International Journal For Technological Research In Engineering
Volume 4, Issue 7, March-2017 *ISSN (Online): 2347 - 4718*

MODELLING AND SIMULATION OF GRID INTEGRATED SOLAR PV SYSTEM USING 3- LEVEL INVERTER

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ABSTRACT: The electrical energy is easily controllable compared with other energy. In addition, the electrical energy has an advantageous feature for environment. The electrical energy is also used as the driving energy of the rolling stock in railway. On the other hand, to supply the electric energy with stability, the power supply system needs to have a sufficient supply capacity for demand. The feature of the electric power used in electric railways is that the peak power is large and the average power is low. This is a factor of the power cost increase. Moreover, electric railway is increasing effective use for the Dead energy of the vehicle and the necessity of the voltage descent measures. The application of unique world leading high-speed flywheel energy storage & Solar Energy to real-time power management and voltage support for the traction industry. It is now the most advanced commercially available solar energy storage system. Its unique features, zero maintenance, 20 year life and high cyclic capability make it ideally suited to applications in rail power supplies. The flywheel & solar system can resolve many of the problems encountered in traction supplies due to the 'peaky' nature of the loads caused by trains accelerating and braking. In addition, the flywheel & solar system can provide energy savings by improving the system's receptivity to energy from trains with regenerative braking.

I. INTRODUCTION

General

Energy plays a pivotal role in our daily activities. The degree of development and civilization of a country is measured by the amount of utilization of energy by human beings. Energy demand is increasing day by day due to increase in population, urbanization and industrialization. The world's fossil fuel supply viz. coal, petroleum and natural gas will thus be depleted in a few hundred years. The rate of energy consumption increasing, supply is depleting resulting in inflation and energy shortage. This is called energy crisis. Hence alternative or renewable sources of energy have to be developed to meet future energy requirement.

High Power Energy Storage Applications

Some energy storage applications require high peak power output but for only a short amount of time, so the total amount of energy required is small. In the high power energy storage applications under consideration here, the limiting factor on improved performance is often the ability to meet the peak power requirement for the application. For these applications, a higher specific power, a higher power density. Improved performance could mean anything from a more mileage efficient car to a smaller power quality solution. The development of the flywheel system in this thesis is aimed at these applications.

Solar Photovoltaic (PV)

Photovoltaic is the technical term for solar electric. Photo means "light" and voltaic means "electric". PV cells are usually made of silicon, an element that naturally releases electrons when exposed to light. Amount of electrons released from silicon cells depend upon intensity of light incident on it. The silicon cell is covered with a grid of metal that directs the electrons to flow in a path to create an electric current. This current is guided into a wire that is connected to a battery or DC appliance. Typically, one cell produces about 1.5 watts of power. Individual cells are connected together to form a solar panel or module, capable of producing 3 to 110 Watts power. Panels can be connected together in series and parallel to make a solar array, which can produce any amount of Wattage as space will allow. Modules are usually designed to supply electricity at 12 Volts. PV modules are rated by their peak Watt output at solar noon on a clear day. Some applications for PV systems are lighting for commercial buildings, outdoor (street) lighting, rural and village lighting etc. Solar electric power systems can offer independence from the utility grid and offer protection during extended power failures. Solar PV systems are found to be economical. Application of Non-Conventional & Renewable Energy Sources especially in the hilly and far flung areas where conventional grid power supply will be expensive to reach.

II. INDIAN RAILWAYS SCENARIO

Introduction

The first railway powered by steam, linked Melbourne with the port of Sand ridge in Australia in 1854, is the first railway line in Australia. China and Japan developed railways in 1870s. The world's first transcontinental railway line was completed across United States in 1869. The world had more than 200000 kilometers of railway by 1870. By 1970s the total railway line was divided roughly with North America with a share of 36 percent, Europe 34 percent, Asia 12 percent, South America 8 percent, Africa 6 percent and Australia 4 percent. Railways are a part of almost every country and currently United States tops the nations in terms of rail network. Earlier railways were profitable business enterprise. With the increasing competition from transport and airlines has cut the proportion of the railways from total traffic, so it cannot finance the huge investment needed to keep railways up to date.

Railways have not been able to invest in new rolling stock and modernization programmes. With the 20th century the railroad reached maturity. The technological emphasis shifted to faster operations, improved passenger amenities, larger and specialized freight cars, safer and more sophisticated signaling and traffic control systems and new types of motive power. The governments in various countries are reducing their control over the railways and railways are in the path of privatization. Railways world over are transferred to different private initiatives within the countries. India the fourth largest largest railway in the world is undertaking projects in public private partnership mode.

III. SOLAR ENERGY STORAGE SYSTEM FOR INDIAN RAILWAY

Introduction:

Awareness for the need of sustainable and ecofriendly mobility has been increasing and various innovations are taking place in this regard. A study was carried out to assess the feasibility of installing solar photovoltaic (PV) modules atop train coaches. Most long-distance trains having Linked Hofmann Busch (LHB) coaches do not have self-generating systems, thus making power cars mandatory to supply the required power for lighting loads. Feasibility of supplementing diesel generator sets with power from solar PV modules installed on coach rooftops has been reported in this communication. Not only is there a conservation of fuel, there is also a significant reduction in CO2 emissions. This work has shown that the area available on coach rooftops is more than sufficient to generate the required power, during sunlight hours, for the electrical loads of a non-A/C coach even during winter. All calculations were done keeping a standard route as the reference. Taking the cost of diesel to be Rs 66/litre, it was estimated that there will be annual savings of Rs 5,900,000 corresponding to 90,800 liters diesel per rake per year by implementing this scheme. The installation cost of solar modules would be recovered within 2–3 years. Implementation of this scheme would also amount to an annual reduction of 239 tones of CO2 emissions. In recent times, much research is being carried out to develop sustainable forms of transportation. This is necessary because transportation sector is a source of CO2 emissions and is a cause of global warming. Solar power cannot be relied upon to completely replace conventional fossil-fuel engines. It can only supplement the power generated by the engine and subsequently reduce CO2 emissions. Buses and cars have been retro-fitted with solar panels on the roofs, hoods as well as the boot lids.

Modelling and Results of Solar-PV System:-

A PV cell is semiconductor with n-type silicon at the top and p-type silicon on the bottom of the cell to form a pn junction that could generate 0.5 to 0.6 V (Vcell) at the junction. A current of the PV cell (lcell) is defined by the area of the cell in combination with the amount of irradiation (G) and temperature (T). A PV module converts light into electricity and the amount of power generated, for a specific cell, depends on both G and T.

A PV cell is conventionally represented by a current source (IL), one or two parallel diodes (D), a shunt resistance (Rsh), and a series resistance (Rs). Generally the value of Rsh is very large compared to Rs so that can be neglected for the simplification of the analysis. Fig. 4.1 shows equivalent circuit of photovoltaic cell [1].

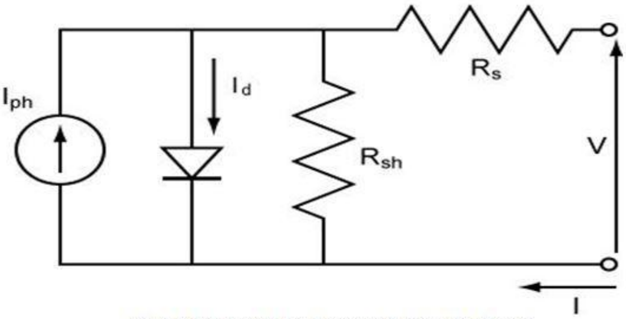
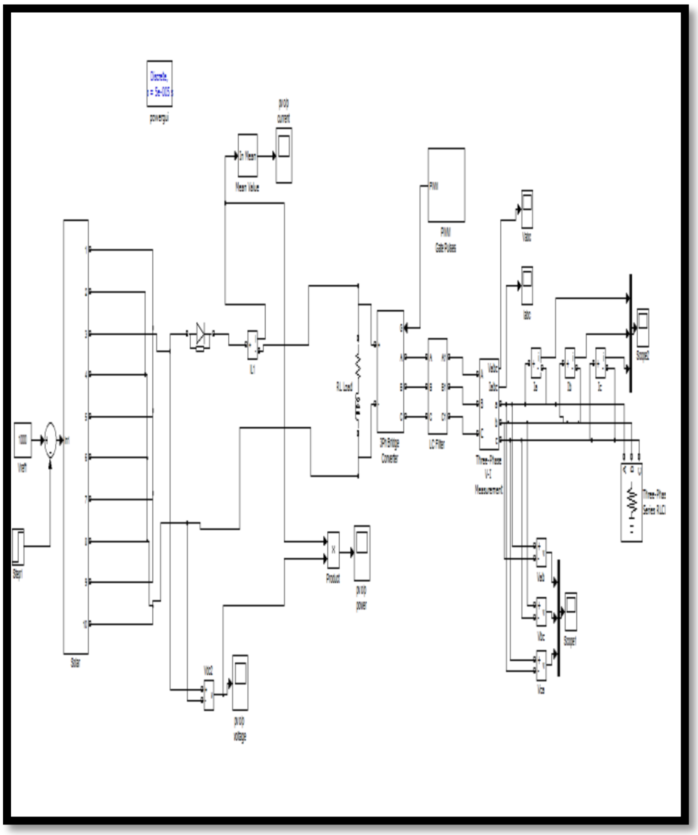


Fig.5.1 The one-diode circuit equivalent of a PV cell

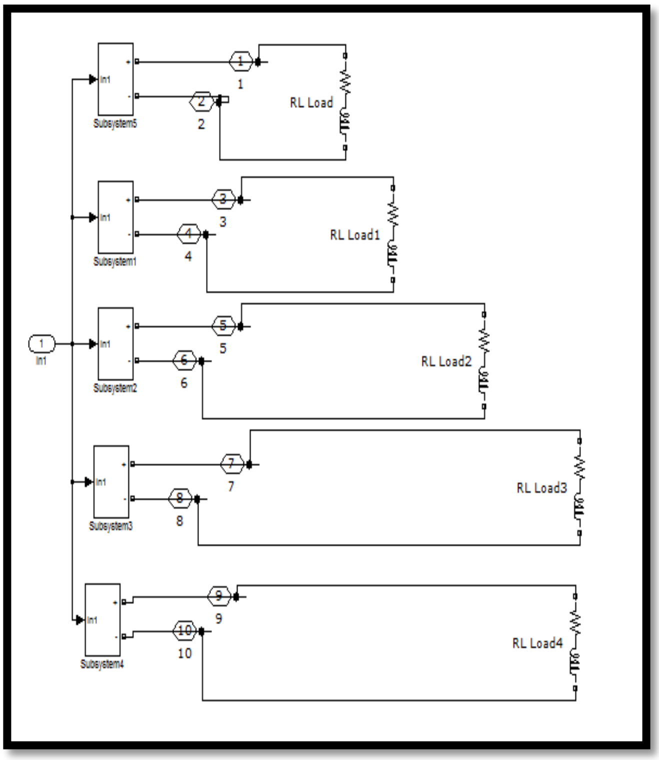
For modeling of photovoltaic array, we must be calculating photo current, reverse saturation current, saturation diode current etc. so first we complete mathematical modeling of PV array. In next sections we are going to do mathematical modelling of the PV system and to implement that using MATLAB/Simulink software. PV cells are grouped in larger units called PV modules which are further inter connected in a parallel-series configuration to form PV arrays. Now, a PV module consists of a number of PV cells connected in series to allow for a usably high voltage level.

IV. MODELLING AND SIMULATION

A MATLAB model for the Solar Energy Storage System for Indian Railways is shown as:-



Subsystem for PV Array :-



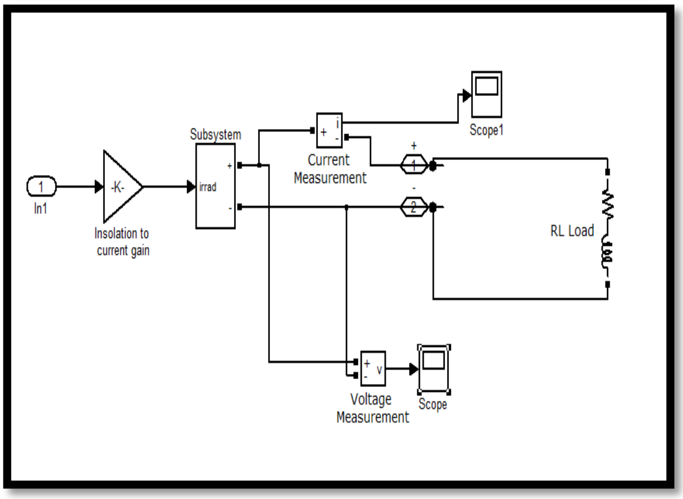


fig-Subsystem of PV Plate

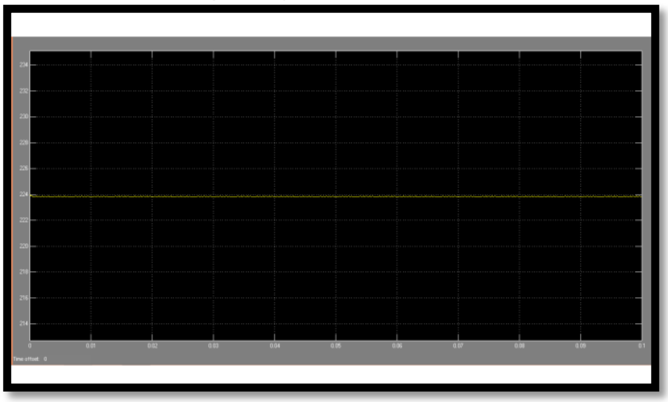


fig-DC Voltage from PV Array

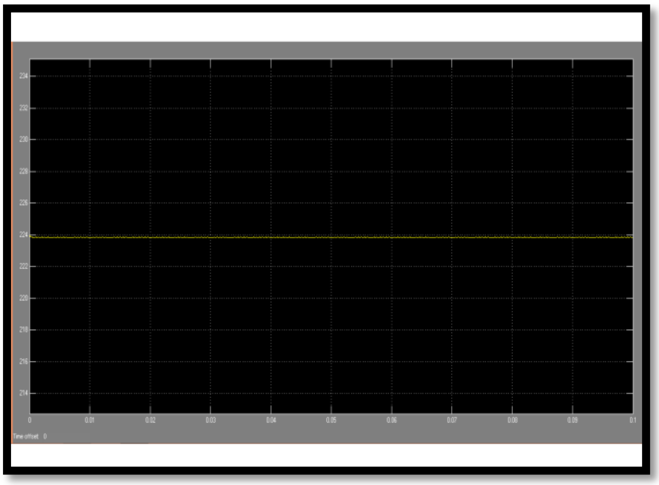


Fig-DC Current from PV Array

WAVEFORMS FOR CONNECTED ELECTRICAL LOAD IN AC COACHES

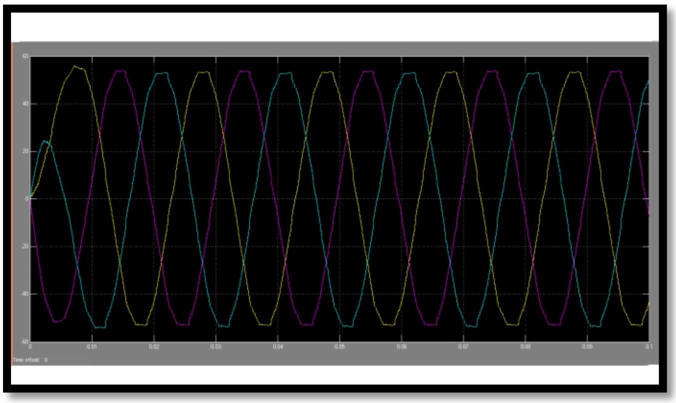


fig-Output AC Voltage Vabc

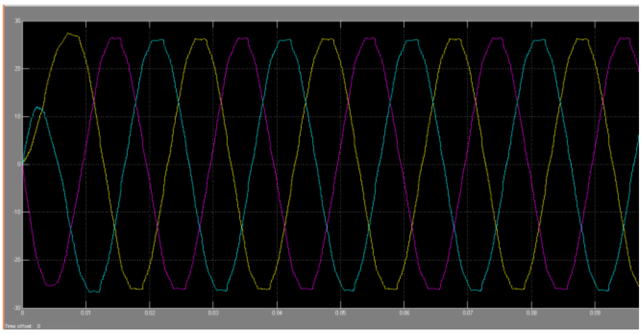


Fig-Output AC Current Iabc

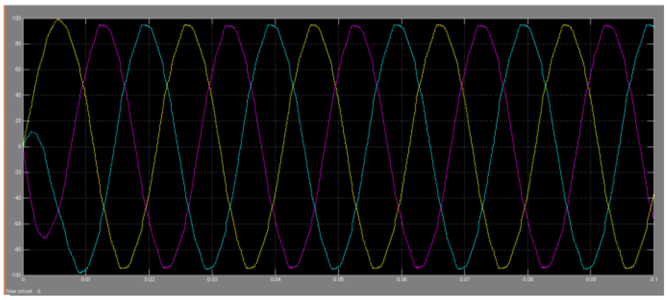


fig-Load Voltage Vab, Vbc, Vca

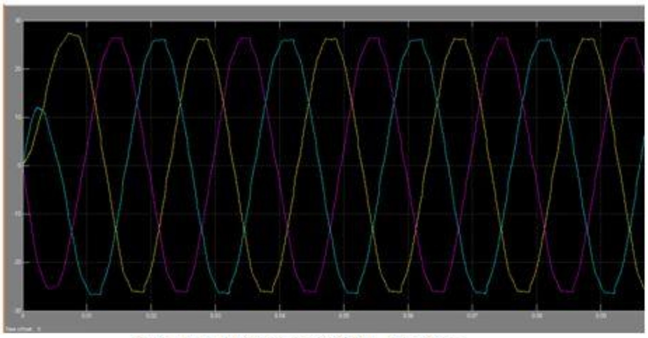


Fig-Load Current Iab, Ibc,Ica

WAVEFORMS FOR CONNECTED ELECTRICAL LOAD IN NON AC COACHES :-

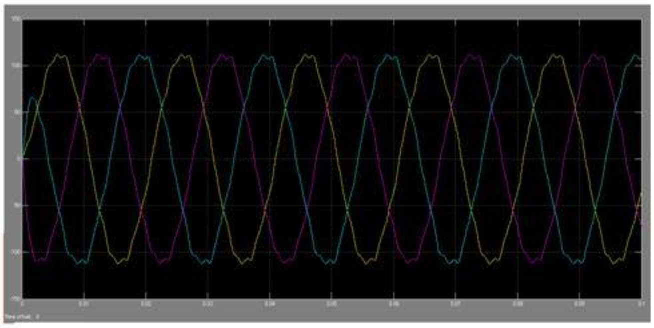


fig- Output AC Voltage Vabc

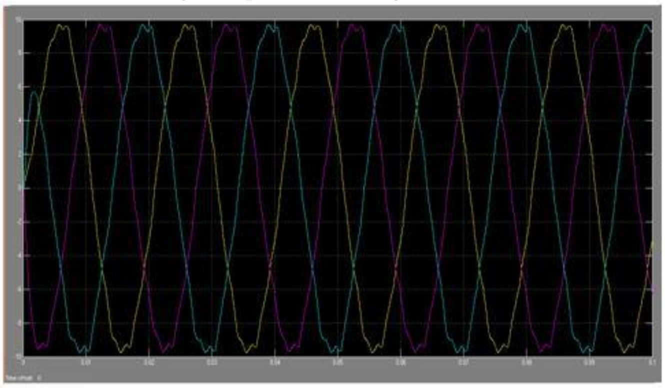


fig-Output AC Current Iabc

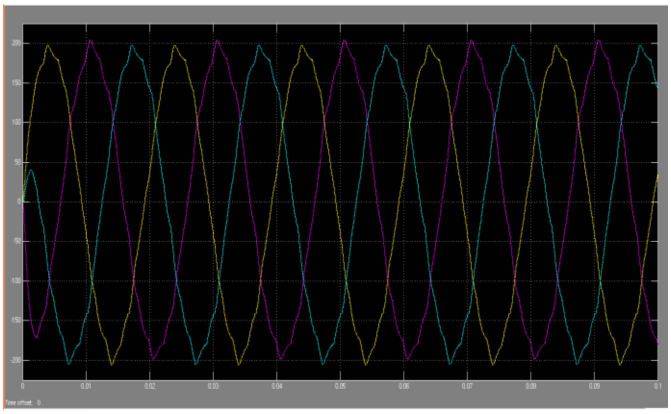


fig-Load Voltage Vab, Vbc, Vca

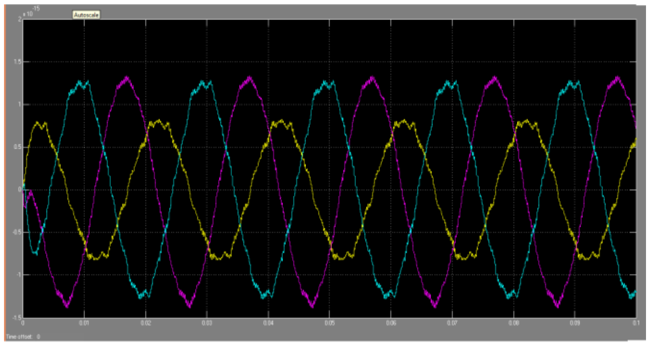


fig- Load Current Iab, Ibc,Ica

WAVEFORMS FOR CONNECTED ELECTRICAL LOAD IN PANTRY CAR

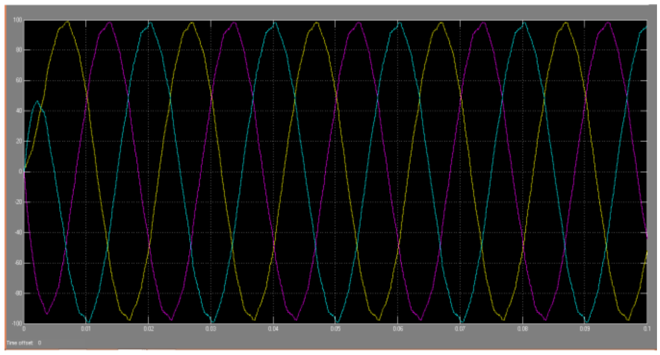


fig Output AC Voltage Vabc

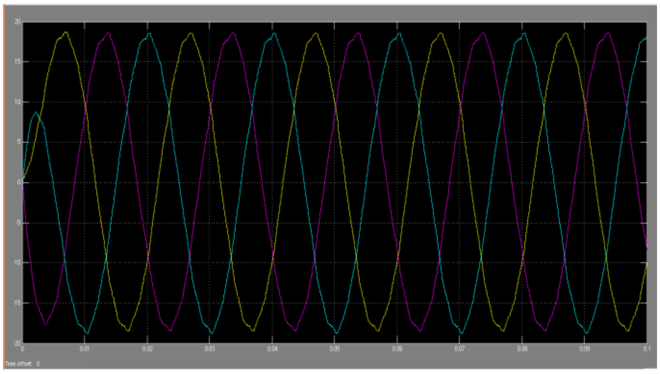


fig-Output AC Current Iabc

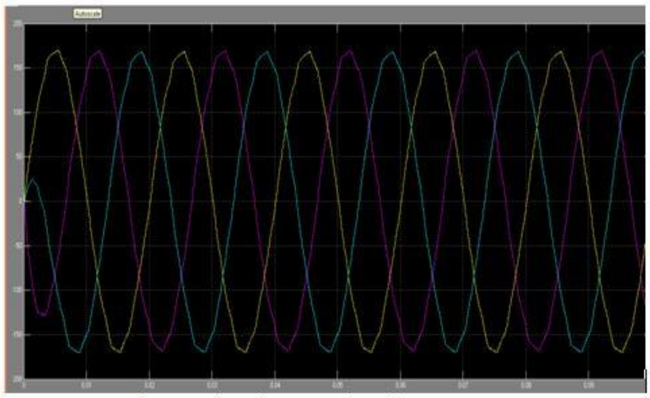


fig Load Voltage Vab, Vbc, Vca

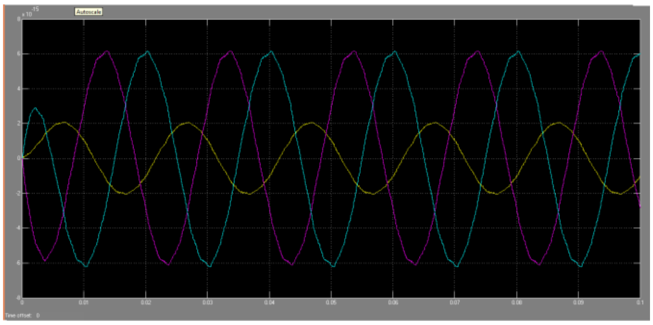


Fig- Load Current Iab, Ibc,Ica

V. CONCLUSION

Vehicles with a flywheel based energy recovery system, though significantly more expensive than Vehicles without this system, have more power and better fuel efficiency. According to www.thegreencarwebsite.co, "the system could reduce fuel consumption by as much as 20% and give four-cylinder engine acceleration like a six-cylinder unit." This effectively means that with the Flywheel Energy Storage system have better fuel efficiency and more power than the Vehicles without the FESS system. It is expected that with present acceleration in the efforts on the part of manufacturers, designers, planners and utilities with adequate Governmental support, PV systems will within the next two decades occupy a place of pride in the country's power sector, ensuring optimum utilization of the energy directly from the sun around the year. It is clear that the Grid Connected SPV system can provide some relief towards future energy demands. Potential of grid connected photovoltaic system in INDIA is trying to find out. From the diurnal variation analysis of eight month we conclude that solar potential is maximum at noon. The April months gives the maximum monthly energy output out of eight months.

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