechanism can track 360-degree rotation of the vehicle and 30-150 degrees (or 3-9-hour angle) of the sunrise (or sunset), and it is the best solution for output to be maximized from the photovoltaic panel [18]. Because, when the irradiation increases, the voltage and current output increases as the result in net mechanisms.This electromechanical structure has four degrees of freedom, motorized by four DC motors to control movement of the double act hydraulic cylinder. The materials help to track the PV system: light dependent resistor (sun tracking sensor), amplifier (to amplify the LDR signals), DC Motors,microcontroller, oil or air reservoir, double acting pneumatic or hydraulic cylinder and Comparator (compares the signals). Microcontroller is commonly known as the control unit; whose task is to generate the control commands to the main driver unit based on the output of comparator.

Table No 1: major cost Estimation of components

Name Of The Component	**Description Of Component**	**Cost Estimated**
BLDC Servo Motor	130mm square face, length: 325mm Continuous toque:15Nm Continuous Rated Power: 2.36kW Rotor inertia:2.37*10^{-3} kgm^2 MAX. Speed:2000rpm Weight- 10-20kg	Rs 27900-30000
Storage Battery	12V /20Ah Lithium ion battery Weight: 2.9kg per battery 181mm*76mm*167*mm	Eight battery cost Rs 91195 Four battery cost Rs 45756
Solar Panel	Sanyo HIP200BA20 Per module specification: STC power Rating 200W STC Power rating per unit area:173.3/m^2 Vmp:55.8V MAX. system voltage : 600V 1,319mm*880mm*46mm Weight: 15kg	Two module cost: Rs 74400
Wind turbine	HAWT - 50cm dia VAWT-120cm dia	Two HAWT: Rs 50000 VAWT: Rs 75000
Boost Converter		Rs 600-1000
Other Spare Parts	Spare Parts : Wiring , Nut & bolts, Casing to fit different components etc.	Approx. Rs 5000
Total Cost		**Rs426595**

5.3 Boost converter

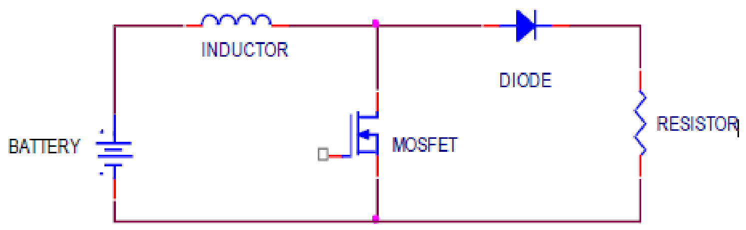

Fig 3 Boost Converter Circuit diagram.

Boost converter is also known as step-up converter which is DC-to-DC converter that has capability to step up input voltage at same time stepping down current to its output, containing least two semiconductors a transistor and a diode.In boost converter high precision is required in selecting the capacitor, inductor or two in combination. If not chosen properly it may require to design by oneself. In boost converter the output is fixed i.e. 48V while there is variation in input voltage i.e. from 21V to 25.5V. 20KHz is the switching frequency required for boost converter. In the boost converter circuit, the switching diode used should be able to withstand a reverse voltage which is almost equal to the circuits output voltage and also should conduct the peak output current. For this there must be a suitable diode which should have minimum reverse breakdown voltage larger than the output voltage of circuit. The didoes often used is Schottky barrier diodes. There is a discontinuous current supplied to the output RC circuit. For this now we would be requiring a larger filter capacitor for limiting the ripples in the output voltage. When the diode is in off state the filter capacitor should provide the output direct current to the load [19]. Capacitor is charged by the ripple current during each switching cycle. The output voltage of battery is 48V and the open circuit voltage is 25.5V. Parameters such as switching and MOSFET are taken as 0.3 and the diode factor is taken as 0.8. following is the value of inductor (L) can be calculated using the following equation [20].

$$L = \frac{V_0 \delta_{Tmin} (1 - \delta_{Tmin})}{\Delta_{Ilf}} = 52.3\ \mu H$$

In boost converter the input voltage will always be lesser then output voltage. The function of the boost converter in solar powered driven electric vehicle is to take input 24V battery connected in series and convert it to 48V which is required rated voltage of BLDC motor [21]

6. Concluding remarks and future research

Based on the study and research we have following remarks over the project and the future worksthatcan be done are following.

- Right now this proposed design will best work as a continuous source of charging through renewable energy source, so that we can reduce the charging time of the batteries rather than, as a complete power source to drive the vehicle. Because both solar and wind energy are in abundance but, still not very efficient in convergence in electric form (due to wastage + resistance + mechanical losses etc.) and also they depend on location on earth and other environmental factors.
- Future project can be done on increment of the efficiency of solar plate by working own their shape design, maximizing irradiance falling over plate by using reflection or refraction technique /material/surfaces/mechanism etc.
- Aerodynamic stability and electrical stability of Wind turbines study can be done for future aspects so; we need to make vehicle body more aerodynamic to reduce air resistance to minimum. We can multiple wind turbines in such a position that they can cancel out each other’s drag and lift forces. Thus, give better stability and efficiency.
- Better mechanism can be used so that during failure of wind turbine (single or multiple) aerodynamic stability is maintained and avoids accident. Like, shutting off all the turbines if single or multiple turbine failure and their opening gets closed for no air inflow.
- For improving efficiency, we can reduce mechanical components for control to the least and use more and more electronics for control so, that power losses can be reduce to minimum such we can use low power microcontroller circuit for speed control (removing major heavy gear box), clutch (removing clutch plate) actuation.

References

[1]- Howell D (2011) Annual progress report for energy storage R&D, Vehicle Technologies Program, Energy Efficiency and Renewable Energy, U.S. Department of Energy, Washington DC International Energy Agency Report, (1997) Key Issues in Developing Renewable

[2]- Gopalakrishnan D. et. al. (2011) Impacts of Electric Vehicles - Deliverable 2 Assessment of electric vehicle and battery technology Delft, CE Delft, April 2011

[3]- W. Short and P. Denholm, (2006) A Preliminary Assessment of Plug-In Hybrid Electric Vehicles on Wind Energy Markets, A national laboratory of the U.S. Department of Energy Office of Energy Efficiency & Renewable Energy, Technical Report NREL/TP-620-39729 April 2006

[4]- Thomas D. Gillespie, “Fundamentals of Vehicle Dynamics”, Society of Automotive Inc.

[5]- Anant et. al. Batteries for Electric Drive Vehicles: Evaluation of Future Characteristics and Costs through Delphi Study, Argonne National Laboratory, Transportation Technology R&D Centre, 9700 S. Cass Avenue Argonne, IL 60439

[6]- http://www.solarpower2day.net/images/7.jpg

[7] Victor Olgyay, "Design with climate", Princeton University Press, 1963, p.104

[7a] Martin O.L. Hansen, "Aerodynamics of Wind Turbines", Earth scan, London.

[7b]- Daniel S. A.andGaunden,N.A. 2001, A standalone integrated array wind turbine gen and photovoltaic-array in feed-forward controlled PWM inverter", Proceedings of the International Conference on energy, automation and information Technology(EAIT 2001), Indian Institute of Technology, Kharagpur, India, pp. 667-670.

[8]- Terry S. Boutet," Controlling Air Movements- A Manual for Builders and Architects", McGraw- Hill Book Company.

[9]- Godfrey Boyle, "Renewable Energy- Power for a sustainable future", Oxford University Press.

[10]- N. Pandiarajan and RanganathMuthu, (2011) Mathematical Modelling of Photovoltaic Module with Simulink, International Conference on Electrical Energy Systems (ICEES 2011), 3-5 Jan 2011

[11]- Jee-Hoon Jung, and S. Ahmed, (2010) "Model Construction of Single Crystalline Photovoltaic Panels for RealTime Simulation," IEEE Energy Conversion Congress & Expo, September 12-16, Atlanta, USA.

[12]- Nema et. al, (2010) "MATLAB/Simulink based study of photovoltaic cells / modules / array and their experimental verification", International journal of Energy and Environment, vol.1, No.3, pp.487-500.

[13]- Chowdhury et. al. (2008) Mathematical Modelling and Performance Evaluation of a Stand-Alone Polycrystalline PV Plant with MPPT Facility," IEEE Power and Energy Society General Meeting - Conversion and Delivery of Electrical Energy in the 21st Century, July 20-24, Pittsburgh, USA

[14]- Rizk, J. and Nagriak, M.H. (2010) Design of permanent magnet generator for wind energy application, Power Electronics, Machines and Drives (PEMD2010) 5th IET International Conference, Australia.

[15] John D. Anderson, "Fundamentals of Aerodynamics", McGraw Hill Book Company.

[15 a]- Dr.Amalesh Chandra Mandal, Dr. Md. Quamrul Islam, "Aerodynamics and Design of Wind Turbines" Published by BUET.

[16]- G.N.Tewari, A.K. Bansal, "Renewable Energy Resources", Narosa Publishing House.

[16a] Bent Sorensen, "Renewable Energy" Academic Press, USA.

[16b] Mukund R. Patel, "Wind and Solar Power Systems" CRC Press, USA.

[17]- Choi et. al (2010) Development of a Novel Tracking System for Photovoltaic Efficiency in Low Level Radiation Journal of Power Electronics, Vol. 10, No. 4, July 2010

[18]- Bhuvaneswari et. al. (2013) Analysis of Solar Energy Based Street Light with Auto Tracking System, International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering Vol.2, Issue 7, ISSN (Online): 2278 – 8875, July 2013

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

[20]- Rafia Akhter and AminulHoque, Analysis of a PWM Boost Inverter for Solar Home Application, Proceedings of World Academy of Science, Engineering and Technology Volume 17, December 2006, pp.212-216.

[21]- Muhammad H.Rashid (2004), Power Electronics circuits, devices, and applications, Third edition, 2004, ISBN 81-297-0229-0, pp.166-225.

[21a] Qasim et.al., (2011) Analyses of Impeller Type Wind Turbine IIUM Engineering Journal, Special Issue,Mechanical Engineering

[21b] Ferdous et. al., (2011) Electric Vehicle with Charging Facility in Motion using Wind Energy, world renewable energy congress 8-13 may 2011, Linkoping, Sweden

[22]- George C.M. Arkesteijn (2007) Loss Modelling and Analysis of the Nuna Solar Car Drive System InternationalConference on Ecologic Vehicles & Renewable Energies March 29 – April 1

[22a]- Gianfranco Rizzo et. al. (2010) Hybrid Solar Vehicles, Solar Collectors and Panels, Theory and Applications, Dr.ReccabManyala (Ed.), ISBN: 978-953-307-142-8,

[22b]- Singh et. al., (2011) Wind driven mobile charging of automobile battery- A case study International Journal ofEngineering, Science and Technology, Vol. 3, No. 5, 2011, pp. 113-119