

Solar vehicles – a feasibility study toward optimization of energy consumption based on regional insolation and traffic data

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Abstract – The concept of energy optimization in vehicles is typically regarded as reducing the fuel consumption. Designing vehicles running on clean, free solar energy is a novel approach that can fulfill all necessities considered in this idea of optimization. Utilization of solar energy in transportation industry particularly commuter urban vehicles may seem impractical due to low efficiency and output of solar cells in comparison with other power sources. Therefore, performing feasibility studies based on technological limitations, regional insolation data and traffic status is absolutely essential. This paper, besides introducing solar vehicles, describes the general equation of power in terms of insolation, resistances and losses. Based on real solar irradiation and traffic information related to the city of Mashhad, the second biggest city in Iran, the feasibility of designing a solar commuter vehicle is investigated. The results clearly state that the idea can provide reasonable annual range of urban traveling. In addition, the environmental effects of utilizing these zero-emission vehicles for reducing hidden ecological costs are studied.

Keywords – Feasibility study, Insolation, Power cycle, Solar vehicle, Traffic data

1- Introduction

Since the outset of automobile industry, internal combustion engines have been employed as the most popular mechanical drivers and hydrocarbons as the most important fuels. After the oil crisis in the late 1970's and beginning of the environmental concerns in 1980's, efforts were started to find an alternative source of energy for power generation in general and automobiles in particular.

Electric vehicles, once being the counterpart of fuel-consuming vehicles in 19th century and then just recognized for research or recreational intentions, have been the most promising ideas receiving considerable attention. Batteries, fuel cells and hydrogen are the main proposed power sources in these vehicles. Solar energy absorbed by solar cells and stored in batteries is another supply of energy that was introduced in solar vehicles.

Solar vehicles technology was firstly introduced by Hans Tholstrup and Larry Perkins who crossed Australia in 1983 just to show the practicability of an electric vehicle mainly dependent on solar energy. The idea was soon welcomed by many other groups from universities and automobile companies attending competitions held in many different countries. These races have been acting as exhibitions for introducing the newest technologies of electric motors, solar cells, batteries, composite structures and many other novel ideas. During these two decades, as the vehicles designed demonstrated promising performance, the idea of employing solar energy in urban vehicles has turned to a practical

concept currently investigated by several groups especially in Australian universities.

In conventional fuel-consuming automobiles, the designer is not concerned about providing enough power to run the vehicle; but in solar vehicles, the balance between generated and consumed electric energy is marginally satisfied and that is just the point where the concept of optimization of energy consumption is well meant. Thus, the feasibility of a design founded on climatologic parameters and vehicles systems specifications must be carefully studied. Such studies have been presented in a number of technical reports but just in a few conference or journal articles [1-6]. This paper proposes a model for doing the feasibility design of solar commuter vehicles based on real solar data in the city of Mashhad and then discusses whether the results are satisfactory or not. Environmental effects of employing these vehicles are also briefly investigated.

2- Solar vehicles technology

A solar vehicle, as mentioned earlier, is an electric vehicle which supplies all or most of its required power by converting solar radiation into electricity with the help of solar cells. Based on the real time balancing of power cycle, electronic devices designed for these vehicles store the energy in the batteries or make use of batteries. Electric motors are the drivers of solar vehicles which are of great advantage in comparison to the internal combustion engines as they are much more efficient, have no