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DESIGN AND DEVELOPMENT OF ELECTRICAL POWER SYSTEM IN SOLAR POWERED ELECTRIC VEHICLE

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Abstract : The energy is one of the most vital needs for human survival on earth. The world is currently dependent on fossil fuels for the automobiles. But the main problem of the fossil fuels is that they are not environment friendly and they are exhaustible. So it is necessary to change for the non-conventional sources of energy. In this paper an approach to the conversion of conventional vehicle into solar powered electric vehicle is discussed in detail.

***IndexTerms*–Hybrid Electric Vehicle, Photo-Voltaic Cell, PV Controller.**

I. INTRODUCTION

A Motorized vehicle is vehicle with an attached motor used either to power the vehicle, or to assist with pedaling. Sometimes classified as a motor vehicle, or a class of hybrid vehicle, motorized vehicles may be powered by a variety of engine types and power sources. Electric vehicles first came into existence in the mid-19th century, when electricity was among the preferred methods for motor vehicle propulsion, providing all Vehicle of comfort and ease of operation that could not be Vehicle by the gasoline vehicles of the time.

The internal combustion engine (ICE) is the dominant propulsion method for motor vehicles but electric power has remained commonplace in other vehicle types, such as trains and smaller vehicles of all types. During the last few decades, environmental impact of the petroleum-based transportation infrastructure, along with the peak oil, has led to renewed interest in an electric transportation infrastructure. Electric vehicles differ from fossil fuel-powered vehicles in that the electricity they consume can be generated from a wide range of sources, including fossil fuels, nuclear power, and renewable sources such as tidal power, solar power, and wind power or any combination of those.

Electric vehicles were among the earliest automobiles, and before the preeminence of light, powerful internal combustion engines, electric automobiles held many vehicle land speed and distance records in the early 1900s. They were produced by Baker Electric, Columbia Electric, Detroit Electric, and others, and at one point in history out-sold gasoline-powered vehicles.

Currently though there are more than 400 coal power plants in the U.S. alone. How Vehicle it is generated, this energy is then transmitted to the vehicle through use of overhead lines, wireless energy transfer such as inductive charging, or a direct connection through an electrical cable. The electricity may then be stored on board the vehicle using a battery, flywheel, or super capacitors. Vehicles making use of engines working on the principle of combustion can usually only derive their energy from a single or a few sources, usually non-renewable fossil fuels. A key advantage of electric or Motorized electric vehicles is regenerative braking and suspension; their ability to recover energy normally lost during braking as electricity to be restored to the on-board battery. In 2003, the first mass-produced Motorized gasoline-electric vehicle, the Toyota Prius, was introduced worldwide, in the same year Going Green in London launched the G-Wiz electric vehicle, a quadric cycle that became the world's bestselling vehicle.

Currently, one of the greatest engineering issues to tackle is the need for clean energy sources. Much of the world is highly dependent on natural gases and coal to produce electricity. Although this power source is abundant, it is shown to assist in global warming. Furthermore, extraction methods such as franking are shown to have detrimental effect on the environment, namely earthquakes. One source of energy being heavily studied is solar energy. Until recently, the efficiency of the solar panels, used in collection of solar energy, was too low for it to be a viable option for replacing energy obtained from fossil fuels. Advances in materials has paved the way for using solar energy as a renewable resource that is slowly meeting the energy demands that society has become accustomed to.

The project is focused on the design of an electric driven vehicle that can regenerate power using solar energy technology. If this type of vehicle became a standard commercial vehicle, the demand for fuel would decrease substantially. The vehicle must be lightweight to minimize the size of the motor required to withstand urban transport needs. The vehicle is being designed to house one driver; practically, there would be need for additional space for other passengers and materials. Another consideration in the use of solar energy to power a vehicle is that the solar panel must be efficient enough to generate enough power for propulsion in a reasonable amount of time. This leads to a variety of decisions that must be considered during the design process. Both mechanical and electrical engineering considerations must be taken into account for the project. Components must be suitable for the application of the urban concept division of the Shell Eco-marathon. Components will be purchased and manufactured from raw materials to suit the application. Some components will need to be machined to specifications due to the abnormal size of the vehicle. Decisions will be made based on monetary constraints and fabrication feasibility.

1.1 Power System of Solar Vehicle & Components

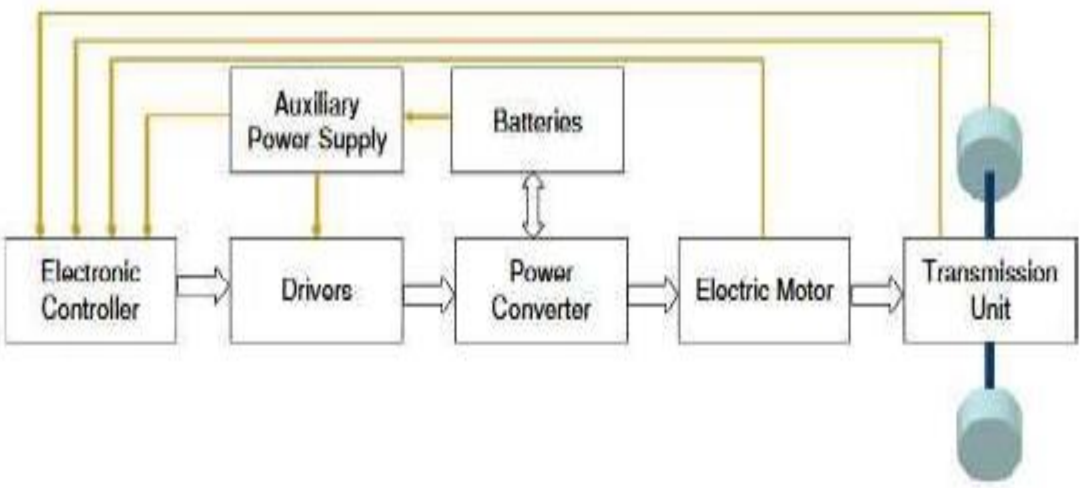


Figure 1.1. Major Components of an Electric Vehicle

In the forward path (white arrows), the Electronic Controller provides information to the Drivers, which provides information to the Power Converter. The Power Converter provides information to both the battery and the Electric Motor, and finally, the Electric Motor provides information to the Transmission Unit, which turns the wheels. In the Vehicle path (yellow lines), information passes from the Batteries to the Power Supply ,which communicates to the Electronic Controller and the Driver. The Electric Motor, Transmission Unit, and wheels are all communicating information directly to the Electronic Controller. The wheels provide information back to the Electronic Controller via an instrument (usually a tachometer), so that the RPM's of the wheels can be adjusted according to the driver's desired output from information received via a user interface.

II. Literature Survey

Electric motive power started with a small drifter operated by a miniature electric motor, built by Thomas Davenport in 1835. In 1838, a Scotsman named Robert Davidson built an electric locomotive that attained a speed of four miles per hour (6 km/h). In England a patent was granted in 1840 for the use of rails as conductors of electric current, and similar American patents were issued to Lilley and Colten in 1847. Between 1832 and 1839 (the exact year is uncertain), Robert Anderson of Scotland invented the first crude electric vehicle range, powered by non- rechargeable primary cells.

By the 20th century, electric vehicles and rail transport were commonplace, with commercial electric automobiles having the majority of the market. Over time their general-purpose commercial use reduced to specialist roles, as platform trucks, forklift trucks, tow tractors and urban delivery vehicles, such as the iconic British milk float; for most of the 20th century, the UK was the world's largest user of electric road vehicles.

III. METHODOLOGY

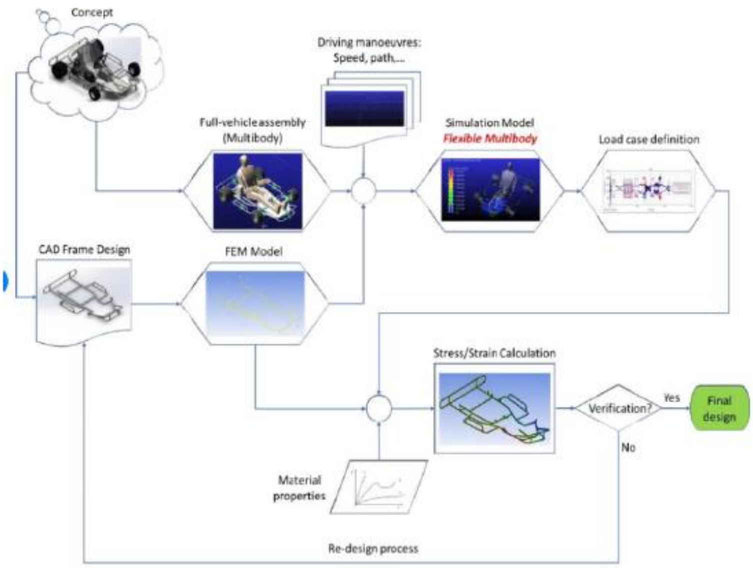


Figure 3.1 Detailed Methodology of Present work

Above chart shows the methodology we use for the chassis design and optimization. This methodology starts from concept l Vehicle, which moves further with CAD frame design. While making the final chassis we consider the suitable material properties along with stress/strain calculations.

3.1 Selection of Components And Type

3.1.1 Motor Selection

For selecting the appropriate electric vehicle motors, one has to first list down the requirements of the performance that the vehicle has to meet, the operating conditions and the cost associated with it. For example, go-kart vehicle and two-wheeler applications which requires less performance (mostly less than 3 kW) at a low cost, it is good to go with BLDC Hub motors. For three-wheelers and two-wheelers, it is also good to choose BLDC motors with or without an external gear system. For high power applications like performance two-wheelers, Vehicles, buses, trucks the ideal motor choice would be PMSM or Induction motors. Once the synchronous reluctance motor and switched reluctance motor are made cost effective as PMSM or Induction motors, then one can have more options of motor types for electric vehicle application.

Figure 3.2 BLDC motor

3.1.2 Batteries Selection

Flooded lead-acid batteries are the cheapest and most common traction batteries available, usually discharged to roughly 80%. They will accept high charge rates for fast charges. Flooded batteries require inspection of electrolyte l Vehicle and replacement of water. The future of battery electric vehicles depends primarily upon the cost and availability of batteries with high energy densities, power density, and long life, as all other aspects such as motors, motor controllers, and chargers are fairly mature and cost-competitive with internal combustion engine components. Li-ion, Li-poly and zinc-air batteries have demonstrated energy densities high enough to deliver range and recharge times comparable to conventional vehicles.

3.1.3 Accelerator and Electrical Pedal

Accelerator is used to trigger the motor controllers. Here we use a cable to attach accelerator pedal to accelerator circuit mechanically. Accelerator consists of a Hall Effect sensor and a magnet. The accelerator pedal sends a signal to the controller which adjusts the vehicle's speed by changing the frequency of the AC power from the inverter to the motor. The motor connects and turns the wheels through. The two wires are for working voltage and other one is the switch wire through which Hall Effect sensor output is Vehicle ride to motor controller. It has a linear type Hall Effect sensor on the fixed part and a permanent magnet on the rotating part.

Figure 3.3 Accelerator and electrical pedal

3.1.4 Motor Controller

The motor controller is the heart of the vehicle. All the electric parts of the vehicle are controlled by this. A BLDC motor controller is shown in Fig. It controls the speed of motor, breaking, battery voltage calculation, speedometer control and electrical accessories control. It has two wires from battery pack, 3 phase wires, 5 rotor position sensor wires, wire to accelerator, brake sensor wires from brake pedal, speed. Regulator wire, speedometer wires, electrical accessory wire for lights, and wire to DC-DC converter. Motor controller consists of IGBT Switching transistors for controlling motor rotation.

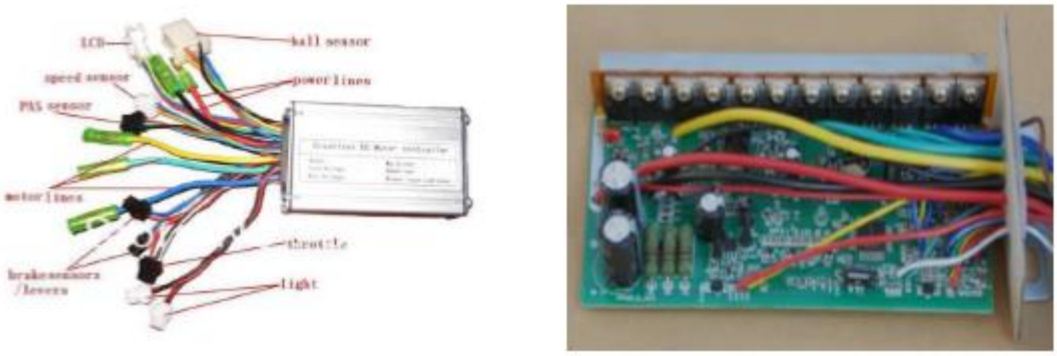


Figure 3.4 Motor controller and transmission controller

IV. DESIGN AND CALCULATION

4.1 Motor

The motor readily available in market we chose are permanent magnet, self-generating motors with 1000-watt power and 3000 rpm. The motors run on a 48 volts and 32 ampere power source. These motors reach a peak current during starting equal to 21 amps.

T = 3.18 N-m ,Now, pulley of 50 and 300 diameters is mounted. So, the ratio is 1:6. T_2 = 19096 N-mm, N_2 = 500 rpm. Speed of electric vehicle: Diameter of tyre is 300mm, V=π DN/60, V= 3.12 x 0.400 x 500/60 = 10.47 m/s, V= 37.69 Km/hr. This is the top speed of our solar

Force generated at wheel by motor

Force at wheel, T = F × R, 19096 = F × 200, F = 95.48 N = 9.72 kg at full speed on rear wheel

4.2 Batteries

An electric vehicle battery (VEHICLEB) or traction battery is a rechargeable battery used for propulsion of battery electric vehicles (BVEHICLEs). Traction batteries are used in forklifts, electric Golf VEHICLE, riding floor scrubbers, electric motorcycles, full-size electric VEHICLEs, trucks, and vans, and other electric vehicles. We Have used four batteries of 12V 32Aeach and connected them in series to make a battery pack of 48V 32A. The battery pack is sufficient to provide max output of 1500W.

The electric motors are usually powered by 12-15 volt rechargeable batteries, similar to those used to power outboard boat engines. These are available in wet or dry options. Many VEHICLE an on-board charger which can be plugged into a standard wall outlet; older or more portable models may have a separate charger unit.

Electric vehicle batteries differ from starting, lighting, and ignition (SLI) batteries because they are designed to give power over sustained periods of time. Deep cycle batteries are used instead of SLI batteries for these applications. Traction batteries must be designed with a high ampere-hour capacity. Batteries for electric vehicles are characterized by their relatively high power-to-weight ratio, energy to weight ratio and energy density; smaller, lighter batteries reduce the weight of the vehicle and improve its performance. Compared to liquid fuels, all current battery technologies have much lower specific energy; and this often impacts the maximum all-electric range of the vehicles.

Batteries are usually the most expensive component of vehicles. The cost of battery manufacture is substantial, but increasing returns to scale lower costs. The predicted market for automobile traction batteries is over $37 billion in 2020.On an energy basis, the price of electricity to run an VEHICLE is a small fraction of the cost of liquid fuel needed to produce an equivalent amount of energy.

Charging Time:
Battery - 12V x 32 Amp = 384 watt, For four batteries 384x4 = 1536 watt, Solar Panel – 100 watt
Charging Time = (Battery Watt/Panel Watt) = (384/100) = 3.84 Hrs for each battery. Hence 15.36 Hrs for all batteries
Discharge Time/ running time = (Total Battery watt/Total watt Consumed), = 1536/1000 ≈ 1.5 Hrs = 90 min
Distance covered by VEHICLE = top speed x running time, 37.69 x 1.5 = 56.53 km

4.3 Controller

General Specifications of Controllers:
• Frequency of Operation: 16.6kHz.
• Standby Battery Current: < 0.5mA.
• 5V Sensor Supply Current: 40mA.
• Controller supply voltage range, PWR, 18V to 90V.
• Supply Current, PWR, 150mA.
• Configurable battery voltage range, B+. Max operating range: 18V to 60V.
• Analog Brake and Throttle Input: 0-5 Volts. Producing 0-5V signal with 3-wire pot.
• Full Power Operating Temperature Range: 0℃ to 50℃ (controller case temperature).
• Operating Temperature Range: -30℃ to 90℃, 100℃ shutdown (controller case temperature).
• Peak Phase Current, 30 seconds: 300A.
• Continuous Phase Current Limit: 150A.
• Maximum Battery Current: Configurable.

4.4 Solar PV

A solar PV system design can be done in four steps:
Load estimation, Estimation of number of PV panels, Estimation of battery bank, Cost estimation of the system.
Base condition:2 CFLs(18 watts each),2 fans (60 watts each) for 6hrs a day.

- The total energy requirement of the system (total load) ie Total connected load to PV panel system
  = No. of units × rating of equipment = 2 × 18 + 2 × 60 = 156 watts
- Total watt-hours rating of the system
  = Total connected load (watts) × Operating hours = 156 × 6 = 936 watt-hours
- Actual power output of a PV panel = Peak power rating × operating factor
  = 40 × 0.75 = 30 watt
- The power used at the end use is less (due to lower combined efficiency of the system
  = Actual power output of a panel × combined efficiency
  = 30 × 0.81 = 24.3 watts (VA)
  = 24.3 watts
- Energy produced by one 40 W/p panel in a day
  = Actual power output × 8 hours/day (peak equivalent)
  = 24.3 × 8 = 194.4 watts-hour
- Number of solar panels required to satisfy given estimated daily load :
  = (Total watt-hour rating (daily load) /(Daily energy produced by a panel)
- Inverter converts DC into AC power with efficiency of about 90%.
- Battery voltage used for operation = 12 volts
- The combined efficiency of inverter and battery will be calculated as :
- Sunlight available in a day = 8 hours/day (equivalent of peak radiation.
- Operation of lights and fan = 6 hours/day of PV panels.
- PV panel power rating = 40 W/p(W/p, meaning, watt (peak), gives only peak power output of a PV panel)
- A factor called "operating factor" is used to estimate the actual output from a PV module. [The operating factor between 0.60 and 0.90 (implying the output power is 60 to 80% lower than rated output power) in normal operating conditions, depending on temperature, dust on module, etc.]

=936/194.4 = 4.81 = 5 (round figure)
Inverter size is to be calculated as :
Total connected load to PV panel system = 156 watts
Inverter are available with rating of 100, 200, 500 VA, etc.
Therefore, the choice of the inverter should be 200 VA.

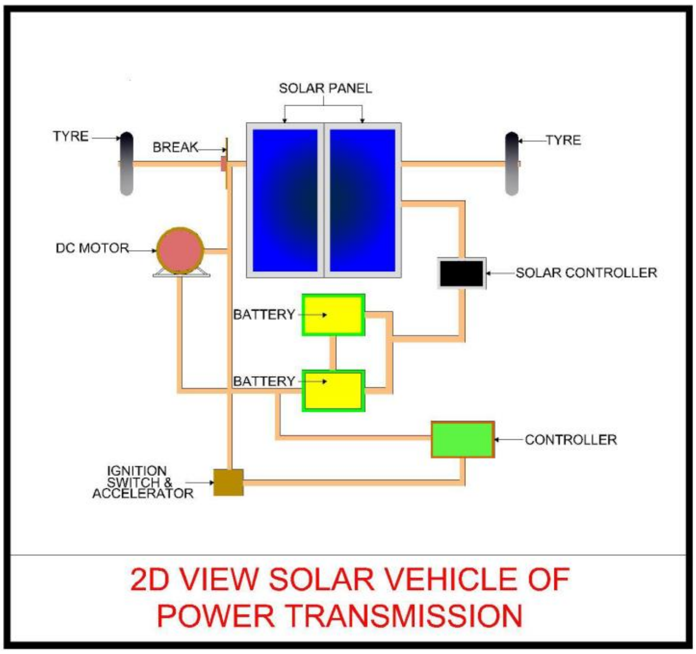


Figure 4.1 2D CAD

Circuit Diagram

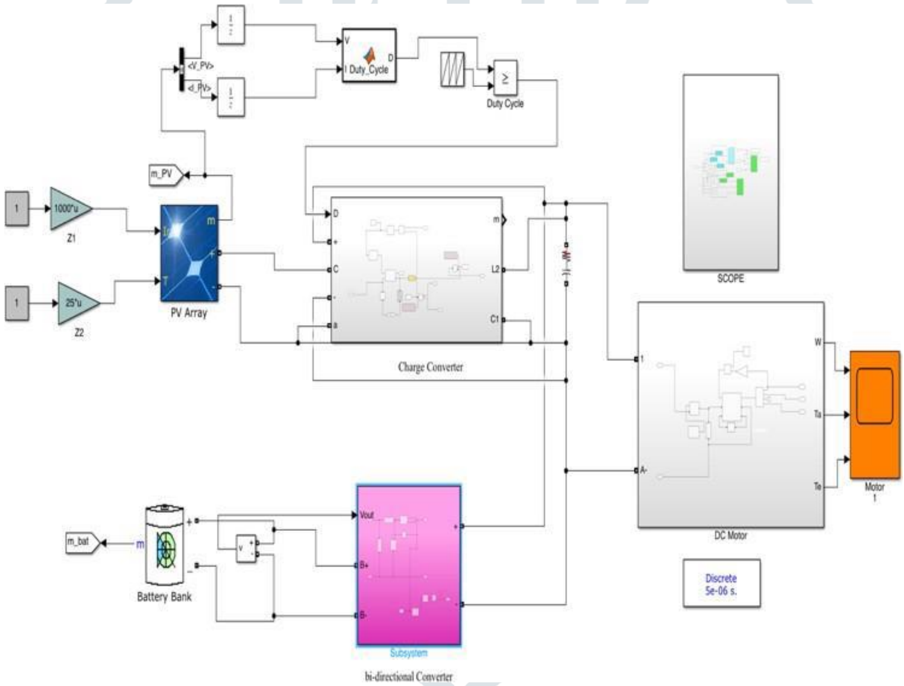
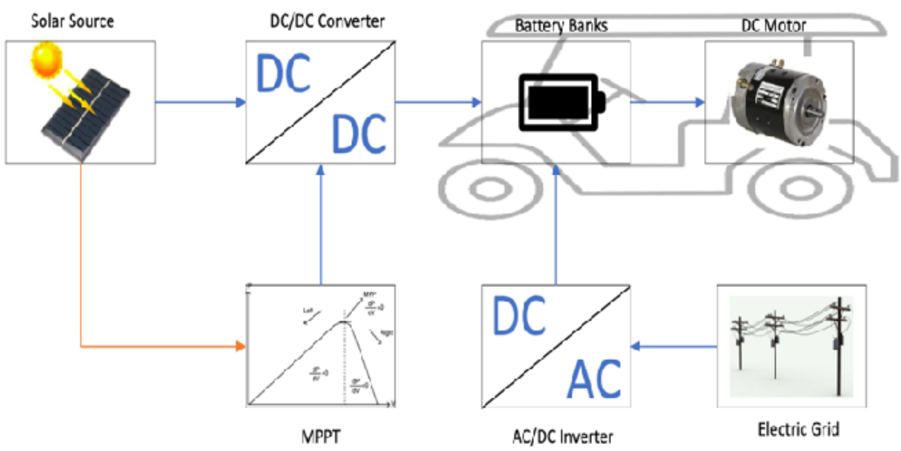


Figure 4.2 Linear circuit



V. WORKING PRINCIPLE

Solar vehicles have solar panels custom-designed to be mounted on the surfaces receiving maximum sun rays, which is generally the rooftop. The photovoltaic cells on the solar panels comprise of Silicon and a combination alloy of Gallium and

Indium and Nitrogen gas. These elements have a natural retentive property that allows them to absorb the light energy from the solar rays. The retained energy then releases in form of free-moving electrons into specially designed storage sections.

In fact, we refer to this storage facility as batteries. They comprise of special elements like Lithium-ion, and Nickel – Cadmium, etc. These batteries have the ability to convert free electrons into usable energy to power the vehicle engine. The specialty of these batteries is that we can use them repeatedly to power a vehicle. We can do it by recharging them using solar energy. With an ability to generate 80 to 150 volts of energy, solar-powered vehicles can cover 30 to 40 km on a single full charge. The best aspect of these Solar vehicles is their ability to constantly keep recharging their battery Vehicle when parked idle under sunlight. Therefor this reduces the cost of operation of a vehicle to almost negligible.

A solar Vehicle solely depends on the photovoltaic cells to absorb the sunlight and convert it into usable energy to power the engine. Photovoltaic cells bypass the original principal of solar thermal energy by converting solar energy directly to usable electricity instead of thermal conversion. Therefore, we can easily store converted electricity in the batteries and use them to power the engine of a vehicle just like a normal Electric vehicle.

VI. CONCLUSION

Solar energy more specifically solar Vehicle would be an amazing advancement in future technology. They would allow a free travel and unlimited accessibility. They would allow a free and pollution less travel. Solar powered Vehicles are running without burning fossil fuels makes them a possible solution to our energy crisis. Solar energy is clean, renewable and free energy that can supply all the energy needs of the world. This energy is pollutant free with no emissions or greenhouse gases released into the air what or Vehicle. With the rising concerns over global warming and climate change, this is one of the most important reasons to pursue Vehicle lopping more ways to utilize solar energy. After the initial investment has been recovered, the energy from the sun is practically free. But solar Vehicles are not successful at all places near polar region and in cloudy environment. If the hurdles are eliminated then solar Vehicles will be the future of the next generation transport.

The solar system includes PV panel, three deep-cycle battery banks, and DC/DC charge controller with MPPT features. The metrological data are analysis by considering solar radiation and temperature at the desired location. The dynamic performance of the modified vehicle is simulated using MATLAB /Simulink with experimental applications. Three case studies have been examined to validate the dynamic performance of the system. A W of PV panel is mounted at the top of the vehicle to charge three deep-cycle battery banks with a rating of kWh. The analysis results show that the PV system installed on the vehicle can produce enough electrical energy to power the Vehicle under the different weather conditions. The PV system can also increase the moving range and limits the charging periods. It also increases lifetime of batteries and improve the overall sustainability. The environmental results show that the PV system can reduce Kg of greenhouse Co2 emission since it does not require external charge from fossil fuels. It can be concluded that the modified vehicle is technically viable, reliable and environmental friendly

REFERENCES

[1] Berthold, F, Ravey, A, Blunier, B, Bouquain, D, Williamson, S & Miraoui, A 2015, ‘Design and Development of a Smart Control Strategy for Plug-In Hybrid Vehicles Including Vehicle-to-Home Functionality’, in IEEE Transactions on Transportation Electrification, vol. 1, no. 2, pp. 168-177.

[2] Bizhani, H, Yao, G, Muyeen, SM, Islam SM & Ben-Brahim, L 2019, ‘DualMechanical Port Machine Based Hybrid Electric Vehicle Using Reduced Switch Converters’, in IEEE Access, vol. 7, pp. 33665-33676.

[3] Gurani, Rajesh, and S. N. Kurbet. "A Detailed Experimental Investigation on IC Engine Using Alternate Fuels for Material Compatibility of Piping and Fitting System." Advanced Aspects of Engineering Research Vol. 5 (2021): 111-117.

[4] Bhattacharya, T, Giri, VS, Mathew, K & Umanand, L 2009, ‘Multiphase Bidirectional Flyback Converter Topology for Hybrid Electric Vehicles’, in IEEE Transactions on Industrial Electronics, vol. 56, no. 1, pp. 78-84.

[5] Gurani, Rajesh, and S. N. Kurbet. "Experimental Investigation on IC Engine using Alternate Fuels for Material Compatibility of Piping and Fitting system." In IOP Conference Series: Materials Science and Engineering, vol. 376, no. 1, p. 012004. IOP Publishing, 2018.

[6] Dokuyucu, HI & Cakmakci, M 2016, ‘Concurrent Design of Energy Management and Vehicle Traction Supervisory Control Algorithms for Parallel Hybrid Electric Vehicles’, in IEEE Transactions on Vehicular Technology, vol. 65, no. 2, pp. 555-565.

[7] Ducusin, M, Gargies, S & Mi, C 2007, ‘Modeling of a Series Hybrid Electric High-Mobility Multipurpose Wheeled Vehicle’, in IEEE Transactions on Vehicular Technology, vol. 56, no. 2, pp. 557-565.

[8] Tadalagi, Prashant B., Rajesh Gurani, and Malikasab Bagawan. "Smoke Emission Levels for CI DI Engine using Blends of Combinations of Biodiesel and Diesel Fuel." In IOP Conference Series: Materials Science and Engineering, vol. 376, no. 1, p. 012008. IOP Publishing, 2018.

[9] Filippa, M, Chunting Mi, Shen, J & Stevenson, RC 2005, ‘Modeling of a hybrid electric vehicle powertrain test cell using bond graphs’, in IEEE Transactions on Vehicular Technology, vol. 54, no. 3, pp. 837-845.

[10] Kanagaraj, N, Ramasamy, N, Manesh, T and Rezk, H 2018, ‘Modified Bidirectional DC-DC Boost Converter Fed Three-Phase Four-Wire PVDVR’, Journal of Testing and Evaluation, Vol. 48, no. 4, pp. 119-125.