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Regenerative Brakingusing Permanent Magnet Synchronous Motor (PMSM) and Supercapacitor

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ABSTRACT
This paper demonstrates exceptionally dependable, expanded range control supply for an electric vehicle. The power sources introduce are solar PV source, a battery and a super capacitor. Vehicles worked just on battery arranged frameworks face issues of charging, discharging of battery quickly. To diminish these effects on battery, it will consolidate with super capacitor. The benefits of this setup include better increasing speed execution, longer driving extent, controlled regenerative braking, smaller battery pack and longer battery life. The work stresses on battery, present during periods of acceleration and braking of three phase induction motor drive. Bidirectional DC-DC converters are used for the proper flow of power to motor during various stages of driving cycle. The THD values are also get reduce up to great level with this framework.

Keywords: *Regenerative Braking, Permanent Magnet Synchronous Motor (PMSM), Super capacitor*

I. INTRODUCTION
Our transportation system is highly depending on fossil fuels yet because of exhaustion of these assets, interest towards other alternatives increases. Hybrid power supply is a system in which different types of energy generation have been connected to energy storage systems supplying the load at any time. PV is a standout amongst the best sustainable power sources. But, it is not accessible around evening time. Hybrid energy storage systems can be a decent substitute for hybrid electric vehicles. The primary energy storage for EVs are Batteries. But, due to frequent charging, discharging, batteries are subjected to high power spikes and also, they cannot satisfy the vehicle demands up to some extent because it has low specific power, short life and bad performance at low temperature, which brought down the performance of vehicle. A hybrid energy storage system is used as a solution to this problem in which a battery is assisted with super capacitor during the transient phase such as starting and braking. To satisfy the high-power demand in short period of time an auxiliary source like super capacitor is used. The power density of an super capacitor is high because it can provide thousands of charging and discharging cycles. By combining the property of both, battery and super capacitor, the losses of battery are reduced. PV cell works during the steady-state operation. The ability of energy storage system can be improved with the help of an super capacitor which is having excellent properties like instantaneous charging and discharging capabilities and low temperature behaviour. Furthermore, UC has longer cycle life. Therefore, the UC handles high peak power, relieving battery stress and extending battery cycle life. In addition, to regain energy from regenerative braking with high charging power peaks and improving EV range, UC is used. Vehicles have two methods of operations- motoring and regenerative braking. The motoring mode happens when energy is pass to forward direction and when brake pedal is pressed, regenerative braking takes place in which kinetic energy is converted into electricity and fed to backward side. Solar based photovoltaic cell is utilized to supply power ceaselessly to load and battery. The net impact of this arrangement is to improve travel range, enhanced battery life and excellent response during the dynamic condition.

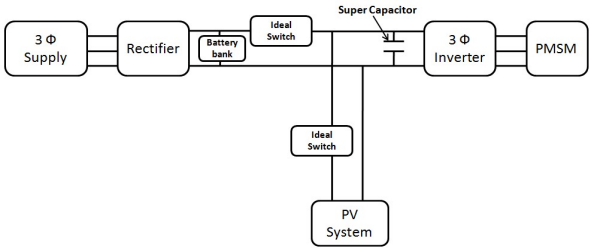

Fig.1. Block diagram of the system

II. System Design and Description

A. Photovoltaic modules:

A single solar cell cannot provide required useful output. So to increase output power level of a PV system, it is required to connect number of such **PV solar cells**. A solar module is normally series connected sufficient number of solar cells to provide required standard output voltage and power. The solar modules or PV modules are commercially available basic building block of a solar electric power generation system. Actually a single solar PV cell generates very tiny amount that is around 0.1 watt to 2 watts. But it is not practical to use such low power unit as building block of a system. So required number of such cells are combined together to form a practical commercially available solar unit which is known as **solar module or PV module**.

B. Charging system:

Two types of charging systems are used in this vehicle: Battery charging system; Super capacitor charging system.

1. Battery charging system:

The arrangement or parallel association of battery structure is used to control up the vehicle relying on the open of voltage of the battery and the requirement. Ordinarily lead corrosive batteries are best for the vehicles because of the high level consistency of voltage level maintenance till its low charge dissimilar to different batteries.

2. Super capacitor charging system:

Amid the regenerative breaking of the vehicle the electrical vitality is controlled back to the super capacitor banks. On the off chance that the regenerative vitality is fueled back to the battery it would not charge momentarily. Since all sort of batteries takes at any rate the day and age of 2-3 hours. Be that as it may, the super capacitors are bested up in a split second in the time span of 90-120 seconds. Consequently the super capacitors would be the correct decision for the regenerative power extraction. To achieve the most extreme required limit the super capacitor banks are utilized

C. MPPT:

This area covers the operation of "Maximum Power Point Tracking" as utilized as a part of solar electric charge controllers.

A MPPT or maximum power point tracker is an electronic DC to DC converter that enhances the match between the solar based group (PV panels), and the battery bank or utility network. On a very basic level, they change over a higher voltage DC output from solar panel down to the lower voltage foreseen that would charge batteries. There are various figuring for MPPT. I used the power under speedy varying climatic conditions anyway it still uncommonly standard and essential than some other technique.

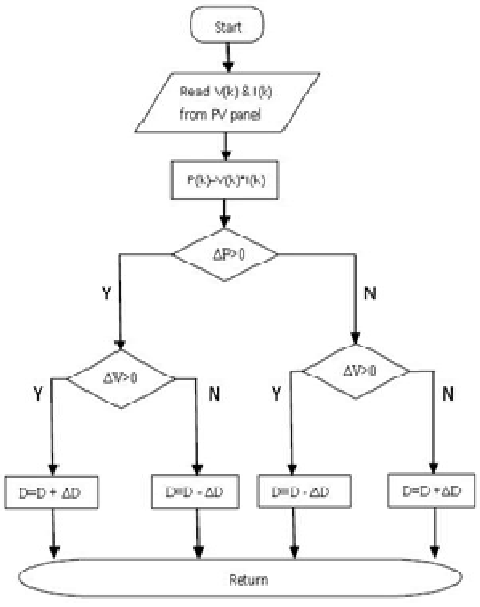

Fig.2. Flow Chart of MPPT

III. METHODOLOGY:

Regenerative braking is a brake method to use mechanical energy from the motor and convert kinetic energy to electrical energy and give back to the battery. In the regenerative braking mode, the motor slows downhill the car. When we apply force to pedal of brake, then car gets slow down and motor works in reverse direction. When running in invalidate direction motor acts as the generator and thus charge the battery. Thus in figure 1 the car which is running in normal condition where motor goes forward and takes energy from the battery.

When using regenerative braking in electric vehicles, it reduces the cost of fuel, increasing the fuel financial system and emission will be lowered. The regenerative braking system provides the braking force during the speed of vehicles is low, and hence

the traffic stop and go thus deceleration required is less in electric vehicles.

This brakes work so effectively in driving in such environment so as to stop in cities. The braking system and controller is the feeling of the structure because it controls the whole part of vehicles of the motor. The brake controller functions are monitor the speed of the wheel, hence calculate the torque, electricity which is to be generated and rotational force thus to be feed to batteries. When we apply brakes the brake controller, it controls and direct the electrical energy which is formed by the motor to the batteries.

IV. RESULT

From the experiment performed we can conclude that the use of photovoltaic solar cells combined with electric type regenerative braking and dynamic inductive charging, both primary and secondary coils resonating at the same high frequency can greatly enhance the range, efficiency and performance of a limited capability electric vehicle.

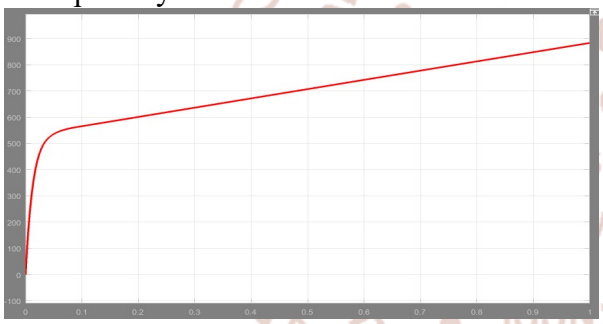

Fig.3.Supercapasitor

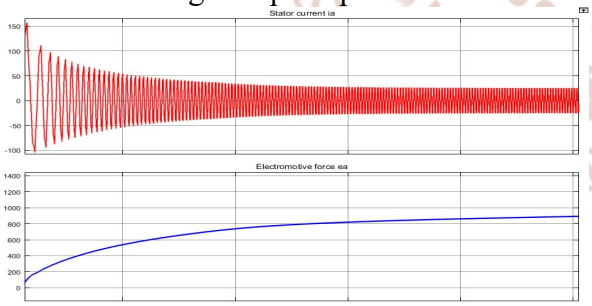

Fig.4. Graph for stator current

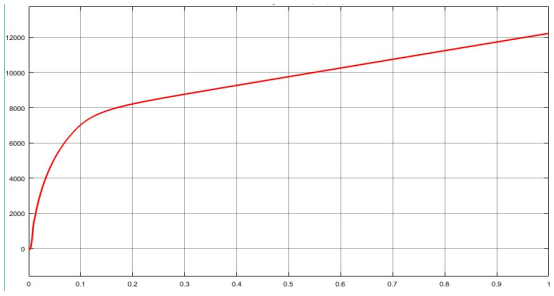

Fig.5.Graph for rotar speed

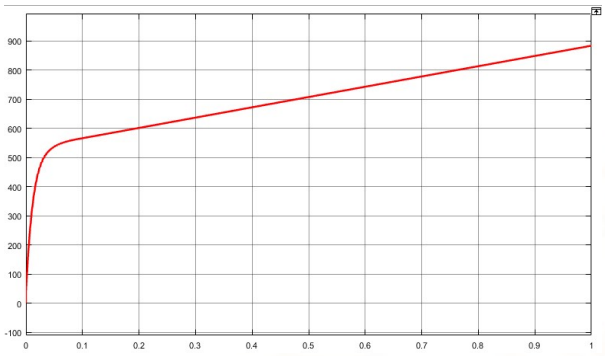

Fig.6.Graph for boost converter

V. CONCLUSION

The regenerative braking is one of the important systems in electric vehicles generation. The regenerative braking has the ability to save the waste energy up to 825%. The regenerative braking system improved by the advanced technologies of power electronic components, are super capacitor, DC-DC converter. The research says that regenerative braking is already in used in many Electric Vehicles. Due to the petrol price increase gives rise to research and progress in energy conservation. It also improves the fuel consumption by 33%.

The results say that the torque driven by the vehicles is measured. Electrical power generated by motor, generator and battery is very useful and hence it should be used in electric vehicles.

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