Alternatives for Urban Public Transport

Energy and Environment

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Abstract

Environment problems related to mobility and transportation policies are nowadays one of the basic troubles considering the city's quality of life.

Consequences of automobile use in cities, with related traffic jams, anarchical parking, impossibility of a correct development and maintenance of road infrastructures and the inapt land use, impose that alternative solutions should be promoted most urgently. These solutions imply certain alternatives such as public transports, transference from motorized modes to non-motorized ones and a more adequate use of cars in the city, in order to find a new balance of means of mobility.

Electric rail transports are already a successful solution, in middle and large size cities. However, other alternatives are needed in which mini and midi-electric buses must be considered.

The use of this kind of buses will allow lines in historical centers with narrow streets or to create feeder lines for already established public transport networks in zones where the public transport network is less developed. Complementary public transport can help today to satisfy urban mobility needs in a sustainable manner.

This paper aims to present the results of the social and operational monitoring performed during the last two and half years in 25 different cities (including one of the two which have already implemented a regular service), which allows to conclude on the real benefits related to the introduction of such vehicles in the Portuguese public transport fleets.

1 Introduction

Electric vehicles (EV) began to be considered more effectively, in Portugal, after 1998 when an interesting experience involving mail distribution by EV's in three towns (Evora, Aveiro and Ponte de Lima), was developed by a national postal service company, CTT Correios. At the same time, the electricity utility company, EDP – Electricidade de Portugal, included electric automobiles and scooters in its fleet. The monitoring programmes developed for these vehicles enabled to show their advantages and disadvantages, and outlined the economical and technical limits of their use.

The constitution of APVE – Portuguese Electric Vehicle Association in June 1999, and the promotion and demonstration activities that were systematically developed, led to the interest of the press in EV's and, consequently, reaching the public.

Regular events involving municipalities, all over the country, have generated a public opinion generally favourable towards alternative technologies in transportation. Several municipalities and companies also began to test EV's in their fleets, in which the support and incentives of the Portuguese Directorate General for Inland Transportation was decisive.

The questions around pollutant emissions and greenhouse effects are no longer addressed as future problems; they are part of our present issues and require urgent solutions.

Given the high efficiency of the electric motor, combined with the absence of local emissions, the electric vehicle appears once again as a logic alternative to conventional propulsion. The objective of this paper is to analyse the use of electric vehicles in real settings, over a significant period of time, in Portugal.

Figure 1 – Regular lines with Electric mini-bus in two Portuguese cities: Coimbra and Portalegre. Two more cities – Bragança and Viseu – are launching their lines now.

2 Demonstrating Electric Mini-Buses in Portugal - Background

The Directorate-General for Inland Transport and the Portuguese Electric Vehicle Association, developed the demonstration action "Introduction of Electric Buses in Public Transportation Fleets", not only to present alternative types of technologies in public transports, that are available today, but also to introduce new mobility concepts [8].

This action travelled to 24 Portuguese cities, over a period of two and a half years; aiming to demonstrate the capability of using electric buses in urban public transport fleets and to test the available vehicles and their market in Portugal.

The demonstration was conceived in **two phases**. The **first** one ran from September 2001 to February 2002, in two modalities: presentation of a bus (MINI bus Gulliver, hybrid) for 1 month in some 16 cities (partly integrated in a National EV rally), and longer term (one week to one month long) experiences in 3 cities (MIDI bus OREOS 55, hybrid). Preparatory activities included the following tasks: market research and terms of references for buses, definition of pilot experience profiles, case studies and selection of cities and transport providers, leasing agreements (only two manufacturers are in condition to propose the demanded buses) training, launching events, information and promotion campaigns.

The **second phase** occurred from June 2002 to January 2005 with two acquired mini buses applied in the second modality: medium term experiences in cities, this time integrated in programs containing other components such as experiences with electric and natural gas passenger vehicles in taxi or car pooling services and other sustainable mobility measures.

Figure 2 – Hybrid Electric midi-bus “OREOS 55H”.

Figure 3 – Electric mini-bus “GULLIVER”.

During the second phase two electric “GULLIVER” mini-buses, manufactured by Tecnobus, were purchased and put into service in twenty four Portuguese cities, for periods of four to six weeks, having travelled more than 74.000 kilometres. Many of these cities adopted the operation system know as “blue line” (invented in Bordeaux), which means that the circuit is defined by a blue line painted on the pavement. There are no stops neither defined schedules, to enter or exit the bus. The passenger only needs to manifest this intention to the driver at any point of the “blue line” stretch. The gap between buses is approximately ten minutes which results on an average waiting time of five minutes (“forget the timetable frequency”).

As a result of this action, two Portuguese cities, Coimbra and Portalegre, have already implemented regular public transport services with electric mini-buses.

3 Monitoring and Social Impact

Several tools were developed in order to assess the social impact, such as interviews with all the persons intervening in the bus service: drivers, mechanics, persons responsible for recharging; inquires to the passengers and monitoring of the variation in daily utilization. These surveys allowed to determinate the level of satisfaction with regard to the service provided by the two buses, from the perspective of the passenger and of the transport operator.

Inquiries to the Passengers

The inquiry allowed for assessing the public opinion towards the vehicle itself, the service provided and the use of alternative energies in public transports. The inquiry was made on board the bus, while in service, and was divided into four different parts:

- Opinion regarding the vehicle;
- Opinion regarding the circuit and the use of alternative energies in transports, in general;
- Use of public transport;
- Characterization of the passenger.

The following figure shows some of the results achieved.

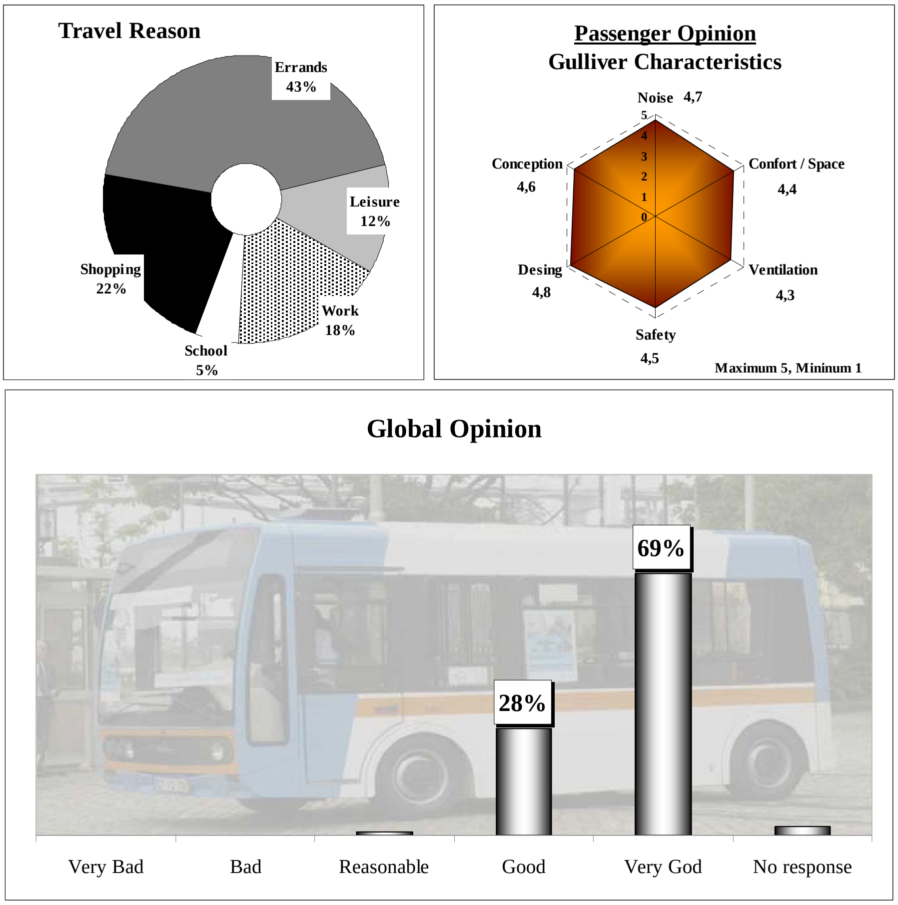

Figure 4 – Data resulting from the inquiries to passengers.

Figure 5 illustrates the summary of the average global opinion, considering the vehicle, the circuit, the type of service, schedules, etc. This indicator was analysed quantitatively, five of the answers corresponding to “very good” and one to “very bad”. As this graph shows, all the values are above four, the mean value being 4.5, which means that the public global opinion towards this demonstration was very good.

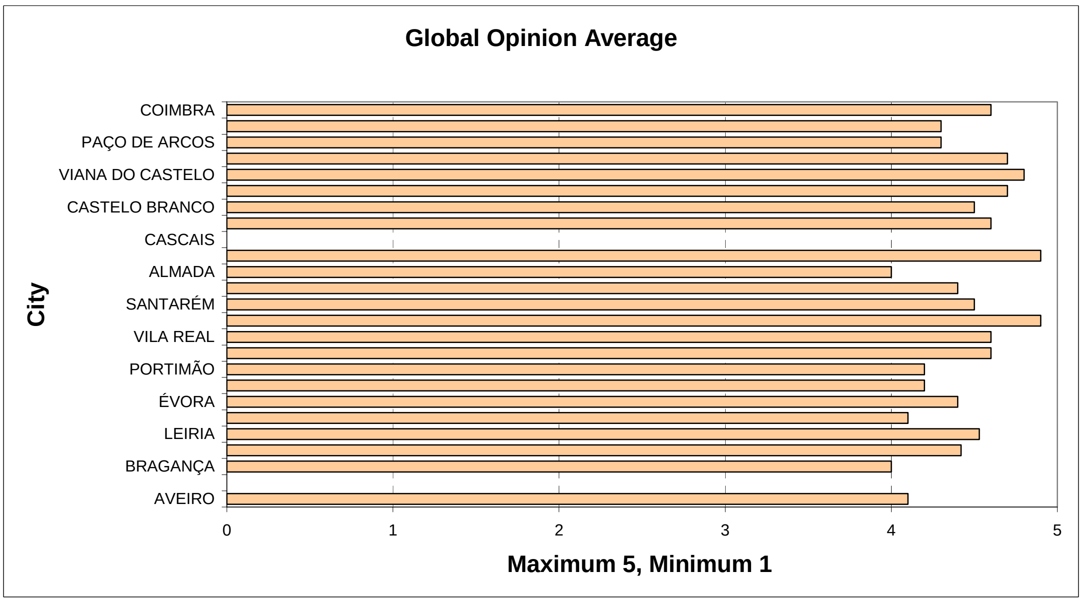

Figure 5 – Global Opinion Average in different cities.

One of the main reasons for this success is related to the fact that these vehicles were mainly used in areas where a conventional vehicle would not be appropriated, such as historical centres. Because they are electric, these vehicles can also co-relate in perfect harmony with the pedestrian, as they do not pollute locally and their circulation produces a greatly reduced noise. Two good examples are the cities of Coimbra and Portalegre that have implemented regular services, connecting the cities' historic centres to other important points of the city, without neglecting pedestrian areas. Such type of service could never have been implemented with a conventional vehicle without causing damage to valuable monuments and disturbing the pedestrians.

Figure 6 – Electric mini-buses in pedestrian areas of Portuguese cities.

Variation of Daily Utilization

The number of passengers getting on and off the buses was taken into account in determined and separated areas of each circuit, in order to calculate the variation of the daily utilization of each mini-bus in the different cities.

The passengers/trip and number of passengers/equivalent day can be seen in Figure 9. Calculating the average for these indicators one achieves 9 passengers/trip and 360 passengers/day equivalent. Note that these buses have a maximum capacity of 22 passengers.

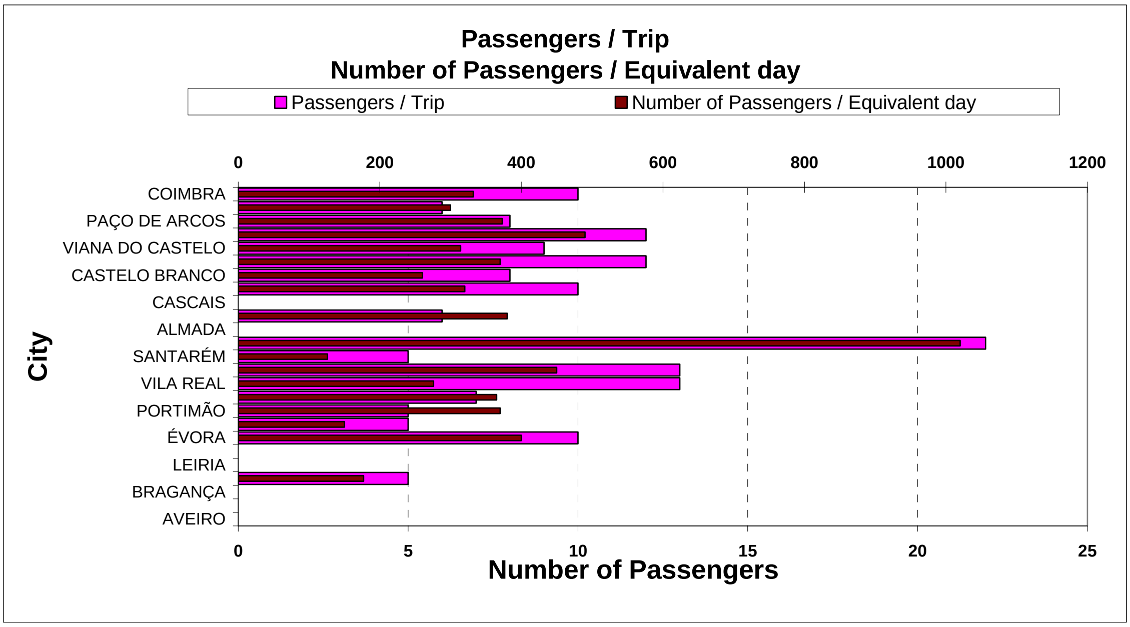

Figure 7 – Passengers/Trip and Passengers/Equivalent day in the different cities.

4 Monitoring the vehicles' performance

During the two and half years in which the second phase of the demonstration took place, several monitoring instruments were developed in order to assess the performance of the vehicles in different settings. The monitoring comprises several variables, in each of the aspects that we point out below.

Daily Consumption and Travelled Distance

These two values characterise the vehicles' performance on the road; the daily consumption depends on a large variety of factors, such as the driver's dynamic behaviour, slopes and number of passengers.

Daily Mean Consumption

The two values mentioned above enable to calculate the daily mean energy consumption, for which the efficiency of the recharging process was taken into account (see point 4.3). Figure 8 illustrates the different consumptions recorded for each city.

As the chart shows, the daily mean consumption presents a significant variation from one city to the other, which indicates its strong relation to the slopes of the circuits. The daily mean consumption – taking in account all cities – corresponds to 76 kWh/100km.

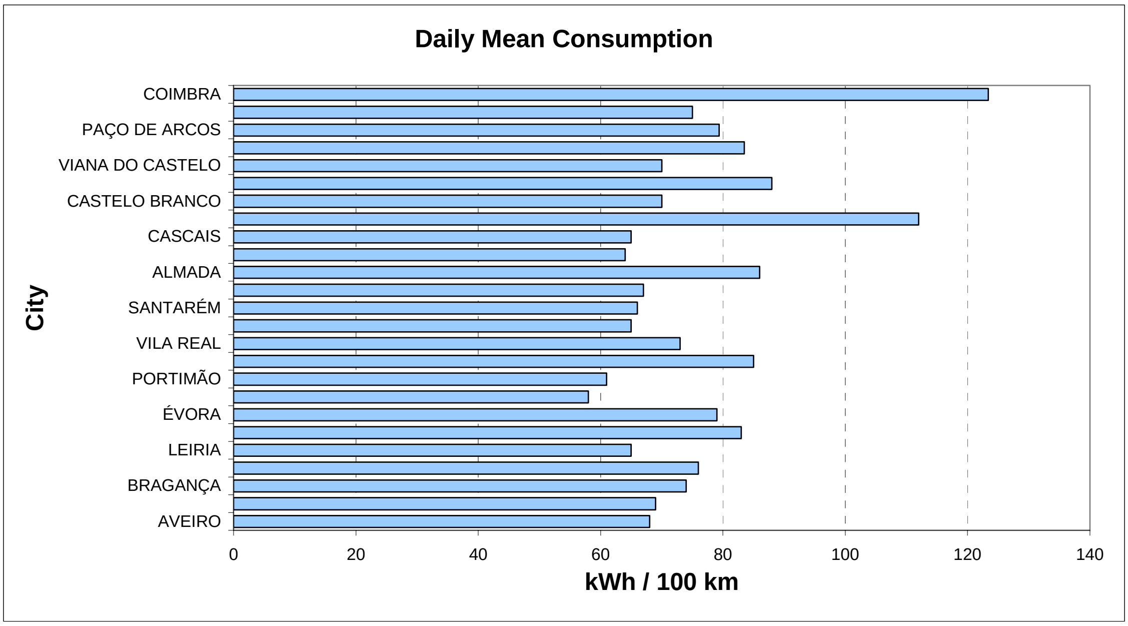

Figure 8 – Daily Mean Consumption in the different cities (kWh/100 km).

Battery Recharging

In order to determine the actual vehicle consumption, the efficiency of the recharging process was monitored and assessed. (Wall to Wheel). The resulting 65% efficiency is represented in the following scheme:

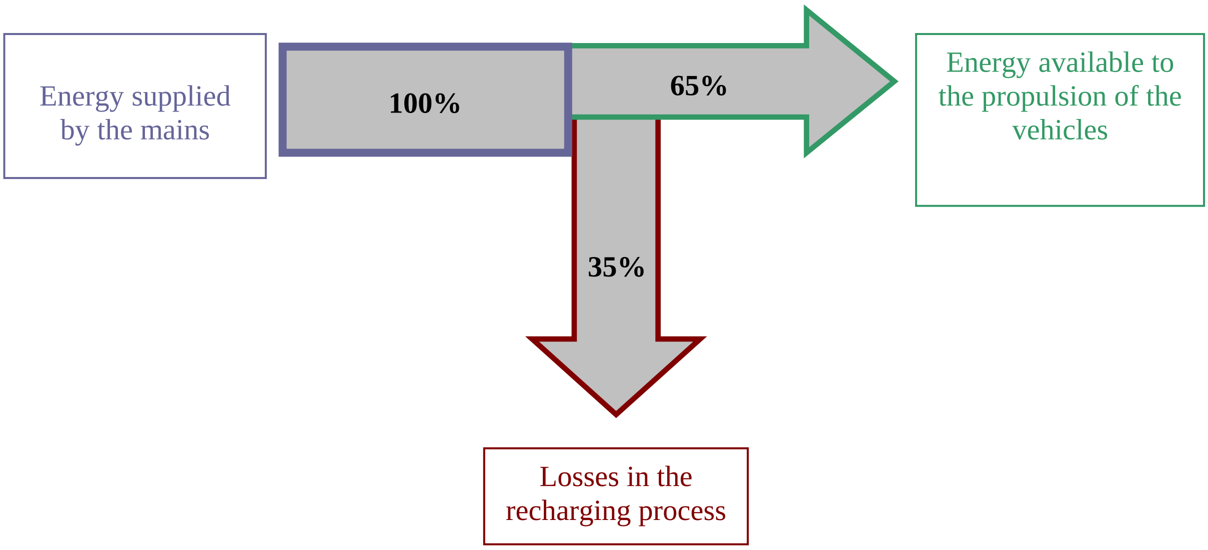

Figure 9 – Scheme of the recharging process efficiency.

5 Conclusions

The following figure represents the summary of the major variables monitored during the demonstration action, in terms of maximum, minimum and average values. From these we can characterize the average service provided by the two vehicles over the past two and a half years:

VARIABLE		ADJUSTED AVERAGE (1)	MIN/ MAX
Type of line (2)	Circular	23	
	Diametrical	2	
Average extension (km)		4	2,5/14
Type of operation	"Blue Line" (no stops)	14	
	With stops	12	
	Average No of stops	14	8/40
Average waiting time	"Blue Line" (min)	6,12	5/18
	With stops (min)	7,4	30
Average load	Per Day (No of passengers)	360	126/1020
	Per Trip (No of passengers)	9	5/22
Average daily travel (km/Bus) (3)		81,4	37/129
Average Energy consumption (kWh/100 km)		74,2	58/123,4
Energy cost	Electricity (4) (€ / 100 km)	5	
	Diesel equivalent (5) (€ / 100 km)	17	
Average global opinion of passengers on the experience (scale 1=min 5=max)		4,4	4/4,9
CO_2	locally	0	0
	Production site (6) (g CO_2 eq / km)	390 (7)	
Tariff	Average single ticket (€)	0,5	0,20/1,25
	Free (experimental)	9	5/22

(1) Eliminating extreme or atypical values
(2) 20 out of 25 lines were newly designed, no existing lines having been found suitable
(3) Normally with 1 battery change
(4) bi-tariff (2/3 night - 1/3 day charging)
(5) 20 liter diesel / 100 km at 0,85 € / liter
(6) Resulting from year 2000 Portuguese production mix
(7) 525 in the case of an equivalent diesel bus

The demonstration action "Introduction of Electric Buses in Public Transportation Fleets" aimed to demonstrate the capability of using electric buses on urban centre lines and to test the available vehicles and their market in Portugal, allowing to put in perspective their potentialities at short-term.

After an initial stage of experience, the two electric mini-buses acquired for the second phase visited 24 cities and were present at several events. Results are very satisfactory. Two cities - Coimbra and Portalegre - have each three electric buses (Tecnobus - Gulliver) and are exploring new urban lines.

Adequate use of electric mini-buses are lines in historical centres with narrow streets or feeder lines, for already established public transport networks in zones where the public transport network is less developed, or proximity services. There is a growing niche market for such public transport to satisfy urban mobility needs in a sustainable manner. The demonstration action shows that transport authorities and fleet operators can be involved to assume such solutions, demonstrating their engagement with environmental problems.

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