Abstract

Economical, ecological and safe driving (eco-driving) is aimed at reducing fuel consumption, greenhouse gas emissions and accidents. Eco-driving is concerned about driving in a way compatible with modern engine technology: smart, smooth and safe techniques that lead to potential fuel savings of 10–15%. The Centre for Renewable Energy Sources of Greece conducted an eco-driving pilot study in collaboration with the Organization of Urban Transportation of Athens, and the Thermo-Bus Company to assess the effects of changing urban bus drivers’ driving style.

© 2007 Elsevier Ltd. All rights reserved.

Keywords: Eco-driving; Energy saving; Fuel saving; Road safety

1. Introduction

The Centre for Renewable Energy Sources (CRES) conducted an eco-driving pilot program in collaboration with Athens Urban Transport Organization (OASA) and the Thermal Bus Company (ETHEL), the largest public bus organization in Athens in terms of fleet size, network scale and passengers (Centre for Renewable Energy Sources, 2003). The aim was to investigate the effects of modifying urban bus drivers’ behavior through training courses on economical and ecological driving.

CRES is the first body to organize such a pilot program in Greece and because there was no experience of eco-driving, CRES was supported on by the Netherlands’ largest training institute for the transport and logistics, Vakopleiding Transport en Logistiek (VTL). The training courses were designed to increase the knowledge of bus drivers regarding economical driving techniques with the aims of (Intelligent Energy Executive Agency, 2005):

- Reducing fuel consumption and exhaust gas emissions of buses.
- Improving road safety.

* Corresponding author.

E-mail address: mariazar@cres.gr (M. Zarkadoula).
• Decreasing the transport undertaking’s maintenance costs.
• Improving the comfort of drivers and passengers.
• Enhancing of the transport supplier’s profile.

2. The pilot program and results

The pilot program was split into

Phase 1: Design of pilot action: CRES prepared the pilot action that lasted four months, in collaboration with ETHEL. The latter had to re-schedule its operations and to designate drivers of two specific urban buses in Athens to be trained in eco-driving.

Phase 2: Data collection of pre-training phase: This phase involved pre-training data collection on fuel consumption, distance traveled, average speed, etc. To maximize data accuracy, specialized equipment, EDM1404, provided by VDO Kienzle, was installed on the selected vehicles. The monitoring period over which the base data was collected was one and a half months.

Phase 3: Development of the training material: The training material was developed by VTL in cooperation with CRES. It constituted a package of instructions concerning driving styles targeted at urban buses with automatic gear boxes.

Phase 4: Training courses execution: Eco-driving courses were given three phases under the guidance of VTL personnel. In phase A, three bus drivers had to drive using their usual driving style over a predetermined 15 km route designed for training purposes whilst fuel consumption and their driving time were recorded. In phase B, the drivers attended an analytical eco-driving seminar. Finally in phase C, they applied eco-driving instructions and practiced driving over the 15 km route. The changes in fuel consumption along with the driving time were recorded. The results are given in Table 1.

Following the implementation of eco-driving practices, under the guidance of the trainer, two drivers not only managed to decrease their fuel consumption by up to 17.8% but also decreased their driving time confirms that driving economically does not mean one must drive more slowly. The third driver almost maintained his fuel consumption, having only a small increase of 1.78%, but he had to drive for almost 40% longer than on the initial route! Finally, the average decrease in fuel consumption for all bus drivers was 10.2%.

Phase 5: Post-training phase: The post training monitoring period lasted two months. The two urban buses used in both pre- and post-training procedure were then used on the two selected urban routes and data gathered to evaluate the bus drivers’ driving performance under actual driving conditions.

Phase 6: Data evaluation: This phase involved the evaluation of the driving performance in actual traffic conditions. Table 2 the results on average fuel consumption per kilometer for the buses before and after eco-driving. The benefit of the training was an overall 4.35% reduction in fuel saving per km with commensurate declines in atmospheric pollution. Additionally, there would be reductions in noise levels and maintenance cost.

Estimating the fuel saving allows calculation of the economic benefits for ETHEL from implementing more general eco-driving education across its drivers. Every ETHEL bus consumes about 60,000 l of diesel per year, indicating that an average saving of 4.35% in fuel consumption would result an annual saving of 2610 l of diesel fuel per bus. If the average cost of diesel for ETHEL is €0.65 l the annual saving for each bus would be €1697 per year amounting to €2,884,900 over the 1700 bus fleet. This could be higher with on-going training

<table>
<thead>
<tr>
<th>Driver</th>
<th>Fuel consumption (l)</th>
<th>Driving time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tour #1</td>
<td>Tour #2</td>
</tr>
<tr>
<td>1</td>
<td>18.9</td>
<td>16.4</td>
</tr>
<tr>
<td>2</td>
<td>19.1</td>
<td>15.7</td>
</tr>
<tr>
<td>3</td>
<td>16.9</td>
<td>17.2</td>
</tr>
</tbody>
</table>
courses because drivers achieved an average 10.2% in fuel saving during training. Assuming an actual annual average improvement of 10%, this would have resulted in savings of €6,630,000 per year.

References


Table 2
Average specific fuel consumption per kilometer (pre to post training phase)

<table>
<thead>
<tr>
<th>Bus #1</th>
<th>Average specific fuel consumption (pre-training phase) (l/km)</th>
<th>Average specific fuel consumption (post-training phase) (l/km)</th>
<th>Difference (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bus #1</td>
<td>1.072</td>
<td>1.024 l/km</td>
<td>-4.5</td>
</tr>
<tr>
<td>Bus #2</td>
<td>1.094</td>
<td>1.048 l/km</td>
<td>-4.2</td>
</tr>
</tbody>
</table>