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Evaluation of automobiles with alternative fuels utilizing multicriteria techniques☆

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Abstract

This work applies the non-parametric technique of Data Envelopment Analysis (DEA) to conduct a multicriteria comparison of some existing and under development technologies in the automotive sector. The results indicate that some of the technologies under development, such as hydrogen fuel cell vehicles, can be classified as efficient when evaluated in function of environmental and economic criteria, with greater importance being given to the environmental criteria. The article also demonstrates the need to improve the hydrogen-based technology, in comparison with the others, in aspects such as vehicle sale costs and fuel price.

Keywords: DEA; Automotive; Hydrogen; Environment

1. Introduction

At present, approximately 97% of the energy consumed by vehicles worldwide is based on oil, a contaminating, non-renewable and geographically very localized energy resource. Numerous studies sustain that the environmental problems and those of energy dependency produced by this energy model will be even more serious in the future if the current tendency continues. For example, the International Energy Agency estimates that the consumption of petroleum fuels will double between the year 2000 and 2030 if the current trends continue, and that there will also be a similar increase in greenhouse effect gases (GHG) [1]. These factors have led, over the last few years, to efforts being increased at national and international level to develop Alternative Fuel Vehicles (AFVs).

The growing interest in the development of new technologies for the automotive sector based on alternative fuels is demonstrated by the ever-increasing number of studies published over the past two decades that have focused on analyzing the advantages of these types of engines as against the traditional technologies based on fossil fuels. Among these works we can find particular studies on every one of these fuels, comparative analyses of several of them (see, among others [2–4]), analysis of costs [5–7], or of the market opportunities for alternative vehicles [8–10].

The fundamental problem concerning the development of AFVs is the fact that the main benefits derived from their implantation (reduction of energy dependency and of environmental damages) have no direct affect on the private sector, while this sector does bear the highest costs in comparison to traditional technologies. In order to resolve this problem, and enable AFVs to compete in the future with the vehicles based on traditional fuels, the participation of the public sector backing the private sector is required.

There are six traditional barriers that obstruct the appearance of AFVs in the market [11]:

1. High cost of the vehicle.
2. On-board storage difficulties, which limit vehicle autonomy.
3. Guarantee of security in the use of new fuels.
4. Limited number of fuel stations.
5. Fuel cost, especially in terms related to oil.
6. Improvements to traditional technologies that are leading to optimized and cleaner petrol and diesel engines.

Each new technology has to overcome these obstacles, which makes its success in the market very difficult to achieve. Along with the above-mentioned reasons, one has also to consider the fact that the efforts being made nowadays to enhance

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