Application of Luminescent Solar Concentrator on HPEV System

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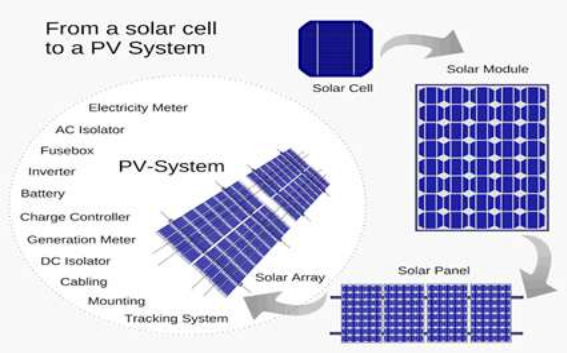
***Abstract*- Sunlight is the most abundant renewable source of energy of our planet and it may become the primary source of energy in future. In the current time period due to increased use of conventional energy resources such as coal, petrol etc the availability of these resources have been reduced and also it may nearly become extinct in the future. Due to rise of petrol and diesel fuels people are now focusing on hybrid vehicles which will help to reduce fuel consumption by using one more energy source such as battery. if we can utilise sunlight through Luminescent Solar Concentrator, to assist the propelling of HPEV Vehicles we can reduce the use of fuel (petrol, diesel) to many extend. Experiments have demonstrated upto 2.49x performance improvement of the proposed LSC based pv system comparing the baseline pv system.**

Index Terms- HPEV Vehicles, Luminescent Solar Concentrator.

1. INTRODUCTION

Photovoltaic systems have been widely applied due to the superior characteristics of solar energy. They are clean, renewable, noiseless and abundant.it can be attached to the vehicle to assist propelling of vehicle and also to enable battery charging whenever there is solar irradiance. Solar panels use semiconductor usually silicon based, to turn sunlight into electricity, these semiconductors works as photovoltaic cells When sunlight hit the cell ,the silicon absorbs the energy in light waves. This energy excites the electrons in the silicon which break loose. Free flowing electrons become electricity. Power output of pv cell will be high if there is uniform solar irradiance

Along with growing public concerns over the energy crisis, hybrid and Plug-in- electric vehicles (HPEV) are becoming increasingly popular.

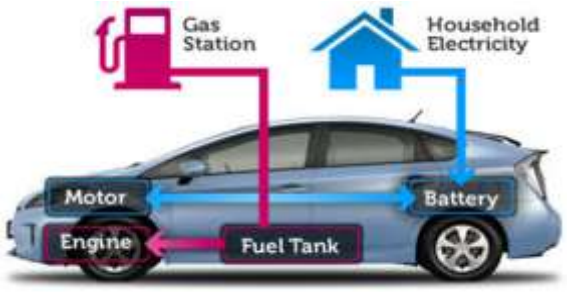


HPEV are classified into 3 types

Electric vehicles-These are propelled by electric motors and use only electricity

Hybrid vehicles-Gasoline powered internal combustion engine is the main power source the electric motor is used to compliment the combustion engine. Electricity is generated on board.

Plug-in- hybrid- Battery operated electric motor is the main power source. The engine is used to compliment the electric motor and extend the range and grid-supplied electricity.



On the other hand pv systems may be an ideal power source for (partially) powering HPEV but this step is inherently expensive because first semiconductors are costly and second because it's not terribly efficient. Some of the sun's energy is lost to heat and lot of it doesn't hit the solar cells at all because the sun isn't stationary. This means it takes a whole lot of cells to generate any significant amount of electricity. if the

distribution of solar irradiance level is non-uniform it will cause output power degradation which is called partial shading effect. Other limitation of mounting pv cells on HPEV are ;

Low efficiency-due to technological limitation of pv material

High cost-direct mounting of solar pv cell to the vehicle will increase the cost of the vehicle.

Appearance- most of the vehicles have curve design which decrease the surface area for mounting pv cells.

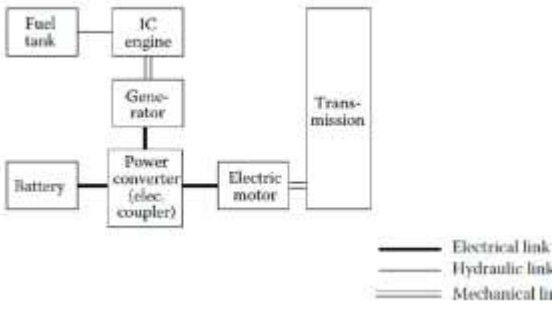
To address these limitations of the conventional pv system we propose semiconductor nano-material based luminescent solar concentrators (LSC) enhanced pv cells for HPEV systems. Experiment demonstrates high performance improvement for proposed pv system.

2. HPEV-SYSTEM

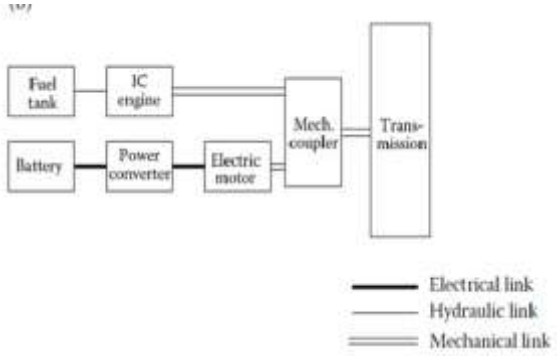
Plug-in- hybrid electric vehicle offer a choice of fuels HPEV has both an internal combustion engine and electric motor these vehicles are powered by an alternative fuel or a conventional fuel, such as gasoline (petrol) and a battery, which is charged up with electricity by plugging into an electrical outlet or charging station. The amount of electricity a HPEV can store in its battery can significantly reduce the vehicle's petroleum consumption under typical driving condition.

These are two basic PHEV Configuration,

SERIES PHEV-also called extended range electric vehicle only the electric motor turns the wheels, the gasoline engine only generates electricity. series PHEV can run solely on electricity until the battery needs recharging. The gasoline engine will then generate the electricity needed to power the electric motor. for shorter trips, these vehicle might use no gasoline at all.



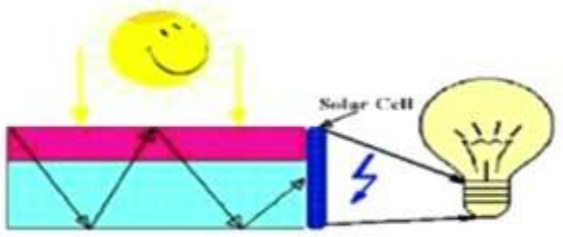
PARALLEL PHEV-both the engine and electric motor are mechanically connected to the wheels, and both propel the vehicle under most driving conditions. Electric only operation usually occurs at Lower speeds.



PHEV also have various battery capacities, allowing same to travel further on electricity than others. PHEV fuel economy like that of electric vehicles and regular hybrids can be sensitive to driving style, driving conditions and accessory use. PHEV are expected to use about 40%-60% less petroleum than conventional vehicle because electricity is produced primarily from domestic resources, PHEV reduce petroleum dependence.

3. LUMINESCENT SOLAR CONCENTRATOR

Luminescent solar Concentrator is a sunlight wave guide it traps light and then moves those light waves along a path to a particular destination. Main components are plastic/glass and dye molecules. Solar energy harvestor was proposed in the late 1970's.LSC absorb and re-emit solar radiation into a wave guide coupled to efficient small-area photo voltaic cells



In current LSC when the sunlight hits the top part of the device the sun's energy is transformed into the dye molecules causing the electrons in the dye molecules to excite into higher energy level .when the electrons falls back to lower energy level the dye molecules release that energy into plastic sheets on

the Lowe part of the device. The energy gets stuck in the lower part of the device and the energy will bounce around tjeaterial and make its way to the side where there are high efficient photo voltaic cells which will convert this energy into electricity.

The main feature of LSC are they are environmental friendly available in different colors, shapes and are transparent and non-toxic. These can be easily integrated in our environment

4. LSC IN HPEV SYSTEM

There are several advantages of employing LSC enhanced PV cells instead of conventional pv cells on HPEVs:

1) LSC absorbs both direct and diffuse sunlight and therefore more solar energy is concentrated into PV strips.
2) LSC enhanced pv cells fits the surface curve design of modern vehicles.
3) LSC polymers are transparent and therefore they do not affect the aesthetic requirements of the vehicle design and also transparency enables mounting LSC enhanced pv cells onto the vehicle windows in addition to the five vehicle panels.
4) Light emitted by QDs in the LSC polymer onto surrounding pv stripes exhibits a shifted spectrum, which can be better converted into electric energy by pv strips.

5. LSC BASED PV RECONFIGURATION AND OPTIMISATION

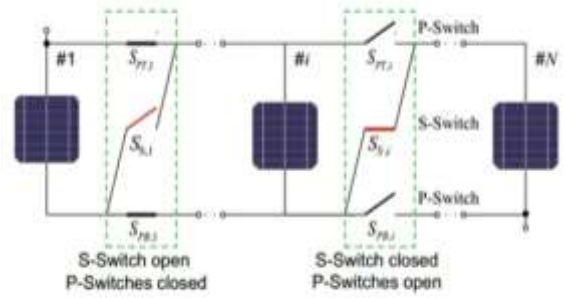


Fig. 3. The structure of a reconfigurable PV array.

A Reconfigurable PV array comprises N pv cells mounted on the hood, trunk, and door panels of an HPEV. Each i-the pv cell is integrated with three insular-gate bipolar transistor (IGBT)

Spt, Spb parallel switches forming pv cell groups

Ssi series switches forming pv array configuration

Parallel connection-Spt,Spb ON,Ssi OFF

Series connection-Spt,Spb OFF,Ssi ON

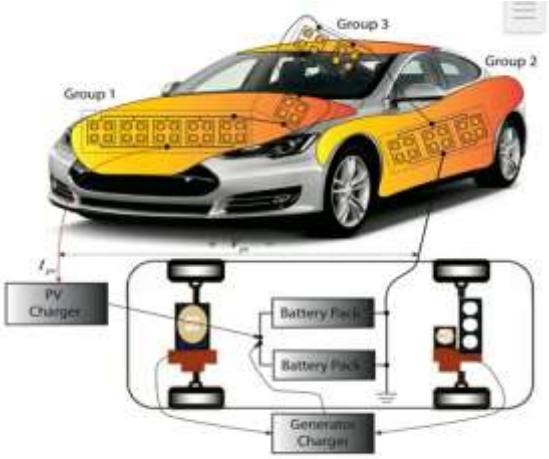
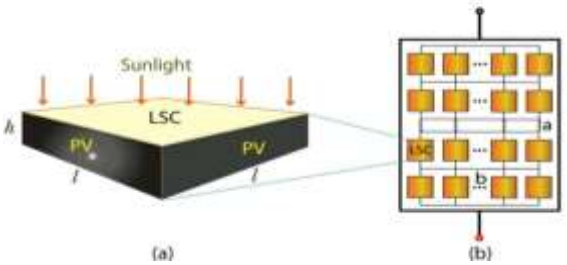


Fig. 4. System diagram of an LSC-based PV system on an HPEV.

LSC ENHANCED PV CELL AND DESIGN

i. Proposed LSC-Based PV Array Structure



It's better to make LSC enhanced pv cell a square top surface so that solar irradiance concentrated on four sides are identical.

Solar irradiance level on pv strips G'=G×Elsc

G'=G×(At÷Ae)×nop

G=direct input solar irradiance level on an LSC enhanced pv cell
Elsc=effective concentration factor
At=top surface area
Ae=edge surface area
nop=optimal conversion efficiency
To reduce computational complexity and capital cost simultaneously we employ macro cell as basic unit for the LSC-based pv array Reconfiguration. Smaller macro cell has better Reconfiguration flexibility and higher performance against partial shading while larger macro cell reduce the cost of programmable switches.so we must keep the size in-between so as for good performance and less cost.

RECONFIGURATION PERIOD OPTIMISATION

Solar irradiance level keeps on changing when vehicle is in motion so the Reconfiguration mechanism should be triggered in periodic basis in order to track the changes in solar irradiance level.
To track the rapid changes in solar irradiance level the Reconfiguration period should not be too large.
The Reconfiguration period should not be too small to avoid the potentially significant timing and energy overhead.
So overall timing overhead of the reconfiguration technique is taken as 15ms by taking care of all the other factors affecting reconfiguration period.

OVERALL OPTIMISATION FLOW

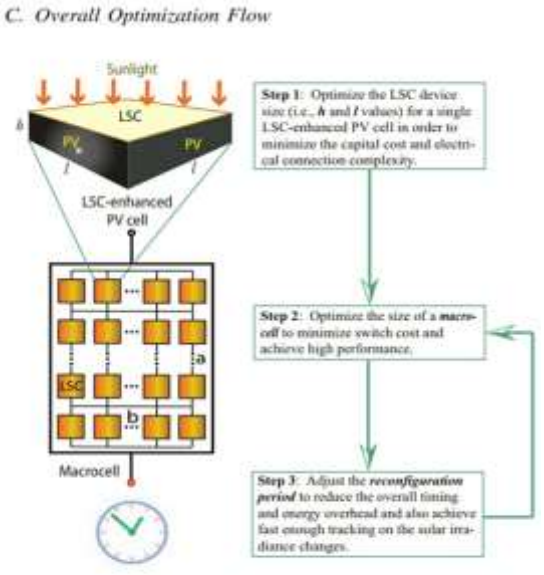


Fig. 8. The overall flow of the proposed LSC-based PV array reconfiguration and optimization.

TABLE I
AVERAGE OUTPUT POWER OF THE PROPOSED LSC-BASED PV SYSTEM AND THE BASELINE PV SYSTEM.

	Avg. Output Power (W)				
Benchmark	B1	B2	B3	B4	B5
Baseline PV	500.3	978.7	804.1	583.5	996.7
LSC-based PV Opt. Step 1	693.8	1367.0	1101.3	793.8	1369.9
LSC-based PV Opt. Step 2	799.4	1581.7	1279.1	933.0	1594.6
LSC-based PV Opt. Step 3	877.9	1744.9	1391.5	1015.1	1756.9

AVERAGE OUTPUT POWER OF THE PROPOSED LSC-BASED PV SYSTEM DEPLOYING LSC-ENHANCED PV CELLS ON VEHICLE WINDOWS AND THE BASELINE PV SYSTEM.

	Avg. Output Power (W)				
Benchmark	B1	B2	B3	B4	B5
Baseline PV	500.3	978.7	804.1	583.5	996.7
LSC-based PV Opt. Step 1	1116.5	2041.8	1768.2	1297.8	2243.6
LSC-based PV Opt. Step 2	1127.2	2070.5	1797.8	1316	2253.1
LSC-based PV Opt. Step 3	1237.6	2283.8	1955.1	1432.2	2482.7

6. CONCLUSION

LSC enhanced HPEV system will increase the efficiency of charging of the battery and also it will suit to the trendy designs of vehicles so it is an apt material for HPEV vehicles. also they can be placed in places where solar panels are not feasible and also in small areas where maximum efficiency is required.so this overall system will help to reduce the carbon emission and also reduce the fuel consumption.

7. ACKNOWLEDGMENT

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