

**CiViTAS**  
Cleaner and better transport in cities

**MIMOSA**

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## Measure Evaluation Results

### FUN 1.1 Sustainable Fleet

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## Executive Summary

The measure 'Sustainable Fleet' aimed to develop a strategy to reduce emissions from the public transport fleet and to promote the use of more efficient vehicles in Funchal. The public transport operator, Horários do Funchal (HF), developed a strategy to renew the public transport (PT) fleet and worked in close cooperation with the municipality of Funchal to promote electric/hybrid vehicles.

The challenging circumstances of this measure have required major changes during the process which implied that the initially expected effects of the measure could not be achieved in the MIMOSA project period. Indeed, the renewal of PT fleet with electric/hybrid vehicles required heavy financial investments and the low availability of financial resources in light of the financial crisis made it necessary to shift the overall strategy of the measure from a planned implementation of an innovative PT technology to the implementation of innovative PT service by mini buses in areas of the city which were not easily accessible before.

Therefore the measure was implemented in the following stages:

**Stage 1: European Regional Development Fund (ERDF) application to purchase buses (2008)** In order to renew the PT vehicles fleet, HF submitted an application in the frame of the ERDF project for the acquisition of 40 diesel standard buses. Due to political choices to give priority to health issues and infrastructure development prior to mobility improvements, the application was not accepted which led HF to review the strategy for fleet renewal.

**Stage 2: Launch of the information campaign and purchase of hybrid private vehicles (2009-2011)** To promote the marketing of clean vehicles among private car users, a 50% discount on parking meters in the city were given to electric/hybrid vehicles owners (see also FUN 1.2 'Electric and Hybrid Vehicles'). Additionally, three hybrid vehicles were purchased by HF in 2009 and one by the municipality of Funchal in 2011 made available for PT operator and Municipality employees and used to demonstrate the real advantages of the hybrid technology to citizens. Furthermore, workshops were held to raise awareness and acceptance of companies which use a large vehicle fleet to stimulate a future shift towards cleaner vehicles.

**Stage 3: Reorientation of the fleet renewal towards more efficient mini-buses (2010-2011)** Following the rejection of the application to ERDF in the stage 1 of the measure, HF endorsed a new strategy with the aim of buying three electric/hybrid standard buses and four electric/hybrid mini buses and five mini diesel buses (EURO V Technology) in the frame of an international tender process. During the tender process, it had been identified that currently available electric/hybrid vehicles did not provide the appropriate technology for the context of Funchal due to its several steep and narrow streets. Therefore HF decided to focus on developing an innovative service with the aim of offering a specific PT service in less accessible areas of the city.

**Stage 4: Research and development (2010-2012)** The entire Madeira archipelago faced several challenges such as logistic issues, fuel supply and maintenance over-costs, low vehicle lifetime and tourist activities which make the development of energy efficiency transportation systems highly complex. Therefore in-depth studies were conducted by external consultancy companies: TIS.pt and AREAM. TIS.pt aimed at defining the specific scope for the privatization of Funchal public transport system to determine an economic

strategy which enhances sustainable mobility for the entire Madeira region. AREAM developed feasibility studies of alternative fuels use and analysed potential added value of mini buses in the PT network of Funchal to prepare a realistic fleet renewal plan tailored to Funchal needs and specific characteristics.

In addition to the focus on process evaluation, the impact evaluation focused on revealing an impact on emission levels of the PT fleet and on the users' perception of the quality of the implemented service. Additional to the impact and process evaluations, a Cost-Benefit Analysis was conducted since a large number of citizens were expected to be reached by this measure through the renewal of PT fleet.

**The key-results of the impact evaluation** showed that the introduction of additional mini-buses is an efficient way to improve sustainable mobility in Funchal. Several **positive environmental impacts** were observed. By introducing the five mini buses in the PT network the average fuel consumption for the entire PT fleet was reduced by 1,2% and the pollutant emissions caused by traffic decreased by 1,2% in CO<sub>2</sub>, by 21,8% in PM<sub>10</sub> and by 10,6% in NO<sub>x</sub> between 2008 and 2011. However, within MIMOSA pollutant emissions decreased by 14% in CO<sub>2</sub> and by 26.3% in NO<sub>x</sub> considering the HF cars and, considering the Municipality cars emissions reduction of 12% in PM<sub>10</sub> and of 22% in NO<sub>x</sub> were measured. In fact, the comparison between the average emissions given out by a standard car and a hybrid showed that the new hybrid passenger cars are almost emissions free, especially in NO<sub>x</sub> emission which are reduced by 99% compared to standard car emissions. Furthermore, the fuel consumption of a hybrid car of the Municipality is 23% lower than the average consumption of all other standard cars of the Municipality. It is important to mention that these results should be carefully interpreted. Indeed, fuel cost was measured per 100 km rather than per passenger transported or per unit which does not provide a fair comparison given the change in vehicle size.

**Regarding impacts on the society**, the number of PT vehicles suitable for persons with reduced mobility increased by 20%. The satisfaction rate, measured through a perceived comfort scale from 1 to 10, has risen 2.5 percentage points among PT users that travel by mini-buses against a do-nothing scenario in which PT users ride standard buses. In 2011, 83% of the population surveyed considered the renewal of Municipality cars as useful or very useful, while 81% estimated investment in renewal of PT fleet by the PT Operator and the Municipality as an action to be taken. Travelling by mini-buses was regarded by the PT users as more comfortable than by standard buses (8.3 in a range of 1 to 10, which means an increase of 2.5 percentage points compared to standard buses). **Regarding economic perspective**, sustainable fleet can also be an incentive to change managers' beliefs with regard to fleet renewal that is often envisaged as a burden and pure investment. Cost-benefit analyses carried out in the frame of this measure have shown that an investment in buying a large fleet of 18 mini-buses can create a positive Net Present Value of 19.549.693€ (in 2008 costs) within a 10-year lifespan.

**The major barrier** encountered during the process was the current lack of appropriate technology in clean PT vehicles to overcome the rough topography of the island of Madeira and the city of Funchal. Additionally, the low availability of alternative clean energy resources on the island makes the use of clean vehicles difficult.

Despite several challenges faced during the studies, the outputs of the analysis and research constitute **significant drivers** which enable context-oriented decision making and efficient changes in the PT strategy.

**The main recommendation** coming out of the Funchal experience is to be aware of the heavy financial investment that a PT fleet renewal implies and to consider such an initiative with a long-term perspective in a step by step process. In Funchal, the MIMOSA project offered a crucial opportunity to elaborate a context-oriented PT strategy and to implement a pilot project on a limited scale as a first step towards a further sustainable PT system. Nevertheless, the combination between technical work development (supporting by MIMOSA project) and additional financial investment (co-funded by ERDF) appeared to be a key-factor for a successful implementation. It is therefore recommended to combine diverse financial sources to ensure the feasibility of the implementation. However, the **MIMOSA team learnt** during the process that it is essential to be continuously aware of the difficulties encountered and able to react in time to adapt strategies during the process.

One of the most significant successes of the measure was the award received from the European Regional Policy in 2011 which recognized Funchal as *City Star* for its Sustainable Fleet Strategy. Thus this MIMOSA measure was an important stepping stone towards further enhancement of the PT fleet in Funchal.

## A Introduction

### A1 Objectives

The measure objectives are:

(A) High level / longer term:

- To achieve meaningful reductions in transport related emissions
- Increase energy efficiency of urban transport systems

(B) Strategic level:

- To establish an alternative fuel and clean vehicle fleet strategy. The renewal of public and private fleets is expected to raise public awareness of greener technologies;
- Study the fleet performance with regard to economic, environment and energy indicators.

(C) Measure level:

The following measure objectives will contribute towards establishing an alternative fuel and clean vehicle fleet strategy, in order to:

- (1) Promote the use of alternative fuels and clean energy efficient vehicles;
- (2) Demonstrate the advantages of the use of more sustainable technologies in the municipality area;
- (3) Improve the “green” image of PT;
- (4) Increase local market share of clean vehicles and alternative fuels;
- (5) Increase accessibility to public transport

### A2 Description

Horários do Funchal (HF), the urban Public Transport provider, did not have a structured and well-defined strategy and long-term policy for the future concerning fleet management.

To meet the objectives of the measure, the local Public transport operator HF established, together with AREAM, the regional agency for energy and environment, an alternative fuel and clean fleet strategy as the first step in an integrated strategy for public and private fleet renewal. This study helped the decision-making process regarding investments in the public transport fleet using a cost/benefit analysis of different fleet scenarios to define the best selection based on an integration of technologies, energy sources, and transport needs.

An application to the European Regional Development Fund to renew 40 buses was rejected. The PT Operator then in 2010 launched an international tender process (again in the frame of assumed ERDF approval) to purchase cutting-edge buses to deploy within the framework of specific CIVITAS measures, namely Park and Ride, Dial and Ride and Green Line. However, the proposals for hybrid/electric buses (3 standard buses and 4 mini buses) didn't meet the technical requirements. Only 5 mini diesel buses were purchased in this tender process.

To cope with this barrier, the PT Operator modified the objective, the aim was now to provide an innovative service (smaller buses to less accessible areas), rather than innovative technology (hybrid/electric). Consequently it is planned to launch a new ERDF application to buy 13 more mini buses (Euro V, at least) to operate during non peak hours and on routes

with less demand and with the ability to transport wheelchairs so that special services can be provided (the mobility-impaired citizens service, for example). The 5 new buses already bought will provide a control group to assess the impact the measure has had in Funchal with the intention of evaluating the energy and emission performance of the new vehicles.

As an ultra-peripheral region, Madeira faces a set of constraints, such as logistic, fuel and maintenance cost over -runs, reduced vehicle lifetime, tourist pressure upon the territory, among others. With this in mind, additional studies defined, measured and evaluated the industrial cost over-runs and studied the economic sustainability of the sector in the Island. This work was carried out by a consultancy named TIS.pt.

In addition to the above, the measure has helped to define the contractual terms for the future privatization of urban public transport in Funchal.

These complementary studies aid the collection of data necessary for conducting proper evaluation, namely undertaking research regarding the feasibility of alternative fuels and helping to determine the added value that a mini fleet can bring to a public transport network as complex as the one that features in Funchal.

This measure has also contributed towards promoting clean vehicles, bringing technologies with added environmental and energy value to public attention. To incentivise the use of these vehicles, the Municipality (CMF) approved, in 2009, a 50% discount at parking meters for electric/hybrid vehicle users, and also HF purchased 3 hybrid cars in 2009 and CMF purchased 1 hybrid car in 2010. Following this approval, changes were made to the municipal parking regulation and taxes for these types of vehicles. This 50% discount will be fully evaluated by FUN 1.2 (Electric and Hybrid Vehicles), whilst the number of vehicles circulating in the Region will be subject to evaluation within this measure as a bundled indicator.

All in all, evaluation will have a strong focus on the 5 mini buses and 4 hybrid cars purchased (3 HF and one Municipality).

## B Measure Implementation

### B1 Innovative Aspects

**Targeting specific user groups, nationally** – This measure brings technologies with environmental and energy added value to the public attention, namely corporate managers from institutions with large fleets, to shift the share of green vehicles circulating in the Region.

**Use of new technology, regionally** – This measure contributes towards promoting greener vehicles, through demonstration activities such as the workshop on hybrid vehicles and the purchasing of hybrid cars by the municipality and PT operator.

**New conceptual approach, regionally** – This measure aims to introduce in Madeira, a regional outermost market, the first integrated strategy for public and private fleet renewal in order to improve the share of alternative fuels and more transport related environmental friendly technologies on the island.

**New conceptual approach to public tendering, internationally** – In the scope of this measure, innovative technical requirements were developed. The steering team has thoroughly investigated altimetry curves to ensure that the buses included in the tender process suit the rough local terrain. For instance it was discovered that the power of electric batteries fade away quite easily in the local context.

### B2 Research and Technology Development

The most important research activities carried out within the framework of this Sustainable Fleet measure comprised the fleet renewal study for both buses and passenger vehicles and the costs over-run study.

HF has studied the most environmentally friendly technologies for private vehicles and for the public bus fleet. Thus the study contributes to the preparation for the increasing shortage in fossil energy supply.

#### B2.1 Fleet Renewal

##### Strategic public fleet renewal

Before CIVITAS, the use of alternative fuels and clean vehicles could hardly be considered a sound choice for PT Operators on Madeira Island. HF had only 4 mini electric buses which started operating in 2006 in the city centre, on a so called Eco Line. People and companies did not have a grasp on the advantages and, above all, on the feasibility of these kinds of technologies in regional areas and on an urban network.

To prepare the tender process for 3 electric/hybrid buses, 4 electric/hybrid mini buses and 5 mini diesel buses, in 2009, HF had to study the specific technical requirements, taking the Funchal conditions (narrow streets, many intersections, high number of stops) into account.

The results emerging from the analysis of these proposals by engineers did not favour the purchase of electric or hybrid buses: the lifetime of such technology in Funchal would be much lower and the maintenance costs for repairing would be higher than on the mainland.

##### Renewal of passenger car vehicles

Regarding passenger car, HF developed a study prior to the purchase of the vehicles to better understand the advantages and the disadvantages of deploying hybrid vehicles.

The main advantages encountered were:

- *Regenerative braking*: the electric motor provides a resistance to movement of traction, causing a small decrease in speed. When the flow of energy is in the direction of the wheels to the engine, as during descent or braking, the motor acts as generator providing electricity to the batteries, instead of the energy being wasted. Thus, when turning the vehicle or going downhill, the wheels begin to power the electric motor, which functions as a generator providing electricity to the batteries.
- *Automatic stop*: Some vehicles have a hybrid system that automatically turns off when the vehicle is idling, switching on automatically when the accelerator is pressed or the gear is changed.
- *Assistance to the traction electric motor*: when the engine is under stress due to acceleration, overtaking, or a steep climb, the electric motor provides additional power to the internal combustion engine.

The main disadvantages were:

- *Complex mechanical system*, which requires experienced mechanics;
- *Short battery life and high cost of replacement*.

It was important to note that the studies demonstrated that hybrid vehicles can produce up to 34% less CO<sub>2</sub> emissions than a standard vehicle, and a reduction of 35% in fuel consumption.

## B2.2 Study about extra transport costs

The study was a dedicated overview of the urban and regional dimension of extra transport costs, taking as basis a benchmarking exercise on transport costs.

The main objective of the study was to identify the extra costs that operators located in Madeira would be subject to as a result of the location, the so-called *costs of the ultraperiphericity*. Those costs integrate all additional costs that regional operators have to face when compared with operators providing public transport in more central locations. Results of the present study should serve as support to a new strategic planning of public transport in the region, including the reason to include urban and regional public transport in the context of specific funding lines to compensate costs of outermost island regions (ultra-peripheral regions).

This extra cost is present in all the regional operators, though particularly felt by Horários do Funchal, and can be estimated for the 2007-2010 period as 6 million euro for HF (and almost 2 million euro for the set of other regional operators).

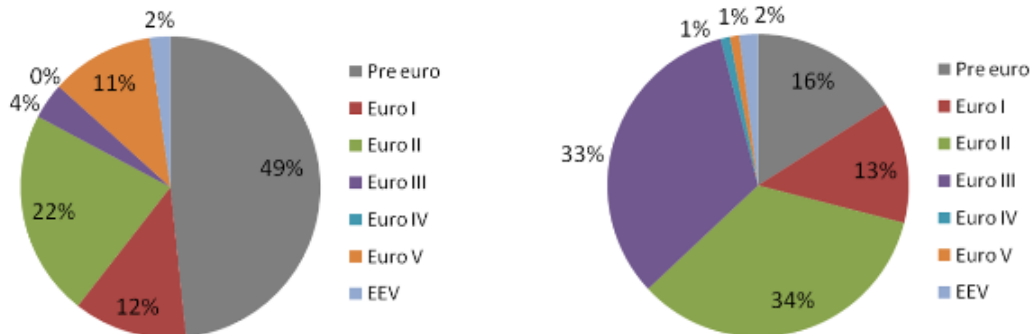
## B3 Situation before CIVITAS

Due to the rugged topography and road network attributes, the bus engines in Funchal emitted high levels of pollution and noise, and incurred high maintenance costs. Due to implicit extra costs and the shortfall of credit for investments, the lifetime of the vehicles had to be expanded more than what would be the ideal lifetime of the vehicles (average age in 2008: 14,5 years). Taking into account that Madeira is set apart from the main land, there are great problems related with the fleet maintenance and stock management, which puts pressure on management to guarantee the schedule and the levels of public transport service provided.



In 2008, the fleet was composed of 180 buses (all of which were regular sized buses) with the following type of technologies:

**Graph B.3.1** *Type of technologies*



In Funchal, the use of alternative fuels and of clean and energy efficient vehicles is very unusual, being restricted to the rare cases of private vehicles adapted to the use of LPG and to electric vehicles at golf courses. Also, in 2006, the HF PT operator started a new urban line in the city centre with mini electric buses.

Horários do Funchal did not have a coherent strategy to reduce transport-related emissions and also needed to redefine the fleet towards the new national framework to guarantee a cost-effective and sustainable public transport service.

Portugal is focused on reducing CO2 emissions and limiting the use of fossil fuels, introducing lower taxes for less pollutant vehicles. The National strategy to promote hybrid and electric vehicles in private fleets foresees a tax reduction of 50% when compared with the tax values for normal standard vehicles. (Law 22-A/2007). Also the recently published National Plan for energy efficiency aims to introduce mini and midi buses to reinforce the public transport fleet, so as to make them more energy efficient. The aim is to have, by 2015, at least 15% of the public transport fleet in Portugal provided by mini or midi buses.

## B4 Actual Implementation of the Measure

The operation phase of Sustainable Fleet is different depending on the type of vehicle. For passenger vehicles the operation phase started in June 2009 whereas the operation phase of the buses began in February 2011.

This measure was implemented in the following stages:

**Stage 1: ERDF application to purchase 40 buses was not accepted (2008)** – The ERDF project was instrumental to support a major fleet renewal of HF. Due to its cancellation the measure goals had to be downsized.

**Stage 2: Launch of the communication stage and purchase of the first private vehicles (2009) -**

Workshops were held to raise the motivation of the stakeholders, mainly managers of companies that operate big fleets, in order to motivate them to purchase greener vehicles, by demonstrating good practices. To incentivise the use of these vehicles, CMF approved a 50% discount at parking meters for electric/hybrid vehicles users. The PT

**Picture B4.1** *Hybrid vehicles at HF headquarter*



Operator purchased three hybrid passenger cars to test and demonstrate the real advantages of the hybrid technology.

### Stage 3: Reorientation of the fleet renewal towards more efficient mini-buses (2010-2011)

– In October 2009, the PT Operator launched the international tender process to buy electric/hybrid buses and mini diesel buses, essential to operate the Green Line (FUN 2.1), Park and Ride (FUN 2.4) and Dial and Ride (FUN 2.2) measures. The proposals for the international tender process to purchase non-diesel vehicles for use in specific CIVITAS measures) didn't meet the technical requirements. To cope with this barrier, the PT Operator modified the focus to an innovative service, rather than innovative technology, and launched a new ERDF application to buy 13 more mini buses (Euro V, at least) able to operate during off peak hours and on routes with less demand. In February 2011, the PT operator received the 5 mini buses.

Picture B4.2. 5 New mini buses



**Stage 4: Purchase of one hybrid car by the municipality (2011)** – The Municipality purchased a new version of the Toyota Prius, to compare the performance with the HF hybrid cars. The main characteristics of the hybrid vehicles bought are outlined below.

Picture B4.3. New hybrid Prius at the European Mobility Week



Table B.1.1. Hybrid vehicles main characteristics (from the manufacturer)

	Honda Insight	Toyota Prius (2011)	Toyota Prius (2012)
<b>Gross vehicle weight (kg)</b>	1.650	1.725	1.805
<b>CC (cc)</b>	1.339	1.497	1.798
<b>CO2 - combined [g/km]</b>	105	104	92
<b>Horse Power</b>	95	76	136
<b>Consumption (combined)</b>	4.1	4.0	4.1

**Stage 5: Subcontracting to the definition, access and proposal of solutions regarding extra transport costs in Madeira (2011-2012)** - This is both an essential and strategic piece of work to cope with on-going ultra-peripheral constraints. The work came to an end in May 2012 and its outputs matter in terms of developing models to finance public transport in deprived and outermost regions.

## B5 Inter-Relationships with Other Measures

At project level, this measure was close related to:

- **Measure FUN 2.2 Control System for Dial and Ride Service** – The buses used for the Dial&Ride service were purchased under measure 1.1. Because they are mini-sized buses, circulation in very narrow and steep streets are allowed.
- **Measure FUN 2.4 Park and Ride with PT School Service** – The buses used in the school service were purchased under measure 1.1. Buses provided the connection between the parking facilities and the schools.
- **Measure FUN 1.2 Electric and Hybrid Vehicles and measure FUN 4.1 Awareness Raising Campaign for Sustainable Mobility** – These measures jointly aim to promote the use of more sustainable vehicles among locals and regional companies. Within measure 1.2, the Municipality implemented a green tariff that is a discount for hybrid vehicles in the city centre car parks. During mobility week (2011) the municipality promoted the use of hybrid vehicles as part of measure 4.1.
- **Measure FUN 6.1 Eco Driving training** – The improvement of the professional drivers' attitudes will necessarily influence the fleet's performances in terms of the reduction of total fuel consumption.

## C Impact Evaluation Findings

### C1 Measurement Methodology

#### C1.1 Impacts and Indicators

The evaluation tasks for the Sustainable Fleet measure will include assessing a wide range of impacts, as is shown below, covering four out of the five MAESTRO headings and showing how to collect information, who collects it and when:

**Table C1.1:** Specific impact indicators related to the Sustainable Fleet measure

Evaluation category	Evaluation sub-category	Impact	Indicator	Description and Source of data	Success quantification	Baseline	After Data collection
Economy	Costs	Maintenance costs	1 - Maintenance costs for fleets (including labour costs and material) (City specific indicator)	<b>Data unit:</b> €/100Km, quantitative, measurements, annual series. <b>Source:</b> HF for buses and PT cars; CMF for CMF cars.	Reduce maintenance cost by at least 5%	2008	2011
		Fuel costs	2 - Fuel costs for fleets (City specific indicator)	<b>Data unit:</b> €/100Km, quantitative, measurements, annual series. <b>Source:</b> HF for buses and PT cars; CMF for CMF cars.	Reduce fuel costs by at least 2%	2008	2011
Energy	Energy Consumption	Fuel Consumption	3 - Fuel consumption for fleets (POINTER core indicator 4)	<b>Data unit:</b> L/100Km, quantitative, measurements, annual series. <b>Source:</b> HF for buses and PT cars; CMF for CMF cars.	Reduce fuel consumption by at least 5%	2008	2011
Environment	Pollution/ Nuisance	Emissions	4 - CO2 emission of fleets (POINTER core indicator 8)	<b>Data unit:</b> G/100km, quantitative, estimated from COPERT, derived, annual series. <b>Source:</b> Data for buses was provided by a subcontracting entity (AREAM); data for cars was provided by a CMF and HF	Reduce emissions by 2%	2008	2011
			5 - PM 10 emissions of fleets (POINTER core indicator 11)				
			6 - NOx emissions of fleets (POINTER core indicator 6)				

Evaluation category	Evaluation sub-category	Impact	Indicator	Description and Source of data	Success quantification	Baseline	After Data collection
Transport	Quality of Service	PT quality of service	7 - PT quality of service (POINTER core indicator 19)	<b>Data unit:</b> Index, qualitative, collected, survey <b>Source:</b> PT Operator and Municipality outsource this task to OCCAM	Comfort of new buses should be perceived as better by at least 5%	March, 2010	February, 2012
			8 – Acceptance level of fleet renewal (City specific indicator)	<b>Data unit:</b> Index, qualitative, collected, survey <b>Source:</b> PT Operator and Municipality collected this data in Expo Madeira exhibition	Increase the perception of usefulness of fleet renewal investments by at least 2%	July, 2010	July, 2011
	Transport System	Regional purchase of electrical/hybrid vehicles	9 - Number of electric/hybrid vehicles purchased in the region (Bundled indicator with FUN 1.2) (City specific indicator)	<b>Data unit:</b> No., quantitative, collected in annual series. <b>Source:</b> Toyota and Honda, the only Regional Company selling hybrid cars, will give information on the regional sales of their hybrid vehicles	Boost green technologies, improving the number of electric/hybrid vehicles sold (by at least 50%)	2008	2011
	Accessibility	Inclusion of mobility impaired users	10 - Number of buses able to transport wheelchairs (City specific indicator)	<b>Data unit:</b> No., quantitative, collected in annual series. <b>Source:</b> PT operator was responsible for collecting this data.	Increase the number of buses able to transport wheelchairs by at least 10%	2008	2011

### **Detailed description of the indicator methodologies:**

**1 - Maintenance costs for fleets:** Buses: This indicator was collected by the PT operator maintenance department; it addresses labour costs and materials. The subcontractor defined calculations for the year 2011. Cars: This indicator for HF and for CMF was collected by the maintenance departments. It addresses labour costs and materials. **This indicator corresponds to specific objective 2.**

**2 - Fuel costs for fleets:** Buses: This indicator was collected by the PT operator maintenance department; it addresses labour costs and materials. The subcontractor defined estimation for the years 2011 and 2013. Cars: This indicator for HF and for CMF is collected by the maintenance departments. **This indicator corresponds to specific objective 2.**

**3 - Fuel consumption of fleets:** Buses: This indicator was collected by the PT operator maintenance department; it addresses fuel consumption measured in litres. The subcontractor calculates figures for the year 2011, considering all the buses that operate on regular PT lines (nearly 180

buses). Cars: This indicator addresses both HF and CMF and is collected by the maintenance departments of each institution. It considers all the passenger cars used by these institutions for administrative purposes. **This indicator corresponds to specific objective 2.**

**4 - CO2 emission in fleets:** This indicator, for buses and cars, was calculated with the support of the subcontractors and the use of COPERT, considering the fleet characteristics and the fuel consumption. **This indicator corresponds to specific objective 1.**

**5 – PM10 emission levels in fleets:** This indicator, for buses and cars, was calculated with the support of the subcontractors and the use of COPERT, considering the fleet characteristics and the fuel consumption. **This indicator corresponds to specific objective 1.**

**6 - NOx emission levels in fleets:** This indicator, for buses and cars, was calculated with the support of the subcontractors and the use of COPERT, considering the fleet characteristics and the fuel consumption. **This indicator corresponds to specific objective 1.**

**7 - PT quality of service:** This indicator results from PT users answers regarding comfort on buses. In 2010 the survey was conducted as part of a motivational study among a sample of PT users developed within the Ad Personam project (co-founded by Energy Cités) with a sample of 1.254 PT users. Whereas in 2012 data was gathered from a survey conducted by OCCAM (a private consultancy hired to handle environment and energy evaluation) with a sample of 105 PT users, of which 84 were boarding standard buses and other 21 boarding new mini buses. The question was “Using a range between 1 to 10, 1 being “very unsatisfied” and 10 being “very satisfied”, rate your satisfaction with the comfort on these buses”. **This indicator corresponds to specific objective 3.** Sample sizes vary a lot because in 2010 the survey was undertaken to analyse a wide range of variables whereas the study in 2012 was more focused on analysing the quality of PT service. Nonetheless, representativeness of PT users was obtained in all surveys conducted.

**8 – Acceptance level of fleet renewal:** This indicator is measured through specific surveys conducted during a relevant event at which CIVITAS-MIMOSA was promoted, Expo Madeira, both in 2010 with a sample of 792 and in 2011 with a sample of 810. People were asked: “Do you think that is useful that the PT operator purchase hybrid cars?”; “Do you think that PT operator fleet renewal is useful?”. **This indicator corresponds to specific objective 2.**

**9 - Number of electric/hybrid vehicles purchased in the region:** This indicator corresponds to the sales of hybrid cars in Madeira directly collected by the hybrid cars sellers. **This indicator corresponds to specific objective 4.**

**10 - Number of buses able to transport wheelchairs:** Data for this indicator was internally collected by the maintenance department of PT operator. **This indicator corresponds to specific objective 5.**

**List of potential effects that were not measured**

Funchal considers it very important to think about and discuss all possible effects a measure can have. For this reason a brainstorming session involving all agents involved in the implementation of the measures was held. This session resulted in the list presented below:

**Table C1.2:** List of potential effects that were not assessed

Impacts category	Effect	How does it impact	Why it was not assessed
Energy	Fuel per passenger transported on urban fleet	Mini buses consume less but also carry fewer passengers than regular size buses. This indicator would enable us to envisage if the new mini buses are more efficient than regular size ones.	Due to technical problems (mainly because buses can be assigned to many different routes within a day), it is not possible to assess fuel consumption per bus.
Environment	Air quality	Decreasing pollutant emissions and increasing air quality parameters is a high level objective of CIVITAS-MIMOSA.	This indicator could have been important to assess if the initial goal of purchasing 40 buses was maintained. Since the number of new buses is limited to 5 during the CIVITAS MIMOSA lifetime, these impacts are very small and were thus not calculated.
Social	Noise perception	New technology of the buses acquired may change noise perception among citizens and tourists, though impact should be low.	

## **C1.2 Establishing a Baseline**

The information regarding when and how the baseline was collected/measured is duly described above in table *Table C1.1*.

## **C1.3 Building the Business-As-Usual Scenario**

The calculation of indicators 1, 2, 3, 4, 5, 6 for the PT buses for the year 2011 was based on a thorough characterization study of the operating fleet and public transport services of Horários do Funchal, taking into consideration the energy, economic, social and environmental impacts conducted by AREAM and having as a reference scenario the year 2008. This is a result from a forecasting study about public transport in Funchal, with reference to new energy sources, technologies and strategic plan for fleet renewal of Horários do Funchal.

The calculation of indicators 1, 2, 3, 4, 5, 6 for PT and the CMF cars was based on the years 2007 and 2008, with the support of the subcontractor OCCAM. BAU figures are included only in the result part (section C2).

### **1 - Maintenance costs for fleets**

**PT buses:** The maintenance costs were calculated based on the indicators for the year 2008, considering the cost per 100 kilometres run by each vehicle, and for the following years applying the respective inflation rate, as announced by INE (Statistics Portugal), to draft a trend line until 2011. This methodology allows a rigorous calculation with regard to maintenance costs of vehicles to be scrapped, by directly subtracting the maintenance costs of vehicles selected for demolition.

**PT and CMF cars:** The maintenance costs were calculated based on the indicators for the year 2008, considering the cost per 100 kilometers run by each vehicle, and for the following years applying the respective inflation rate (5.5% a year).

### **2 - Fuel costs in fleets**

**PT buses:** The fuel costs were calculated based on the diesel prices between 2002 and 2010, from official information from the DGEG (Directorate General for Energy and Geology). A trend line for 2011 was drafted.

**PT and CMF cars:** The maintenance costs were calculated based on the indicators for the year 2008, considering the cost per 100 kilometers run by each vehicle, and for the following years applying the respective inflation rate (5.5%).

### **3 - Fuel consumption by fleets**

**PT buses:** The calculation of fuel consumption was defined for each type of bus, considering the size and Euro emission norms. From the Copert4 software version 7.1, consumption curves with three variables were carried out, namely: velocity, slope and occupancy rate. Given the rugged topography of the city of Funchal, there was still the need



to consider slopes greater than the 6% foreseen in Copert, hence the introduction of this term in the final equation. This methodology allowed us to obtain energy consumptions specific to each route, considering the various types of buses running on those routes as well as the particular characteristics of the bus routes, namely average speed, average slope and occupancy rate.

**PT and CMF cars:** For Business as Usual, the fuel consumption in 2011, was the same as in 2008.

#### **4 - CO2 emission in fleets**

**PT buses:** The CO2 emissions for diesel fuel were calculated from the value of carbon mass, reaching an indicator of CO2 emissions per liter of diesel consumed: 1 L Diesel = 0.002736 t CO2.

**PT and CMF cars:** For Business as Usual, the CO2 emissions in 2011 were the same as in 2008.

#### **5 - PM 10 emissions in fleets and 6 - NOx emissions in fleets**

**PT buses:** The calculation of NOx and PM 10 emissions was defined similarly to the calculation of the fuel consumption, having obtained, from Copert, emission curves for each pollutant agent, fuel consumption being the only variable.

**PT and CMF cars:** For Business as Usual, the PM10 and NOx emissions in 2011 was the same as in 2008.

#### **7 - PT quality of service**

For 2012, and for Business as Usual purposes, the perception of the comfort of the mini buses is the same as it is for the standard buses.

#### **8 – Acceptance level of fleet renewal**

The first data collection was due to begin after the measure had started (after the PT Operator had bought hybrid vehicles) so the Business as Usual scenario was not calculated.

#### **9 - Number of electric/hybrid vehicles purchased in the region**

Due to the lack of data for this indicator before the implementation of the measure, the Business as Usual scenario could not be calculated.

#### **10 - Number of buses able to transport wheelchairs**

Business as Usual assumes that the number of buses able to transport wheelchairs in 2011 is the same as in 2010 because if the PT operator does not have the financial support of FEDER, they won't purchase new buses.

## C2 Measure Results

The results are presented under sub headings corresponding to the areas used for indicators – economy, energy, environment, society and transport. To allow a better understanding and to present the analysis separated per each type of vehicle, the results for Economy, Energy and Environment are grouped together.

### C2.1 Economy, C2.2. Energy and C2.3 Environment

#### PT buses:

It is important to note that at the beginning of 2011, 5 mini buses were introduced into the urban fleet. The table below presents the indicators for the total urban fleet of Horários do Funchal (regular service and mobility impaired users service), so it is possible to see the effect of the introduction of 5 mini buses.

**Table C2.1.1** Indicators regarding PT buses

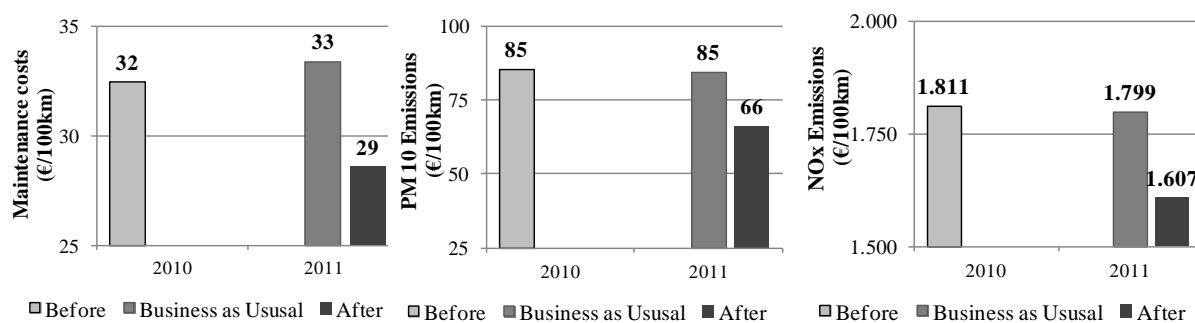
Indicator	Before 2010	B-a-U 2011	After 2011	Difference: After Before	Difference: - After - B-a-U	Difference: (%) After Before	Difference: (%) - After - B-a-U
1-Maintenance costs (€/100km)	32,4	33,4	28,6	-3,9	-3,9	-12,0%	-12,0%
2-Fuel costs (€/100km)	54,6	65,4	64,3	9,8	-1,1	17,9%	-1,6%
3-Fuel consumption (L/100km)	63,2	63,0	62,2	-1,0	-0,8	-1,5%	-1,2%
4-CO2 emissions (g/100km)	172.814	172.324	170.192	-2.622	-2.131	-1,5%	-1,2%
5-PM10 emissions (g/100km)	85,4	84,5	66,1	-19,4	-18,5	-22,7%	-21,8%
6-Nox emissions (g/100km)	1.811	1.799	1.607	-204	-191	-11,3%	-10,6%

Clearly, the maintenance costs, PM10 and NOx emissions are the indicators that have decreased the most, comparing the after and Business as Usual scenarios.

It is obvious that maintenance costs have decreased due to the introduction of new vehicles which are under guarantee. Fuel costs have decreased even though the fuel costs have risen sharply during the measure lifetime. The achievement of decreasing the average fuel consumption is partially a success of the measure but also has to be attributed to the overall change in the driver's attitude as a result of the implementation of Eco Driving training (FUN 6.1.).

Considering the forthcoming petrol shortages, and consequently the rise in fuel costs, in conjunction with the decrease of passengers in public transport service, these results are very important to maintain levels of service in the future, not cutting back trips. Reducing the service would only lead to an even larger decrease in the number of passengers transported and in the competitiveness of the public transport system.

The next graphs displays data related to the three indicators that decreased the most due to the implementation of this measure.

**Chart C2.1.2** Maintenance costs, PM10 emissions and NOX emissions per 100km

Results shown in graph C2.1.2 illustrate the extent to which this measure has contributed to the high level objectives of achieving meaningful reductions in transport-related emissions (indicator:PM10 and NOX emissions) and increasing energy efficiency on urban transport systems (indicator of maintenance costs). New buses often require less maintenance expenditure because they are under warranty, therefore following the introduction of mini buses, the maintenance costs were reduced by 12%. The goal of achieving fewer emissions from buses have been fully achieved, especially as far as PM10 is concerned as this pollutant registered roughly 22% fewer emissions than before MIMOSA, in part due to the introduction of mini and less pollutant buses.

The next table compares the performance of a mini bus and a standard bus in the year 2011, highlighting the benefits associated with the introduction of these mini buses into the local public transport system.

**Table C2.1.3** Difference between Mini and Standard vehicles

Indicator	Mini	Standard	Difference %
Maintenance costs (€/100km)	3	29	-90%
Fuel costs (€/100km)	29	66	-55%
Fuel consumption (L/100km)	28	63	-56%
CO2 emissions (g/100km)	76.276	173.629	-56%
PM10 emissions (g/100km)	13	68	-81%
Nox emissions (g/100km)	316	1654	-81%

When comparing a standard bus with a mini bus, it comes as no surprise that mini buses are more efficient considering the performance per kilometres. So these buses are more appropriate for routes with low demand (mainly in the East side of the city and on new innovative routes aiming to increase accessibility in steep areas, as in Dial&Ride – FUN 2.2). With these results, the PT Operator has found a suitable solution for non-profitable trips like these.

The biggest difference lies in the maintenance costs that could be also explained due to the fact that the mini buses are new and arguably less problematic in terms of maintenance

investments. But the above table also stresses significant differences with regard to pollutants that impact heavily on human health, such as PM10 and NOx for which values have decreased by 81%.

### **PT passenger cars:**

Horários do Funchal, the PT provider, also purchased some passenger cars for administrative tasks and to set an example for other companies and for citizens alike.

The next table shows the impact of introducing 3 new hybrid vehicles into the total Horários do Funchal car fleet, two Honda Insight and one Toyota Prius. It's important to note that in 2008, HF had 1 car powered by gasoline and 7 cars powered by diesel. In 2011, HF had 3 hybrid cars powered by gasoline and 6 cars powered by diesel.

**Table C2.1.4** Indicators regarding PT cars

Indicators	Before (2008)	BAU (2011)	After (2011)	Difference: After – Before	Difference: After – BAU	Difference (%): After – Before	Difference (%): After – BAU
1 - Maintenance costs (€/100km)	10,6	12,4	8,3	-2,2	-4,1	-21,0%	-28,7%
2 - Fuel costs (€/100km)	9,0	10,5	9,5	0,5	-1,1	5,3%	-5,0%
3 - Fuel consumption (L/100km)	8,4	8,4	8,5	0,0	0,0	0,2%	0,2%
4 - CO2 emissions (g/100km)	18.716	18.716	16.015	-2.701	-2.701	-14,4%	-14,4%
5 - PM10 emissions (g/100km)	4,8	4,8	4,0	-0,8	-0,8	-16,3%	-16,3%
6 - NOx emissions (g/100km)	74,7	74,7	55,1	-19,7	-19,7	-26,3%	-26,3%

Apart from the maintenance costs, the biggest positive effect these cars have had is on NOx emissions -a gas that damages human health.

The next table presents the average results for hybrid cars and other standard cars, showing the difference between the two types of vehicles.

**Table C2.1.5** Difference between hybrid and standard PT cars

Indicators	Hybrid	Standard	Difference %
1 - Maintenance costs (€/100km)	5,2	9,3	-44%
2 - Fuel costs (€/100km)	11,5	8,9	30%
3 - Fuel consumption (L/100km)	7,8	8,7	-10%
4 - CO2 emissions (g/100km)	10.043	18.410	-45%
5 - PM10 emissions (g/100km)	2,0	4,8	-58%
6 - NOx emissions (g/100km)	0,6	77,0	-99%

The difference in the costs between hybrid and standard cars (more than 30%) is owing to the fact that the new hybrid car engines are fed with gasoline that is far more expensive than diesel and also to the fact that the Company has a protocol to purchase less expensive diesel (as the buses have diesel engines). Gasoline is however purchased at the standard price.

Other achievements allow us to outline that the purchase of hybrid vehicles benefit the public realm with CO2 emissions savings. Hybrid vehicles produce in most cases 30% less CO2 than standard vehicles, a value that is even higher if we consider fine

particulate matters (PM) emissions and NOx emissions (hybrids cut as much as 99% when compared to conventional vehicles).

But from another point of view, the hybrid vehicles have to cope with higher fuel costs higher than standard vehicles due to gasoline costs. Balancing environment and operation costs is thus a puzzling game which only further tests and research can help to clarify.

### **CMF cars:**

The next table shows the results of introducing 1 new hybrid vehicle (Toyota Prius) into the Municipality car fleet. It's important to note that in 2008, CMF had 8 cars powered by gasoline and 33 cars powered by diesel. In 2011, CMF had 1 hybrid car and 1 standard car powered by gasoline and an additional 55 cars powered by diesel.

**Table C2.1.6** *Indicators for CMF cars*

Indicators	Before (2008)	BAU (2011)	After (2011)	Difference: After – Before	Difference: After – BAU	Difference (%): After – Before	Difference (%): After – BAU
1 - Maintenance costs (€/100km)	10,1	11,9	6,0	-4,1	-5,9	-40,8%	-49,6%
2 - Fuel costs (€/100km)	13,8	16,1	11,9	-1,8	-4,2	-13,3%	-26,2%
3 - Fuel consumption (L/100km)	11,4	11,4	9,6	-1,8	-1,8	-15,5%	-15,5%
4 - CO2 emissions (g/100km)	28.875	28.875	24.551	-4.323	-4.323	-15,0%	-15,0%
5 - PM10 emissions (g/100km)	11,2	11,2	9,9	-1,3	-1,3	-11,8%	-11,8%
6 - NOx emissions (g/100km)	84,3	84,3	66,0	-18,3	-18,3	-21,8%	-21,8%

All the indicators with regard to maintenance, fuel costs and consumption and emissions show positive effects after MIMOSA. However, the outcome of the after/BaU must have been caused by the introduction of 16 new vehicles, 15 of which are conventional and only one is hybrid, the Toyota Prius.

So to understand the real effect of MIMOSA, one should not consider the whole fleet but, instead, look at the differences between the average figures related to hybrid and standard vehicles themselves. The next table presents these results:

**Table C2.1.7** *Differences between hybrid and standard CMF cars*

Indicators	Hybrid	Standard	Difference %
1 - Maintenance costs (€/100km)	1,6	6,1	-73%
2 - Fuel costs (€/100km)	11,7	11,9	-2%
3 - Fuel consumption (L/100km)	7,4	9,6	-23%
4 - CO2 emissions (g/100km)	9.622	24.749	-61%
5 - PM10 emissions (g/100km)	1,7	10,0	-83%
6 - NOx emissions (g/100km)	1,0	69,3	-99%

The CMF hybrid car has registered less consumption than the standard cars, and also less than the HF hybrid cars. This probably is less to do with the operation area of these cars, all of which usually circulate in streets with very high slopes and on an urban environment, and more to do with the model being used. The new version of

Toyota Prius sets out to perform better than the former version and the Honda Insight.

When we take into consideration the vehicles from the Municipality, another conclusion is that CIVITAS has enabled robust savings of CO<sub>2</sub> (nearly 15.000 g/100km of CO<sub>2</sub>) and helped to purchase vehicles which are almost NO<sub>x</sub> and PM<sub>10</sub> emission free.

Another valuable finding encountered relates to the fact that greenhouse gases actually produced by cars more or less match the characteristics provided by the manufacturer which said that the Toyota Prius emits 92 g/km while in more extreme geographic conditions it emits 96g/km.

As for consumption, all the cars tested in Funchal consume much more than the manufacturers promised. The values provided by glossy brochures were not achieved in Madeira: for example, the Municipality car consumed 7,4 L/100Km against the 4,1 suggested by the manufacturer. Also in HF, the real consumption is almost double what one would expect: 7,8 L/100km achieved after being driven for 2 years against the 4,1 and 4,0 suggested by the manufacturer (inexperience in driving this kind of vehicle is not the cause of these mismatched figures), thus roughly 90 percent more fuel was consumed than claimed by the factory specifications.

## C2.4 Transport

### 7 - PT quality of service

In 2010 and 2012, surveys were conducted to understand the PT quality of service regarding the buses. The question was “Using a range between 1 to 10, being 1 “very unsatisfied” and 10”very satisfied”, rate your satisfaction with the comfort on these buses”.

**Table C2.4.1** Satisfaction rate with the buses

	Before 2010 1.254) Standard buses	BAU (N= 2012 (N=84) Standard buses	After 2012 (N=21) Mini buses	Difference: After –Before	Difference: After –BAU	Difference (%): After –BAU
<b>Comfort on buses</b>	6,8	8,0	8,3	1,5	0,3	2,5 percentual points (p.p.)

The satisfaction results obtained from citizens mean that overall the new mini buses are perceived as more comfortable than the standard ones. It is though noteworthy to take into consideration that the sample size has reduced a lot from 2010 to 2012 and that the number of people surveyed on board the mini buses was low, which can potentially create a bias in data collected. However the small sample size in 2012 may decrease the meaningfulness of the results found with regard to satisfaction levels.

The investments that are being made in the deployment of new and smaller buses could have led to an increase in the inconvenience of public transport most notably in smaller buses where the lack of space could have impacted negatively on quality of service. Fortunately these worries have not been met and present clients are satisfied with the quality of the new buses. It is relevant to note that the difference between after and BaU was not

even higher. This is probably due to the introduction of 10 new standard buses a couple of months after the 2010 survey. These new buses had nothing to do with CIVITAS but the event of purchasing them might have increased the overall satisfaction rate with the buses. This event shows that the increase in approval ratings may be attributed largely to fleet renewal in general rather than to particular innovative features of the new minibuses.

### 8 – Acceptance level of fleet renewal

During a relevant event at which CIVITAS-MIMOSA was promoted, Expo Madeira, the most important exhibition of commercial activities in the entire Region, people were asked about the usefulness of the PT operator fleet renewal (distinguishing between cars and buses). The CIVITAS local team used this opportunity to survey 792 individuals in 2010, and 810 in 2011 and the results are shown below<sup>1</sup>.

**Table C.2.4.2 Perception of usefulness of the measure with regard to PT vehicles**

Categories of perception of usefulness	PT hybrid cars		PT bus fleet renewal	
	2010	2011	2010	2011
Not at all useful	1,8%	2,4%	2,8%	0,8%
Not useful	3,5%	5,9%	9,2%	9,0%
Neither useful nor useless	15,5%	8,6%	13,0%	9,0%
Useful	36,9%	34,0%	44,6%	41,6%
Very useful	42,3%	49,1%	30,4%	39,5%
<b>Useful and very useful ratio</b>	<b>79,2%</b>	<b>83,0%</b>	<b>75,0%</b>	<b>81,2%</b>

PT users were questioned about the importance they assign to public transport fleet renewal. The question was “Using a range between 1 to 10, ranging from 1 “very unimportant” to 10 “very important”, rate the importance that you give to the renewal of the public transport fleet”. In 2010, 79,2% of the users rated the acquisition of hybrid cars by the public transport operator as important or very important whereas in 2011 the value had increased to 83%.

As for the PT bus fleet renewal, in 2011 the number of persons stressing this issue was important or very important rose about 8,3% from 75% to 81,2% which may mean that these kinds of vehicles are really penetrating in the local agenda of priorities for local authorities to deal with.

Particular attention should be paid to the fact that the increased perception of usefulness of public transport hybrid cars, and public transport bus fleet renewal could be caused by the communications campaigns for the Electric and Hybrid Vehicles (1.2) and Awareness Raising Campaign for Sustainable Mobility (4.1) measures. It was not possible to collect data for the Municipality vehicles, because the Municipality hybrid vehicle was only purchased in September 2011, and the last event was held in July 2012.

### 9 - Number of electric/hybrid vehicles purchased in the region

<sup>1</sup> This sample is not representative of the population of Madeira. The enquiries were selected randomly and so no significance tests were carried out.

In the next table the number of hybrid/electric cars purchased in Madeira each year are presented.

**Table C2.5.2** Annual evolution of the number of private and public electric/hybrid vehicles sold in Madeira

Type	2008	2009	2010	2011
Hybrids	5	12	27	4
Electric	-	-	-	2

In 2009 and 2010 the number of hybrid cars purchased increased. This could be related to the 3 hybrid cars that HF purchased in 2009 and the workshops that were held to raise the motivation of the stakeholders. This might have generated a demonstrative effect that led other citizens and companies to feel confident in buying a greener vehicle themselves.

It is important to stress that the effect depicted from this indicator has benefited from the campaigns carried out within the framework of FUN 1.2. (Electric and Hybrid Vehicles) as well as from the complementary actions introduced by that measure, most notably the Green Tariff, which gives a 50% off tariff to electric/hybrid vehicles that decide to park in the city centre.

The relationship between the measures and the number of citizens purchasing the vehicles is difficult to establish. Further research work needs to be carried out in order to find out the profile of the citizen/company who decides to purchase an electric or hybrid car. Nonetheless, it is obvious that 2009 and 2010 were the years where they were in the spotlight so arguably they should have generated interest among locals for the benefits of achieving a more efficient use of private vehicles.

Considering that the goal was to achieve a 50% increase in the number of vehicles sold in 2011 in comparison to figures from 2008, one should consider that it was not accomplished, possibly because of the crisis experienced by this sector. To contextualize and interpret this data, one should take into account that in 2011 less than 43% of passenger cars were sold in Portugal<sup>2</sup> so the slight increase in the number of greener vehicles sold in Madeira should be viewed as a success of the development of CIVITAS in the sense that it might have created framework conditions for the successful introduction of a market for electric/hybrid vehicles.

Another pre-condition which might have prevented people from buying hybrid cars is that most of them have gasoline engines and this fuel is much more expensive in Madeira than diesel. As new diesel hybrid electric models start becoming more available in the market, it is possible that these figures will increase.

## 10 - Number of buses able to transport wheelchairs

**Table C2.5.3.** Number of buses able to transport wheelchairs

	2010	2011	Difference (%) 2010-2011
Number of buses able to transport wheelchairs	30	35	17%
% of total urban bus fleet able to transport wheelchairs	17%	20%	20%
Number of wheelchair users	262	423	61%

<sup>2</sup> Source: ACAP - Associação Automóvel de Portugal



In 2008 HF purchased, though not in the frame of CIVITAS, 20 standard new buses (capacity of 83 passengers and 1 wheelchair), and 10 standard new buses (capacity of 78 passengers and 1 wheelchair).

With the purchase of this new set of 5 mini buses, the % of vehicles that can transport a wheelchair rises 20%. It is therefore of paramount importance to purchase the remaining group of 13 mini-buses to keep pace with the sharp increase in wheelchair users, a number that rose from 262 in 2010 to 423 in 2011.

This is again a success of the measure, which aimed to increase the accessibility to public transport for «weaker users». Universal accessibility is a big issue for the PT Operator which provides a tailored service for disabled people which is fairly expensive. As the buses start to be able to accommodate wheelchairs, users can head to the bus stop knowing in advance that this kind of bus will arrive. The special service can be dropped in a matter of years, which is an important indirect effect of the measure.

There is also another indirect effect. Only the last 10 buses suit all the bus lines on the PT urban network. So the 5 new mini buses, that suit all the routes, can increase the area where it is possible to transport wheelchairs.

## C2.5 Society

Not applicable.

## C3 Achievement of Quantifiable Targets and Objectives

No.	Target	Rating
1	Reduction of energy consumption by 5 to 10%	PT buses: O HF cars: O CMF cars: ★★★
2	Reduction of CO <sup>2</sup> , NO <sub>x</sub> and PM emissions by 2 to 10% in new vehicles	PT buses: ** HF cars: *** CMF cars: ***
3	Increase the number of wheelchair spaces available to citizens in LPT buses by at least 10%	PT buses: ***
4	Increase the number of electric/hybrid vehicles sold by at least 50%	(*)
5	Increase the public's awareness of the advantages of the "green" technologies	PT buses: ** HF cars: **
6	Incentivise a more cost effective public transport fleet by generally decreasing maintenance and fuel costs per km by at least 5%	PT buses (maintenance costs): *** PT buses (fuel costs): O PT cars (maintenance costs): *** PT cars (fuel costs): ** CMF (maintenance costs):

		*** CMF (fuel costs): ***
7	Increase the satisfaction of PT users with regard to comfort when comparing to regular sized buses	**
<b>NA = Not Assessed    O = Not Achieved    * = Substantially achieved (at least 50%)</b> <b>** = Achieved in full            *** = Exceeded</b>		

Even though fuel consumption per 100km for all the PT urban fleet has decreased by only 1,2%, with the introduction of 5 new mini diesel buses (in a fleet comprising a total of 180 buses), it's important to note that the consumption of one mini bus is 56% lower than a standard diesel bus. The only reason the result was not accomplished was due to the low number of buses that were bought. The demonstration of the added value of mini-buses was not compromised, neither in relation to their performance ratios, nor the feasibility of assigning them to specific and less profitable services like off-peak hours and areas where the operating conditions do not allow access by another kind of bus. If more buses are purchased then we can expect to achieve more substantial fuel consumption reductions.

As for the Municipality cars, fuel consumption has decreased by 15.5%, thus surpassing the initial goals for this measure. Fuel consumption of the Municipality Toyota Prius, a 3<sup>rd</sup> generation model, is even more efficient than the group of two Honda Insights that the PT Operator has together with a 2<sup>nd</sup> generation Toyota Prius (the Municipality car consumes 0,4 litres less per 100km).

On the other hand, the PT cars consumption increased by 0,2% after the implementation of this measure. This is due to the fact that other new cars were bought during MIMOSA that had no relationship with the project and the cars that had the highest fuel consumptions stopped operating. What should be taken into consideration is that hybrid cars consume 10% less than standard ones so the result is not positive due to the formula to measure success in this measure.

Probably the area in which this measure has shown the strongest and most long-term effects was in terms of air pollutants. The introduction of 5 new buses has decreased CO2 emissions by 1,2%, PM10 by 22% and NOx emissions by 10,6%. Passenger cars are almost absent from emissions exhausts, they have contributed to a decrease in emissions of 14,4% (CO2) to 26,3% (NOx) in Horários do Funchal and from 11,8% (PM10) to 21,8% (NOx) in Municipalities vehicles.

Another forward-looking and striking result lies in the number of spaces that are now available for wheelchairs on board local urban buses. They have increased by 20% thanks to CIVITAS. This is consistent with the goal of promoting social inclusion by granting a responsive service open to mobility impaired citizens.

Meanwhile, the number of cars sold in Madeira with an electric or hybrid engine slightly increased during the project lifespan. For the correct interpretation of this result one should take into account the promotional campaigns and activities developed within FUN 1.2. (Electric and Hybrid Vehicles). On the other hand, this outcome could have been achieved with greater success if it was not for the effect of the financial crisis that has slowed down private consumerism a lot in Portugal in 2011.

Citizens' awareness with regard to fleet renewal, measured with their subjective satisfaction to new buses and, at the same time, with the importance they give to a fleet renewal policy

has also been examined. Citizen's satisfaction with mini buses outweighs their satisfaction with smaller capacity vehicles. However, this indicator was measured through a survey targeting people at a commercial exhibition (Expo Madeira). The surveyed group could apply to win mobility-related prizes by answering the questionnaire. This methodology was necessary to secure a decent sample size, but on the other hand makes the results statistically not representative because not all the population had an equal chance of being selected.

## C4 Up-Scaling of Results

The sustainable fleet measure was an important first step in increasing the efficiency of the PT fleet on the overall level, providing food for thought among local technicians. It was by all means a starting point for discussing small capacity buses on-site and for discussing the future of public transport with regard to fleet composition and co-founding a framework for public transport on outermost islands.

While the studies and the outcomes that emerged underline that urban bus operators are not likely to welcome hybrid or electric technologies in the coming years, the local partners were able to choose wiser solutions to cope with structural threats to the PT service such as the decrease of passengers or the rise in fuel costs.

The purchase of the other set of 13 mini-buses will generalize the use of small capacity buses for non profitable service, tackling the need to further reduce PT services and making it more appealing to citizens as the comfort of the new buses seem to be very good and might give a boost to their usage.

As for passenger cars, hybrid technology is generally seen as a positive thing as it is assumed to lead to a more attractive public transport system and to higher usage. However, for various reasons, of which the main one is precisely the high cost of gasoline, hybrid vehicles powered with this kind of energy do not seem to be the best choice for those who wish to save money on fuel<sup>3</sup>.

## C5 Appraisal of Evaluation Approach

Evaluation is a learning process in which sometimes the evaluator redefines their strategy so as to follow recent trends related to the subject under investigation. Sustainable Fleet is surely a measure which involved many deviations from what was originally planned. These changes were outside the control of the evaluation team but have implications and require a major re-thinking of the evaluation framework.

An appraisal of the evaluation approach should note that for the indicators of maintenance and fuel costs, for the PT buses, the number of passengers should be calculated and taken into consideration to better show the efficiency of the new buses which consume less and have lower operating costs, but will also and arguably carry fewer passengers because of their smaller passenger capacity and because they run in off-peak times and on non profitable routes. However it was not possible to access data relating to the number of

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<sup>3</sup> Recently, in April 2012, a new policy has been established which prejudiced even more the cost of gasoline. Gasoline used to cost 20 cents more than diesel and now costs on average 30 cents more. This will encourage even more citizens to buy a diesel car rather than a gasoline one, and so it is important to introduce into the local market the newly released hybrid diesel car models.

passenger using the mini buses, as the PT provider does not have a policy of always assigning one vehicle to the same route.

As for the PT car fleet and CMF car fleet, the numbers encountered depend a lot on the operating conditions (urban/sub-urban, level/hilly) and above all data manipulated in the frame of the evaluation activities entail many types of cars (different ages, horse power and type of fuels). For these reasons the indicators of economy, energy and environment for private cars are mostly influenced by the use and characteristics of these vehicles, and not only influenced by the new cars themselves.

For the assessment of the impact this measure has had on the development of a green market for vehicles powered by non conventional energy sources, one has taken into consideration the number of vehicles sold in Madeira. Therefore this indicator does not include vehicles purchased in other places that might be circulating in the region (and that came by boat, for example). On the other hand, it was not analysed, whether the people who bought these cars were directly influenced by the activities developed under this measure. Ideally, the measure would evaluate the number of green vehicles circulating in the Region and a survey would target those who use them (companies and particular citizens) to know how many kilometres (to understand if their mileage is higher than the one performed by standard cars) and thereby to understand to what extent and in which operating conditions they are really competitive.

The indicator regarding PT quality of service (satisfaction levels) had to rely on fairly irregular sample sizes which may have decreased the meaningfulness of the results even though the private consultancy companies that carried out the surveys have assured us that representativeness was not at stake even with the smaller samples.

Some of the objectives related to reducing energy consumption in the PT Operator fleet of buses and cars was not fully accomplished not because the new vehicles are less efficient than what was forecasted, but due to the fact that only 5 mini-buses were purchased and not the total mini fleet of 18 and only 3 hybrid cars which reinforced a much broader fleet.

## C6 Summary of Evaluation Results

The key results are as follows:

- **Fuel costs for Municipality cars have decreased by 15.5% after MIMOSA** – This result has however been affected by the renewal of several other Municipality cars, including new Diesel ones. In fact, the fuel consumption of the Toyota Prius bought by the Municipality even outweighs this number: the difference in fuel consumption between a hybrid Municipality car and the average consumption of all other standard Municipality passenger cars is 23%.
- **Emissions have decreased during MIMOSA by 14% (CO<sub>2</sub>) to 26,3% NO<sub>x</sub> in Horários do Funchal and by 12% (PM<sub>10</sub>) to 22% (NO<sub>x</sub>) in Municipality cars** – Shifting the share of passenger vehicles towards cleaner ones has allowed the local partners to reduce their carbon footprint and provide an example for other entities and citizens to follow. These new cars are almost emission free, especially where NO<sub>x</sub> is concerned, emitting 99% less than a standard vehicle.
- **The inclusion of 5 mini-buses in the PT Operator fleet has decreased the average fuel consumption of the overall fleet by 1,2%** – This result is owing to the fact that these new buses consume 56% less fuel than regular size ones and

moreover allow the PT Operator to keep the same service on non-profitable routes (and during off-peak hours).

- **After CIVITAS, the mini-buses have contributed to the reductions in traffic related emissions of 1,2% (CO<sub>2</sub>), 21,8% (PM<sub>10</sub>) and 10,6% (NO<sub>x</sub>)** – The direct contribution of the mini-buses can be predicted from its own emissions against regular buses; mini-buses are responsible for emitting 56% less CO<sub>2</sub>, and 81% less PM<sub>10</sub> and NO<sub>x</sub> than standard buses.
- **The number of urban buses able to transport wheelchairs has risen by 20%** - This figure clearly underlines the social inclusion dimension of the measure. Also the number of wheelchair users increased by roughly 60%.
- **Citizens feel that fleet renewal is useful and are satisfied with the comfort of the new mini-buses** – Unlike one would imagine at first, as the capacity of the mini buses is smaller than normal size buses, this change has impacted positively on users appraisal of comfort. However different sample sizes selected during the project might have had some influence on this result.

## C7 Future Activities Relating to the Measure

HF will keep track of the fleet renewal strategy defined by AREAM and will purchase the remaining 13 mini buses (Euro V at least), because the 5 mini-buses already owned by HF proved to be more efficient to operate during non peak hours and on routes with less demand. ERDF will co-fund this purchase.

HF together with the Municipality will also continue to keep a close eye on the performance indicators from the hybrid vehicles and promote these technologies at regional events.

Presumably, further applications will be prepared in order to access incoming structural funding streams able to compensate for the ultraperipheral location of Madeira and its impacts on the public transport sector.

## D Process Evaluation Findings

### D1 Deviations from the Original Plan

As outlined below this measure involved a number of deviations from what was planned in the initial measure description form:

- **ERDF refusal to co-found supportive actions** - In the scope of the public fleet renewal, the investment in more efficient vehicles was complemented by a referral to the European Regional Development Fund (ERDF) to support this strategic measure as an essential step to improve the mobility in the city and the regional sustainable development. However, due to the refusal of this application, it was not possible to purchase the 40 diesel standard buses that were planned. Thus, the measure outputs and results were sharply reduced.

- **Mismatch in the technical requirements** - The PT Operator launched an international tender process to purchase non-diesel buses, and mini buses so as to use them in the frame of specific CIVITAS measures in 2010. However, the proposals for hybrid/electric vehicles didn't meet the technical requirements. Only the 5 mini buses were purchased. To cope with this barrier, the PT Operator modified the focus to providing an innovative service, rather than innovative technology, and will most likely launch a new tender process (co-financed by ERDF) to buy 13 more mini buses (Euro V, at least) which will operate in non peak hours and on routes with less demand.

- **Municipality purchased only one hybrid vehicle** - The information collected by the PT Operator during the first operational months of the new cars (purchased in 2009) flagged to the Municipality that this solution might not fit Funchal's particular features. This may be due to the fact that the engines of the private vehicles bought by the PT Operator were not strong enough. So the Municipality was cautious and tested a stronger version. The financial crisis and the extra-commitment and resources that have to be deviated to refurbishment of the city after the floods and fire damages of 2010 also contributed to scaling-down the number of passenger vehicles bought by the Municipality.

- **Endorsing subcontracting activities** - The subcontracting landscape of this measure shifted significantly from the first plan. The main changes were the inclusion of a "study on solutions regarding extra transport costs in Madeira", and a reinforcement of the subcontracting to fully evaluate the impacts derived from the CIVITAS-MIMOSA measures (extra-funds were allocated to this activity). A workshop about the privatization of public transport was also included in this measure working plan and is expected to provide valuable inputs for the liberalization of the market. The research activities entailed in this measure have therefore turned it into a strategic piece of the sustainable policy of the Region.

### D2 Barriers and Drivers

#### D2.1 Barriers

##### Overall barriers

- **Rejection of ERDF co-fund for big fleet renovation (9 – Financial)** – this rejection, allied with the financial difficulties of Portuguese companies to take forward big

investments, hampered the contribution this measure could make to achieve its high level objectives.

- **Lack of energy sources in the Island (10 – Technological)** – this technological barrier severely limited the use of alternative fuels such as natural gas.

### Implementation phase

- **Uncertainty about regional elections has postponed the launch of a new tender process for the purchase of 13 additional mini-buses (1 – Political/strategic)** – HF is a public PT company so it had to wait until the elections to know if the new party elected clarified if the additional 13 mini-buses were to be purchased.
- **Difficulty in convincing local companies to adhere to green vehicles (5 – Involvement/Communication)** - The incentive award that the Municipality planned to launch during MIMOSA did not go ahead due to lack of interest among regional companies. Hybrid passenger vehicles are seen not as an economical solution but rather solely as environment-friendly vehicles. The resistance among local stakeholders to choose a hybrid car is a barrier which hampers the goal of increasing local market share of clean vehicles and alternative fuels.

## D2.2 Drivers

### Overall Drivers

- **National legal framework favours the strategy of purchasing small capacity buses which can be more efficient for a number of services (6 – Positional)** – The reorientation of the measure scope, from a technological focus to a service innovation approach, strongly fitted into the Action Plan to boost energy-efficiency – Portugal Efficiency 2010 (Ministers Council decision n.80/2008). This national action plan advocates the usage of midi/mini buses during non peak hours in order to make Urban Mobility more cost-effective. This long-run strategy introduces the aim of making the PT fleets 15% mini/midi buses by 2015. This sustainable vision provides an important support to the changes this measure has dealt with.
- **Sustainable fleet measure strongly fits into the more recent austerity demands (9 – Financial)** – The financial crisis Portugal has been experiencing caused great priority and sense of urgency in the need to cut down on overspending. Financial measures that Portugal has been forced to take by TROIKA (EU; ECB and IMF) fit well with the strategy of deploying small-capacity buses on routes with less demand or to use them during non-peak hours. These buses are more efficient and are helping the PT Operator to improve its performance ratios.
- **Integration planning (7 – Planning)** – The evaluation campaign purchased in the frame of FUN 1.1. was instrumental for the whole package of measures. This is a long arching environment and energy evaluation of the impact MIMOSA has had in Funchal. This campaign was launched during this reporting period and run as planned. The data resulting from this campaign has provided the local team with important information for improving the measure design and process.

### Implementation phase

- **The mini-buses purchased in the frame of this measure were showcased in Brussels (6 – Positional)** – HF was granted with the inspiring Regio Stars trophy for CITY STAR category addressing *Integrated, clean urban transport projects*. By using these new and award winning buses in the urban PT network, this action has increased awareness of clean transport and of MIMOSA as well among local citizens and authorities.

## D2.3 Activities

### Preparation phase

- **Financial incentives (9 – Financial)** – To incentivise the use of electric/hybrid vehicles, CMF approved a 50% discount at parking meters for electric/hybrid vehicles users. Following this approval, changes were made to the municipal parking regulation and taxes for these type of vehicles. Further incentives of this kind were created. The Municipality created an annual prize that awards the companies that renew their fleets with less pollutant vehicles and a new legal framework that gives electric and hybrid cars access to some competitive parking areas in the city centre at reduced prices.
- **Creation of the building blocks to engage local actors in the necessity of improving the share of alternative fuels and making transport more environmentally friendly (5 – Involvement/communication)** – During the preparation phase, the Municipality was a very effective player, gathering a wide range of stakeholders in an electric and hybrid vehicles workshop to promote these kinds of vehicles on the Island.
- **Commitment of the Regional Authority (2– Institutional)** – The partnership with the interurban Operators with regard to the study of the extra costs was steered and smoothed by the Regional Authority that handed all the documents to the stakeholders. This attempt has lead to good results, as all partners started exchanging their perspective and came up with remarks on what they think should be the definition of the study.

### Implementation phase

- **European recognition of Sustainable Fleet strategy (6 – Positional)** – The application to the REGIO Stars award was of paramount importance to stress the role of cleaner public transport fleets to the Regional Government.
- **Liaison of the measure working plan with the most urgent issues to cope with (4 – Problem related)** – As the public transport operator HF is on the brink of being privatized, the studies comprised in this measure (about the fleet renewal and the extra costs study) have actually aided decision-makers to meet future challenges and discuss practical solutions for this area.

## D3 Participation

### D3.1 Measure Partners



- **Horários do Funchal** was responsible for the measure and was responsible for steering most of tender processes under this measure and for renewing buses and passenger vehicles.
- **Municipality of Funchal** supported the deployment of this measure by managing the evaluation consultancy company in charge of some evaluation activities and acted as a demonstrator partner by purchasing a hybrid vehicle.

## D3.2 Stakeholders

- **Regional Government for transport affairs** by facilitating the contact with interurban partners involved in the extra costs study. The regional government also had a lot of stake in this measure as the discussion on scenarios about the PT fleet and the research activities conducted to provide insights for the definition of incoming structural funding streams affect them directly.
- **Interurban operators** because they were involved in the extra costs study developed to examine and monetize the extra costs related to the deployment of public transport in outermost countries and in extreme topographic conditions.
- **AREAM** – is an energy and environment agency based on Madeira that carried out a fleet renewal strategy within this CIVITAS Sustainable Fleet measure. Their inputs were also relevant to calculate emission from the buses using the COPERT software.

## D4 Recommendations

### D4.1 Recommendations: Measure Replication

#### *Public Urban bus fleet*

**Mini buses can play a role in a strategy to maintain levels of PT service** – When crisis strikes, the passengers stop using public transport and the operation costs grow, the first reaction is to cut down non-profitable PT services. Yet, smaller buses can help local authorities to tackle the decrease in the public transport service supply, thus helping to maintain good levels of service.

**To keep pace with green technologies, outermost contexts require tailored solutions**– Although urban public transport companies from the most advanced cities all over Europe have been incorporating hybrid buses into their fleets, the manufacturers proposals do not fit the high slopes of Funchal, where buses powered by diesel combustion engines have seemed to be the best choice until now. Thereby, further research needs to be carried out to find effective and alternative solutions to conventional sources of energy.

**Complementary actions were needed to raise the debate about the sustainability of public transport services** – Cities should not only focus on the purchase of state-of-the-art vehicles to test during the measure, but address also the more strategic outcomes such as the funding of the public transport service in the long term. This is the reason why this measure has comprised a task to study the extra costs related to the public transport system in outermost regions. The city of Funchal believes it is essential to have this long-term vision so that a sustainable public transport system able to provide high quality service to both

citizens and visitors of Madeira Island can become a reality. This study might also help by allowing us to acknowledge funding opportunities to keep studying and testing new technologies able to successfully meet the challenges raised by the local topographic landscape.

### ***Passenger vehicles***

**Involvement of the Regional Authorities is essential** – It is important that regional authorities lead the way and provide a good example by purchasing hybrid vehicles and confronting citizens with real incentives to park these cars in the inner city. This was not fully undertaken in Funchal and therefore the market share did not grow as much as one may have forecasted even though the Municipality has launched a very positive measure to reduce the parking fees in the city centre for greener vehicles. This is sending a clear signal to citizens and to companies as well that Funchal is on the right track for improving the liveability of the city in terms of vehicle emissions.

**Current stage of hybrid technology development does not seem to perfectly fit Funchal** – Even though hybrid vehicles are nowadays often taken for granted as the most economical choice for consumers (the manufacturers regularly try to emphasize this idea in marketing campaigns), the experience of Funchal proves that they are still less competitive than diesel powered vehicles for urban journeys. This is due to the fact that gasoline is far more expensive in Portugal than diesel, and the hybrid cars engines were powered by gasoline. With new technologies arising combining electric engines with diesel, this barrier can be overcome in the future.

## **D4.2 Recommendations: Process (Related to Barrier-, Driver- and Action Fields)**

**Project was a mindset for alternative fuels** – Following the figures and the learning previously described, one must say that the measure was useful to initiate the first integrated strategy for public and private fleet renewal in order to improve the Islands' share of alternative fuels and more environmentally friendly technologies. As far as local engagements are concerned, the Municipality and the PT Operator have been very active in promoting new technologies whenever there is a sound event, so as to bring this debate to public attention.