

**MUTA 2003**

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## **"les autobus électriques pour le transport urbain" Demonstration of Electric Mini Buses in 15 Portuguese Cities**

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### **Abstract**

The action "Introduction of Electric Buses in Public Transportation Fleets" aims 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 throughout 2001 in two modalities: presentation of a bus 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. Preparatory activities included the following tasks: market research and terms of references for buses, definition of pilot experience profiles, case studies, 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 is running for all of 2002/3 with 2 acquired mini buses applied in 4 to 6 weeks experiences in 15 towns, and in several special events.

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 action shows that transport authorities and fleet operators can be involved to assume such solutions, demonstrating their engagement with environmental problems.

Without sub estimating the difficulties in running such operations, with new technologies, it is possible to conclude that actions like the presented one can help to create necessary market condition for electric vehicles.



## 1. Introduction

Following other agreements signed between the Portuguese General Directorate for Inland Transportation and the Portuguese Electric Vehicle Association, it was agreed to develop a demonstration action regarding the introduction of Electric Buses in Public Transportation Fleets in Portugal, during the last four months of 2001 and all through 2002/3.

This demonstration program is the first initiative implemented in the framework of the “Lisbon Undertaking: Mobility and Technology: What policies for tomorrow?”, launched by the Portuguese Electric Vehicle Association. Integrating eight Portuguese General Directorates (Customs, Energy, Industry, Land Use and Urban Development, Inland Transportation, Traffic, Environment, Patrimony), the Science and Technique Foundation, the National and Lisbon Energy Agency, Lisbon and Oporto Metropolitan Boards, Lisbon Mayor, this agreement aims to promote alternative technology use and integrate them in new mobility policies.

These entities assumed that the transport sector must be deemed as one of the fundamental areas where urgent intervention regarding aspects of energy, environment, and technology is considered necessary in order to foster:

- ❖ an improvement in air quality through reduction of harmful emissions
- ❖ a diminution of emissions linked to global warming
- ❖ a reduction of an excessive dependency on oil fuels
- ❖ an overall increase in energy efficiency

With the “Undertaking” the involved entities assumed the believing that the time is ready to ***prepare and implement actions, programs and projects*** which are largely recognized as acceptable in Portugal and the European Union and which aim, inter alia:

- ❖ To coordinate the relevant issues pertaining to urban mobility and transport under social conditions which may allow for the success of the above targets
- ❖ To gradually support measures which may strategically diminish an excessive dependency on oil-based fuels and increase an efficient and sustainable diversification of primary energy sources, as recommended by the Kyoto Protocol
- ❖ To facilitate the gradual but firm introduction of renewable forms of energy which may also, directly or indirectly, be used in road transport under national and/or European programs and projects, in order to increase the benefits associated to low emission vehicle
- ❖ To support the national industry in a key sector of our economy, under the perspective of sustainable development
- ❖ To create synergies from the awareness resulting from this debate, in the framework of a more general consideration of the sustainable city of tomorrow

Having assumed that it is necessary and appropriate to:

- ❖ implement a horizontal working group including all participants
- ❖ design and create policies for mobility and technology in Portugal, including advanced and sustainable transport solutions, in relation to low emissions vehicles
- ❖ facilitate the design, the development and the monitoring of exemplary pilot-projects for electric vehicle applications, in *partnership with municipalities and public and private entities*, as deemed adequate and sustainable
- ❖ Notwithstanding all tax and fiscal measures already approved and a future analysis of their effects, to consider the design and implementation of integrated incentive programs, including direct or indirect monetary and non-monetary incentives related to the acquisition and use of low emission vehicles in Portugal, in order to create a sustainable and efficient market for such vehicles
- ❖ develop policies aiming at creating technical competence related to low emission vehicles, which may render industrial investment attractive in Portugal and may allow the country to implement programs and projects in this domain

## 2. Electric Mini-buses: a complementary approach

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 be promoted most urgently.

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 and mini- and midi- electric buses must be considered (standard electric buses are not available in the market; also no hybrid bus with track report is presently available on the European market).

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. In this way, complementary public transport can help today to satisfy urban mobility needs in a sustainable manner.

Transport authorities and fleet operators should assume such solutions, which, more costly than traditional ones, demonstrate their engagement with regards to environmental problems.

### 3. Objectives of the action

The action “Introduction of Electric Buses in Public Transportation Fleets” aimed 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 throughout 2001 and part of 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** is running for all of 2002 and 2003 with 2 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.

### 4. Available electric buses

The two buses being tested were the *Gulliver* from *Tecnobus* (Italy) and the *Oreos* from *Gépébus* (France) – [Figure 1](#).

The MIDI bus *Gulliver* is 5,3 m long and 2,07 m wide, pure electric or hybrid version bus manufactured in Italy, transporting 22 passengers, 8 of which can be seated. Equipment and ramp for wheel chairs are optional. With a maximum speed of 33 km/h its autonomy in urban circuit is for 4 to 5 hours, after which the batteries are exchanged, in a few minutes. Two packs of batteries assure a whole day operation. Some 300 Gullivers (and some Pantheons – 6 m / 30 passengers) are already running in Italy, France (6) and England (8 + 6).



Figure 1 – [Gulliver from Tecnobus and Oreos 55 from Gépébus](#)

The MIDI bus Oreos from Gépébus is a French 7-meter bus, used by RATP as Montmatrobus in Paris, in an electric version, transporting 55 passengers. During trips, this bus is recharged with a four minutes fast charge after each run. Powered by a 75 kW induction motor drive includes an updated control system and IGBT power electronics converter.

## 5. Phase 1 – September 2001 to February 2002

The Gulliver bus was tested during the last three weeks of September 2001. Integrated in the first National 1 week EV Rally with more other 40 EV's, involving 25 entities; it ran trough 410 km and 12 cities, connecting Aveiro-Leiria-Évora and Beja. For the first time, it was possible to present EV's in several Portuguese small and medium sized cities and this hybrid-electric mini-bus was a major star of the rally. Several national and local responsables for the transportation policies participate in the road shows, video-conference and other activities. Also responsables from public transport operators were involved, Figure 2.



Figure 2 – First National 1 Week EV Circuit (September 2001)

September 21st and 22nd, the Gulliver was integrated in the activities promoted by the Portuguese Electric Vehicle Association in the European Day “In the City Without My Car!”. After being at the Alternative Propulsion Vehicles Exposition organised at Lisbon centre, Figure 3, the Gulliver bus visit Almada, Oeiras and Sintra, three major cities of Lisbon suburbs.



Figure 3 – European Day “In the City Without My Car!” 2001

Several tests related to the Tecnobus Gulliver’s performance resulted in a positive first impression, with considerable media impact.

October 15th, it was time for the arrival of OREOS 55 H (hybrid, 55 passengers) of Gépébus. A public session at Lisbon involved more than 80 participants from different cities and transport operators - [Figure 4](#). The strong adhesion to this meeting showed the expectative created and the initiative resulted in 18 candidacies for demonstrations.



Figure 4 – Launching of the demonstration action: October, 15th public session

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The Gépébus Oreos 55 H has been tested in Lisbon, Aveiro, Guimarães and Braga for 3 months - [Figure 5](#). The bus has been integrated in existing public urban transport services.



Figure 5 – Oreos 55 H in test in several Portuguese cities

The bus presence in different towns was the opportunity for several promotional initiatives. A series of dissemination material was produced in order to motivate public adhesion to the initiative - [Figure 6](#). Also press and TV were extensively involved,.





Figure 6 – Some of the produced promotional materials and media activities

Awareness rising actions, especially concerning the youth, are considered strategic. Visits to the schools included presentation sessions and bus riding - Figure 7. Several schools work the subject during classes.



Figure 7 – Dissemination Activities

In each town, experience has been accumulated about the way to carry out the initiative. Involvement of the public transportation operator is fundamental and technicians' enthusiasm is a key point. Aspects like transportation between cities, garage adaptability, and electric recharge availability must be considered.

The stay in each town allows for analysing and studying the status of public transportation and evaluation of the adaptability of electric buses to the service. Inquiries aiming users and key actors were performed leading to preliminary results and conclusions.



Figures 8 + 9 show questionnaire results related to the acceptance level of the vehicle by Aveiro users of Oreos bus and Braga of the Gulliver. Design and noise were the two aspects with the most favourable opinion, on a scale from 1 to 5. Comfort and security were the worst aspects.

The users trip purpose and travel habits we also inquired as well as distribution by age and sex - Figure 10.

Bus' technical performance was also analyzed. Figure 11 shows speed evolution and electric power consumption by Oreos 55 running on a typical Lisbon bus line. Due to the hilly characteristic of Lisbon's center, important slopes must be negotiated during the travel.

Collected data allows technical and economical projections about the two buses and different bus lines. Based in the acquired experience, in November 2001 it was decided to buy two Tecnobus electric mini-buses (model Gulliver) for a one year demonstration program.

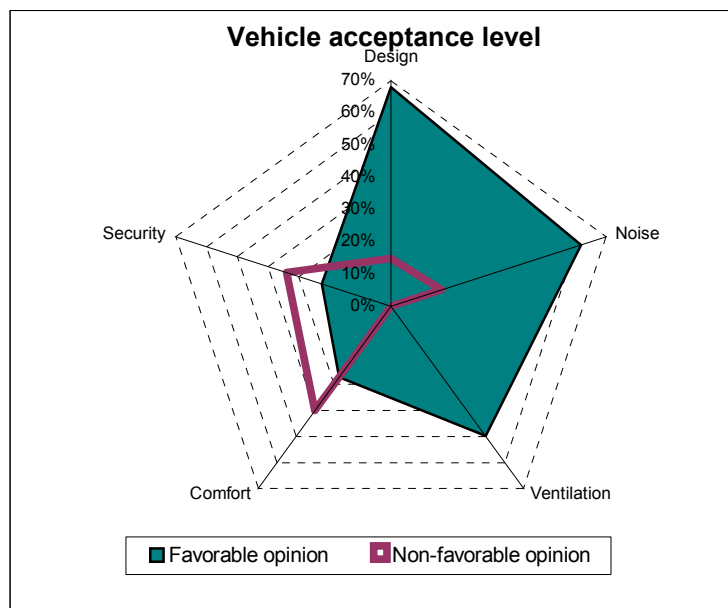


Figure 8 – Acceptance level of the Oreos 55 H MIDI bus, Aveiro (November 2001)

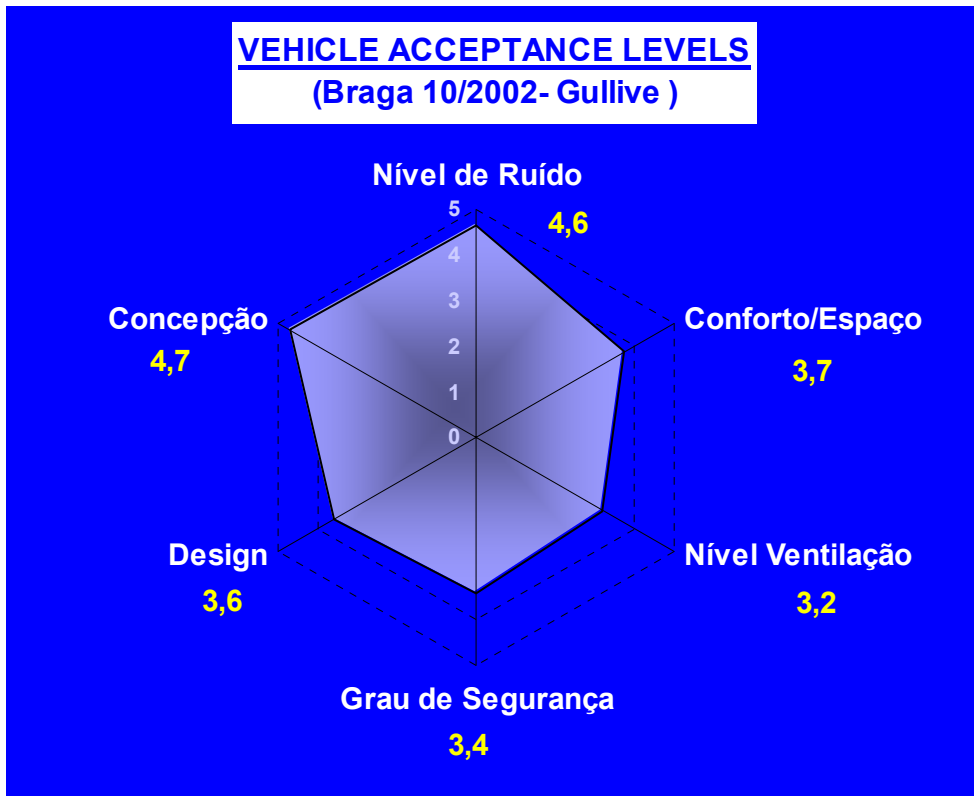


Figure 9 – Acceptance level of the Gulliver MINI bus (Braga - October 2002)

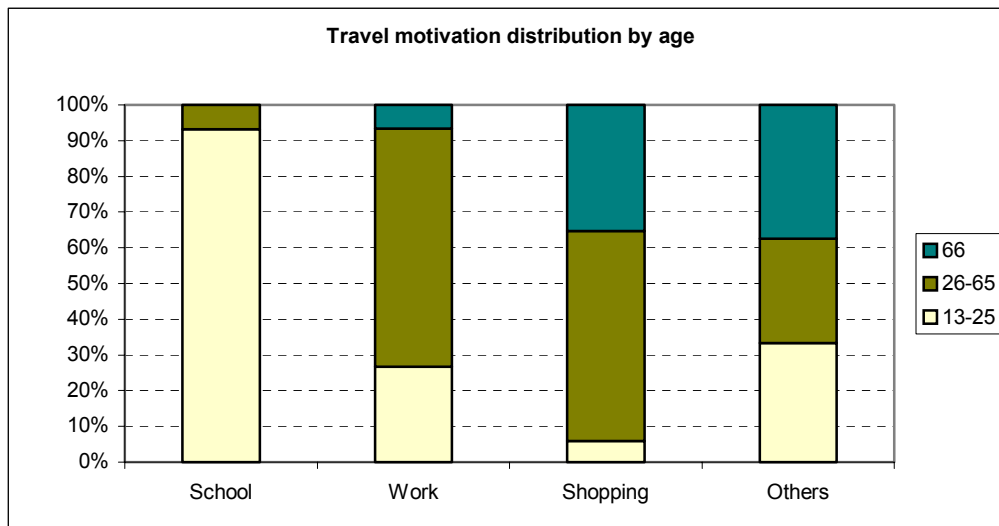


Figure 10 – Trip purpose by age groups (Aveiro – November 2001)

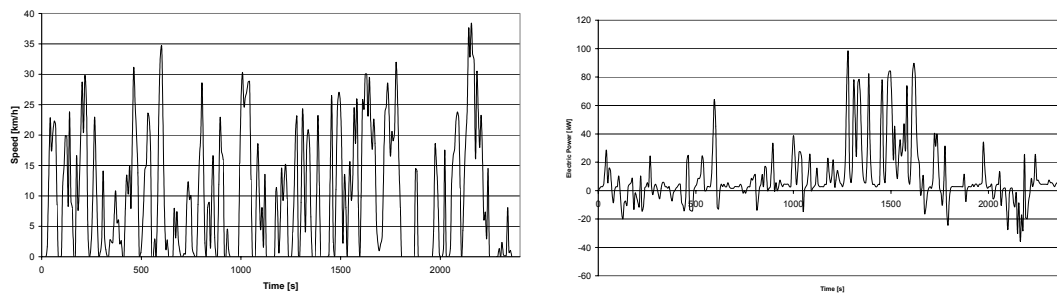


Figure 11 – Speed evolution and consumed electric power - Oreos 55 H (Lisbon - November 2001)

### 6. Phase 2 – Year 2002/3

In June 2002, the two electric mini-buses Gulliver from Tecnobus arrived in Portugal. After an official reception at Coimbra, the electric buses were the major attraction of an environmental dedicated exposition “Portugal Ambiente 2002”, at the Oporto international fair centre. One of the buses was exposed at the APVE stand and the other was the exposition shuttle. A reasonable media impact was achieved with this participation.



Figure 12 – The two buses arrival and participation as an exposition shuttle

The demonstration programs are illustrated in Figure 13. Originally, the program was to be concluded by end of 2002, with 6 cities. Due to the success of the demonstration action and requests from other cities pending, the program was extended until the end of 2003, with another 9 cities to be tested.

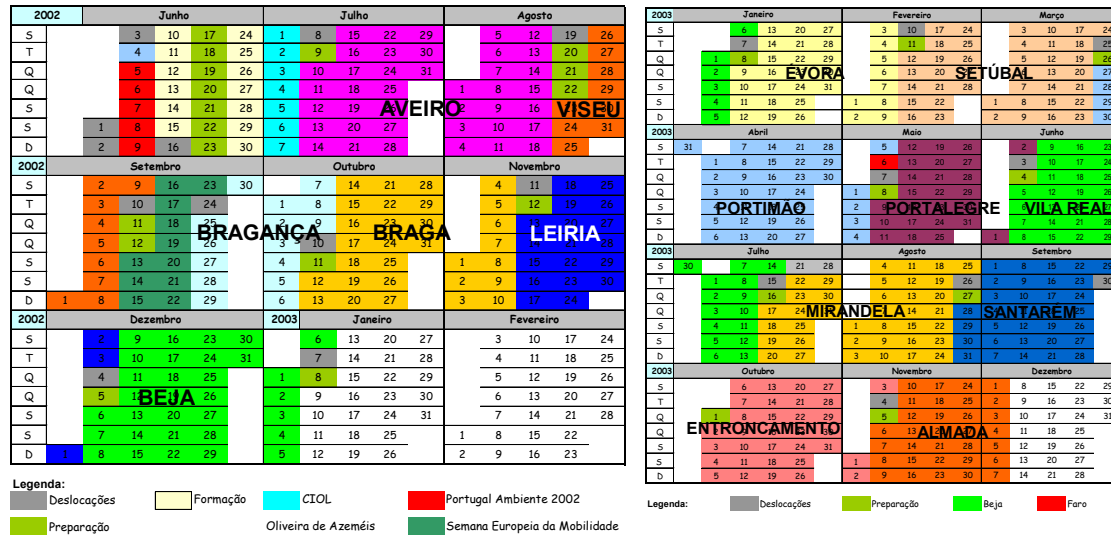


Figure 13 – Demonstration program 2001 + 2002

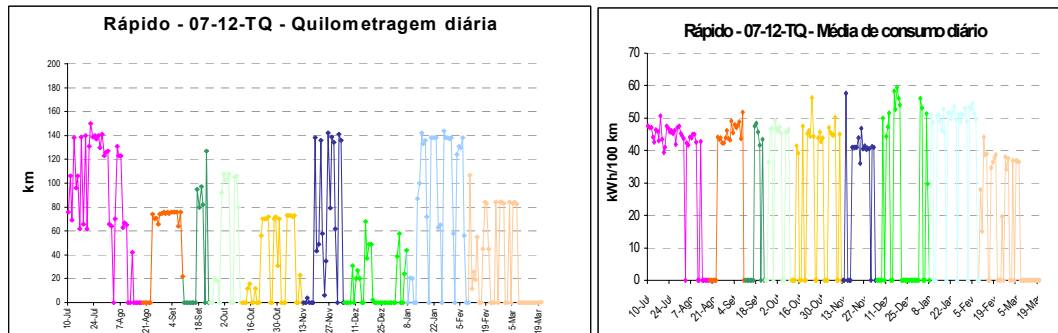


Figure 14 – Medium distance traveled and consumed electric power by the GULLIVER (8 cities)

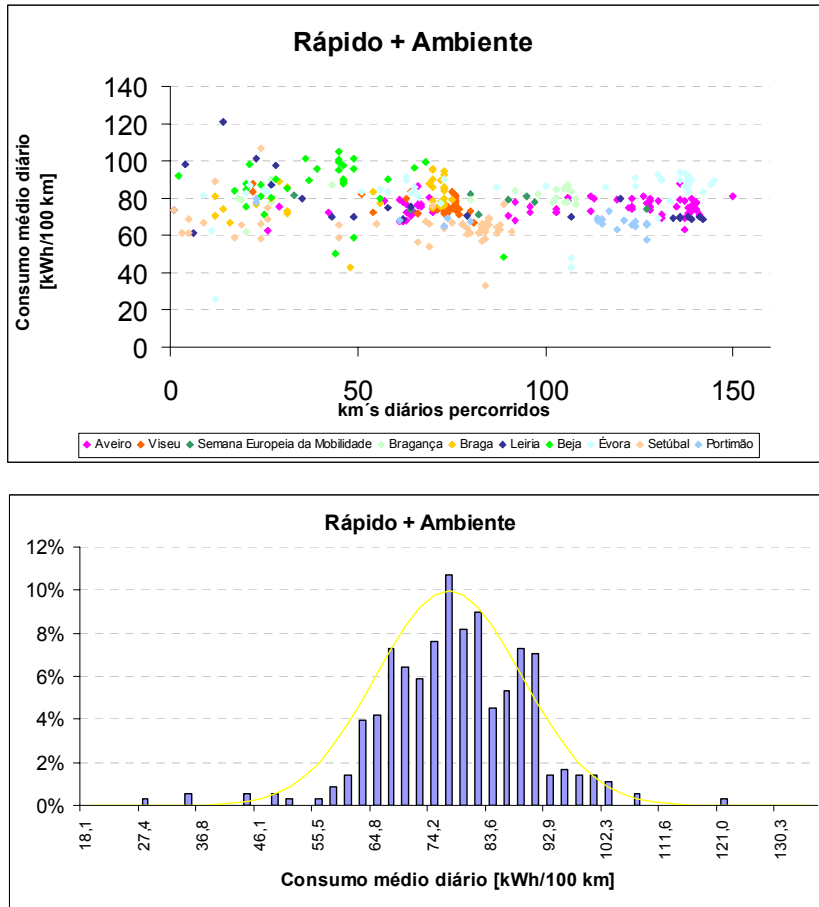


Figure 15 – Average daily consumption (kWh/100 km) and service length (km/Day) for the 2 Gulliver busses – 8 cities

<b>AVERAGE ELECTRICITY CONSUMPTION</b> 66,1 kWh / 100 km	<b>AVERAGE DIESEL EQUIVALENT CONSUMPTION</b> 20 l / 100 km
<b>4,36 € / 100 km</b>	<b>14,8 € / 100 km</b>
BI HOUR TARIFF 4/2003 (DAY/NIGHT 1/3+2/3)	0,74 €/LITRE
<b>AT ROAD SITE</b>	
<b>ZERO g CO<sub>2</sub> eq / km</b>	<b>525 g CO<sub>2</sub> eq / km</b>
<b>AT PRODUCTION SITE</b>	
<b>341 g CO<sub>2</sub> eq / km</b>	
ENERGY PRODUCTION mix 2000	
<b>323 g CO<sub>2</sub> eq / km</b>	
KYOTO ACTION PLAN FORECAST ELECTRICITY PRODUCTION 2005	
<b>284 g CO<sub>2</sub> eq / km</b>	
KYOTO ACTION PLAN FORECAST ELECTRICITY PRODUCTION 2010	

Figure 16 - CONSUMPTION COST AND CO<sub>2</sub> COMPARISON ELECTRIC - DIESEL

## **7. Conclusion**

The demonstration action “Introduction of Electric Buses in Public Transportation Fleets” has been active for the last 19 months. Aimed to demonstrate the capability of using electric buses on urban centre lines and to test the available vehicles and their market in Portugal, allows already to perspective their potentialities at short-term.

After a initial stage of experience with a leased Gulliver and Oreos 55 bus, both in hybrid version, the two electric mini-buses acquired for the second phase visited already 9 cities and were present at 4 events, including the European Mobility Week 2002. Results are very satisfactory. One city - Coimbra - has already ordered three electric buses (Technobus - Gulliver) in order to explore a new urban line, from July 2002. Estimates allow for concluding that the potential medium term market for electric buses in Portugal may account for some 50 units.

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.

## **8. References**

1. APVE, *Demonstração de Autocarros Electricos Amigos do Ambiente Urbano* (in Portuguese), Report from the action “Introduction of Electric Buses in Public Transportation Fleets”, phase 1, February 2002.
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3. J. Esteves, F. Vale, N. Teixeira, I. Santos, P. Matos, T. Farias, R. Stüssi (2002), “*Hybrid Electric Buses: Dimensioning the Intermediate Electric Storage Stage*”, **Proceedings of “Electrimacs 2002, 7th International Conference on Modelling and Simulation of Electric Machines, Converters and Systems”, Montreal, Canada, August 2002.**

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**APPENDIX**

**CONTENTS OF PRESENTATION**

**GULLIVER: WHAT IS IT?**

MANUFACTURING  
SIZE  
CHARACTERISTICS  
PERFORMANCES AND CONSUMPTION  
NEW MODEL

**GULLIVER: WHAT COUNTRIES?**

**PREFERABLE LINES FOR MINI BUSES**

SHORT LINES (4 to 6 km)  
PREFERABLY CIRCULAR LINES  
SHORT INTERVALS (8 to 12 min)  
HYPER CENTRE / PEDESTRIAN AREAS

**PORTUGAL - WHO DOES IT ?**

GULLIVER's ARRIVAL  
1st NATIONAL CIRCUIT OF ELECTRIC VEHICLES  
22nd of SEPTEMBER  
MOBILITY WEEK September 2002 - AVEIRO

**2002**

ARRIVAL OF THE 2 GULLIVER  
PRESENTATION IN COIMBRA  
ENVIRONMENT FAIR - EXPORTE  
ELECTRIC CAR MUSEUM  
DEMONSTRATIONS PROGRAMME  
ORGANIZATION

**PREPARING A DEMONSTRATION**

TRANSPORTATION BETWEEN CITIES  
DRIVING  
RECHARGING AND CHANGING BATTERIES

**DISSEMINATING THE CIRCUIT**

BUS STOPS  
TICKETING  
INFORMATION  
IMAGE  
AWARENESS  
LAUNCHING

**MONITORING**

CONTROL REGISTERS  
SURVEYS TO THE INVOLVED ACTORS  
SURVEYS TO THE PASSENGERS  
OPINION ABOUT THE VEHICLE  
OPINION ABOUT ALTERNATIVES  
TRAVELLING HABITS  
BUS PERFORMANCE