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**ANALYSIS OF HYBRID ENERGY STORAGE SYSTEMS  
BASED ON PHOTOVOLTAIC PANEL, SUPERCAPACITORS  
AND BATTERY FOR ELECTRIC VEHICLES**

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**Abstract**

Nowadays, with the evolution of technology, energy storage systems have become a concern for automotive industry. It is intended to develop, through different methods, green energy systems to power up electric vehicles. During the last years, several energy storage systems have been tested and implemented, but each solution has brought advantages and disadvantages regarding infrastructure, charging stations, speed of charging or autonomy.

This paper proposes to study a power management strategy for a hybrid energy system which consists in a photovoltaic panel (PV), as main power source and super-capacitors and batteries. The last two energy storage devices, due to the various power densities, will provide the steady and transient power demand. For each power source of hybrid storage energy system, dynamic and mathematical models are described and a strategy of power sharing is presented.

The experimental stand, represents the main contribution to this paper, and is made on small scale using low voltages and currents. The entire purpose of this paper was to build a system for energy management, controlled by a microcontroller ArduinoNano.

The overall objective of present work is to analyze the distribution of energy between existing sources in the system according to their characteristics. During simulations, each energy storage device is predominant in either charging or discharging mode and different control strategies for sharing energy will be developed and studied.

*Keywords:* battery, energy storage system, hybrid system design, super-capacitor

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