SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Automotive Engineering Department

Effect of Using Photo-Voltaic Cells for Range Extension of Series Electric Hybrid Vehicles

A Thesis submitted in partial fulfillment of the requirements of the degree

of Master of Science in Mechanical Engineering

(Automotive Engineering)

by

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Mechanical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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SUMMARY

This research is directed to the utilization of the solar energy in the transportation section to replace nonrenewable sources of energy which are finite and their prices is in a continuous increase, in addition to the Environment that suffers from the concentration of CO, NO_X, noise and rising of temperature. Taking into consideration the capitals and industrial cities, where the pollution concentration reaches high percentage, limited average speed and long stopping time in traffics especially at rush hours. Electric vehicle with more advantages of no noise, no pollution, saving energy and reduce emissions is a good solution for both the environmental and the depletion of fossil fuels. The electric vehicle is the optimum solution for those areas. In general the EV range and speed were the main obstacle that faces this mean of transportation to be comparable with conventional vehicles which are driven by ICE. This is due to the limited energy stored in the batteries and the time needed to recharge the batteries.

Cairo as a big city with its crowded streets is a suitable environment for the target of this research. After determining the average vehicles speeds in different districts at different working days, the performance of a pre-chosen battery electric vehicle is studied in order to convert it to work as a hybrid solar vehicle to overcome the disadvantages of both electric and solar cars. The hybrid solar vehicle has two sources of power, It can be driven by PV output power or battery stored power independently, which greatly affects the vehicle range.

After the vehicle is practically converted to work as a solar hybrid electric car, some practical tests are done and the results are analyzed which proved its reliability as an in-city mean of transportation and this was confirmed by a road test.

Key words: Hybrid vehicles, Renewable energy, Photovoltaic, Battery electric vehicle range

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LIST OF ABBREVIATIONS

AC	Alternating Current
A-Si	Amorphous Silicon
AGM	Absorbed Glass Mat
BEV	Battery Electric Vehicle
CdTe	Cadmium Telluride
CIS	Copper Indium Diselenide
CIGS	Copper Indium Gallium Diselenide
CO_2	Carbon Dioxide
DC	Direct Current
DOE	Department Of Energy
EM	Electric Motor
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
GaAs	Gallium Arsenide
GM	General Motors
HEV	Hybrid Electric Vehicle
HSV	Hybrid Solar Vehicle
ICE	Internal Combustion Engine
NEV	Neighborhood Electric Vehicle
NiCad	Nickel Cadmium
PEV	Plug-in Electric Vehicle
PHEV	Plug-in Hybrid Electric Vehicle
PV	PhotoVoltaic
PCU	Power Conditioning Unit
SEV	Solar Electric Vehicle
SLA	Sealed Lead Acid

TWC	Three Way Catalyst
TTWE	Tank To Wheel Efficiency
VRLA	Valve Regulating Lead Acid
V2G	Vehicle to Grid
WTTE	Well To Tank Efficiency
WSC	World Solar Champion

CHAPTER 1

INTRODUCTION

1-1 Introduction

The demand for petroleum continues to increase whilst oil supplies remain limited. In the near future, conventional oil supplies will no longer be able to satisfy the global demands. The oil production will peak and then commence to decline. There is no certainty when the peaking will occur, but it has been forecasted that it could happen soon [1]. According to a report in 2006, 80 million barrels of petrol is used per day. The transportation sector consumes 66% of this petrol and the portion of the land transportation is 56% of this quantity [2]. Consuming this amount of fuel continues to aggravate the environmental issues. Consequently, when it comes to energy security and climate change concerns, cars and trucks are considered one of the principal problems. They consume relatively a big portion of the oil in the world and emit a large amount of toxic gases that affect both human and environment.

In response to the increase in the impacts of the vehicles on the environment and energy security, improving fuel efficiency can play a massive role. There are many techniques to improve the efficiency in vehicles. Over the past few decades, there has been significant development in automobile engine and body technology. Thus, there are few gains achieved in fuel economy through vehicle engine and body. The emissions that impacted health were mostly mitigated by the invention of the Three Way Catalyst (TWC), which successfully converts the harmful emissions to less harmful ones. But Depletion of fuel resources has been tried to overcome by using alternative fuels, like biomass-based (Methanol/Ethanol) or other fossil fuels (like the liquefaction of Coal) as a feedstock. These; however, have a limited capacity due to cost constraints,