Measure title: **Biofuels and Clean Vehicles**

City: **Donostia–San Sebastián** *Project:* **ARCHIMEDES** *Measure number:* **4**

Executive Summary

Within this measure biodiesel at high blends has been tested by CTSS, the urban public transport company of Donostia-San Sebastián. As a first step in the development of the measure, a mixing/filling station was purchased and implemented at the CTSS headquarters. Once in operation, a testing pattern with increased blends has been deployed. At the end of the demonstration period 95 out of 120 buses are running on a B-30 blend, 15 buses with B-50 and 6 buses with B-100.

Also within the measure, part of the bus fleet was replaced by new EEV vehicles. This further lowered local emission levels. Now there are 31 EEV buses fully operational on the urban routes, including 1 fully operative hybrid bus.

As a complementary action to the introduction of biodiesel in the city bus fleet the municipality started using biofuel in its municipal fleet. 82 municipal vehicles are powered by biofuel blends. Also the municipality has introduced 13 hybrid cars and 7 electric vehicles among the Municipal Police, the Mobility Department and the Town Hall services, as well as 4 electric bicycles, as part of the ARCHIMEDES demonstration project.

The measure has succeeded in its main objective, which is the improvement of the environmental performance of the public transport fleet in Donostia-San Sebastián. CO2 and air pollutant emissions (CO, HC, NOx and particulate matter) have considerably decreased by means of the introduction of clean vehicles and the use of high biodiesel blends in a significant proportion of the CTSS fleet.

In 2011, the relative reduction of all pollutant emissions is above 20%, ranging from 20,15% for CO2 emissions to the 45,33% reduction achieved for particulate matter. In absolute terms, the use of biofuel has meant a reduction of 1.707 tonnes of CO2 emissions in 2011. While local pollutants emission saving nearly reached 81,3 tonnes in the same year (24,3 tonnes of CO; 6,7 tonnes of HC; 47,7 tonnes NOx and 2,57 tonnes PM).

As already expected, the use of biofuels has led to increased fuel consumption. Which together with the increased requirements for maintenance have resulted in higher operation and maintenance costs. Nevertheless, a significant impact on the energy side is the decreased dependency on fossil fuels for the operation of this service.

The Cost-Benefit analysis of the measure has resulted in a BCR of 0,96, which means that costs are somewhat larger than benefits. Nevertheless, this figure is very close to 1, which can be considered as a positive result.

As for the public perception of the measure, a survey among public transport users has revealed that environmental issues are perceived as very important, with an average score of 8,96. Regardless this high score, only 5% of the new users of the public transport service (previously users of other means of transport for the surveyed trip) points out to environmental performance as the reason for their modal change, most often in combination with other reasons such as punctuality, convenience, etc.

A Introduction

A1 Objectives and target groups

A1.1 Objectives

The main motivation for including the measure in the project was to test energy-efficient public transport fleets at a significant scale in the CIVITAS corridor and serve as a local showcase for the use of alternative fuels.

The measure objectives are:

(A) High level / longer term:
- The main goal of this measure is to go well beyond the EU Directive 2003/30/EC (on the promotion of the use of bio-fuels or other renewable fuels for transport) requirements using first generation bio-fuels in medium sized cities in an innovative manner, and lay the foundations for maximising the opportunities for the take-up of second generation bio-fuels and EEV vehicles

(B) Strategic level:
- The aim of the demonstration in Donostia - San Sebastián is to reduce the emissions of air pollutants and greenhouse gases by operating bio-diesel buses at high blends at a significant scale in the CIVITAS corridor.
- The demonstration of the bus fleet and the additional promotional actions and incentives are expected to have an awareness raising effect on other local fleet operators and individual citizens.

(C) Measure level:
- During ARCHIMEDES in San Sebastián more than 3,600,00 litres of fossil fuels will be substituted by biodiesel.
- A high proportion of the bus fleet has been replaced during the CIVITAS Plus lifetime, and the ARCHIMEDES project has stimulated a commitment that all 30 planned new vehicles are of EEV standard

A1.2 Target groups

Citizens from the whole city and especially in the CIVITAS corridors are benefiting from the noise and pollutant reduction of the new vehicles and the use of bio-fuel.

At the city level, workers of the City Hall are also a target group, since the promotion of the use of bio-fuel among other municipal fleets (police, public works and official vehicles) is also part of the measure. The additional promotional actions and incentives are expected to have an awareness raising effect among citizens too.

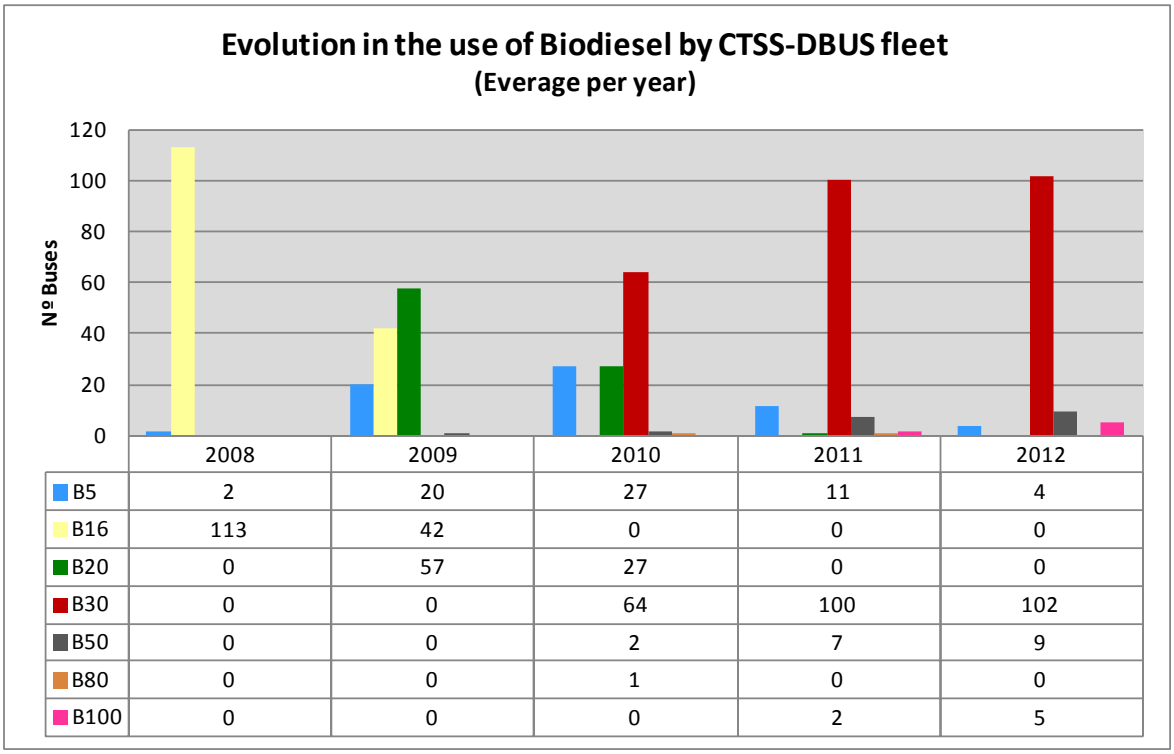
Finally, at a regional level, it is expected that the measure will encourage other fleet operators to start using bio-fuel.

A2 Description

Within this measure biodiesel at high blends has been tested by the urban public transport company CTSS.

As a first step in the development of the measure, a mixing/filling station has been purchased and implemented in CTSS headquarters.

Once that the filling station was operating, the testing pattern started by introducing a B16 blend (16% of biofuel) on a high share of CTSS buses (100 vehicles). The biofuel mix was gradually increased. Currently most of the buses are running on B30 (95 out of 120 buses). Tests with B50 have been conducted in 15 buses, some of them with EEV technology. A test with B100 was also done with 6 buses.



	2008	2009	2010	2011	2012
B5	2	20	27	11	4
B16	113	42	0	0	0
B20	0	57	27	0	0
B30	0	0	64	100	102
B50	0	0	2	7	9
B80	0	0	1	0	0
B100	0	0	0	2	5

Graph 1 -Evolution in the use of biodiesel by the CTSS-DBUS fleet

The biodiesel is being applied to the whole fleet, which means that not only the CIVITAS corridor, but the whole network has benefited by the use of biodiesel.

At the same time, part of the bus fleet has been replaced by new EEV vehicles, further lowering the local emission levels. Now there are 31 EEV buses fully operational in the urban routes.

Picture 1 -Three of the latest EEV buses

After a testing period with a pre-serial Hybrid bus (running fully operational in several bus routes, with performance data being used by the bus manufacturer (MAN) to develop the final model), in September 2011 the final serial vehicle (purchased) was received, introduced in a press conference at the municipality to the media, and immediately put into service. Drivers and technical staff of CTSS were previously trained.

Picture 2 -Hybrid training courses

The use of Biodiesel in the local buses is serving as a local showcase and promotional actions have been done to convince also other fleet operators (other municipal fleets: police, public works and official vehicles) and individual car users to switch. Promotional campaigns for recycling used oil were developed in September 2010 and in September 2011.

As a complementary action to the introduction of bio-diesel in the city bus fleet the municipality started using biofuel in its municipal fleet. In particular 82 municipal vehicles are powered by biofuel blends. Also the municipality has introduced 13 hybrid cars and 7 electric vehicles among the Municipal Police, the Mobility Department and the Town Hall services, as well as 4 electric bicycles, as part of the ARCHIMEDES demonstration project.

In addition, regarding measure 4, an international conference on Biofuels was organized in June 2011, were the experience of Donostia – San Sebastián was shown and exchanged with European experts.

Picture 3 -"Clean Vehicles, Clean Fuels, Cleaner Cities" conference opening session

B Measure implementation

B1 Innovative aspects

The innovative aspects of the measure are:

- **Long term use of biodiesel in bus fleet (at national level):** during CIVITAS the consequences of long-term use of biodiesel in buses are being tested. There is also little existing experience with testing bio-diesel in cities with many hilly areas
- **Use of new Hybrid technology in buses (at national level):** during CIVITAS-ARCHIMEDES, first series of hybrid buses by the European main bus manufacturers have come out to the market. CTSS is testing one hybrid bus during this period.
- **Combination of Biodiesel and EEV (at national level):** there is no experience with the combination of biodiesel and EEV engines. And even bus manufactures don't recommend this combination because of technical reasons.

B2 Research and Technology Development

CTSS subcontracted a comparative study on different alternative fuels (bio-ethanol, hydrogen, hybrids and second generation biodiesel). The study supported the bio-diesel demonstration in Donostia - San Sebastián as well as the future introduction of other alternative fuel types and propulsion technologies. The study was completed by Month 12 (Sept. 2009)

B3 Situation before CIVITAS

Before ARCHIMEDES, bio-fuels were not used by the public transport company in Donostia-San Sebastián. Bio diesel at higher blends is not publicly available.

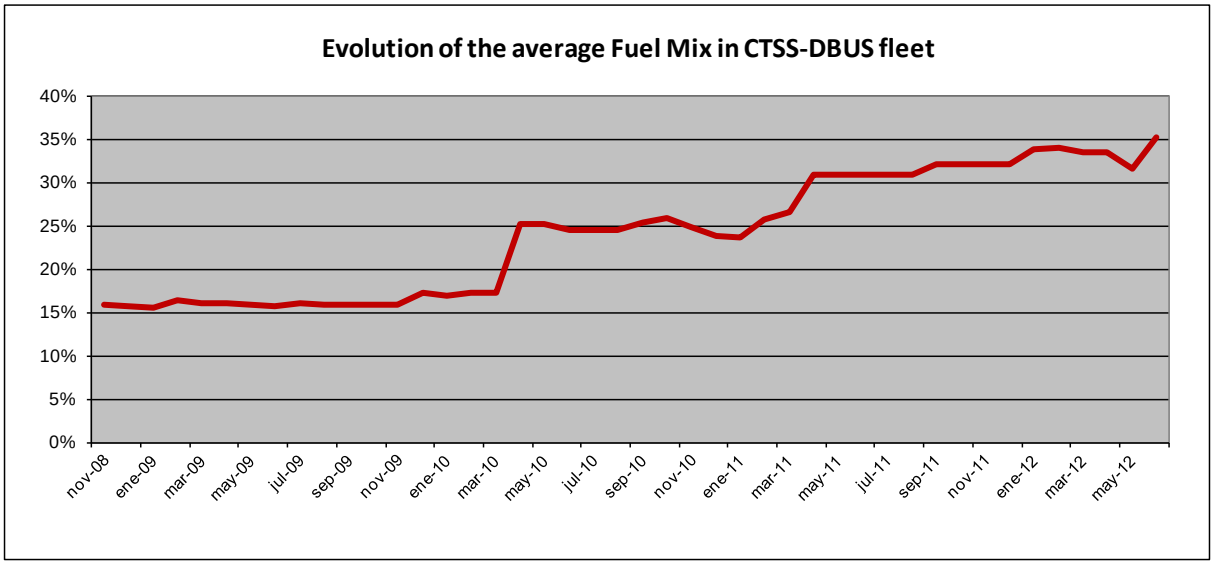
Also there was not EEV vehicles in the bus fleet before CIVITAS, neither in Spain. The EEV diesel buses of San Sebastián were the first ones of such technology in Spain.

B4 Actual implementation of the measure

During the ARCHIMEDES project, the San Sebastián public transport company (CTSS) gradually introduced biodiesel in its fleet. After the implementation of the mixing/filling station at CTSS headquarters (November 2008), both the number of vehicles using biodiesel and the blend levels were increased over time, according to the following milestones:

Picture 4 -Biofuel filters and mixing/pumping station

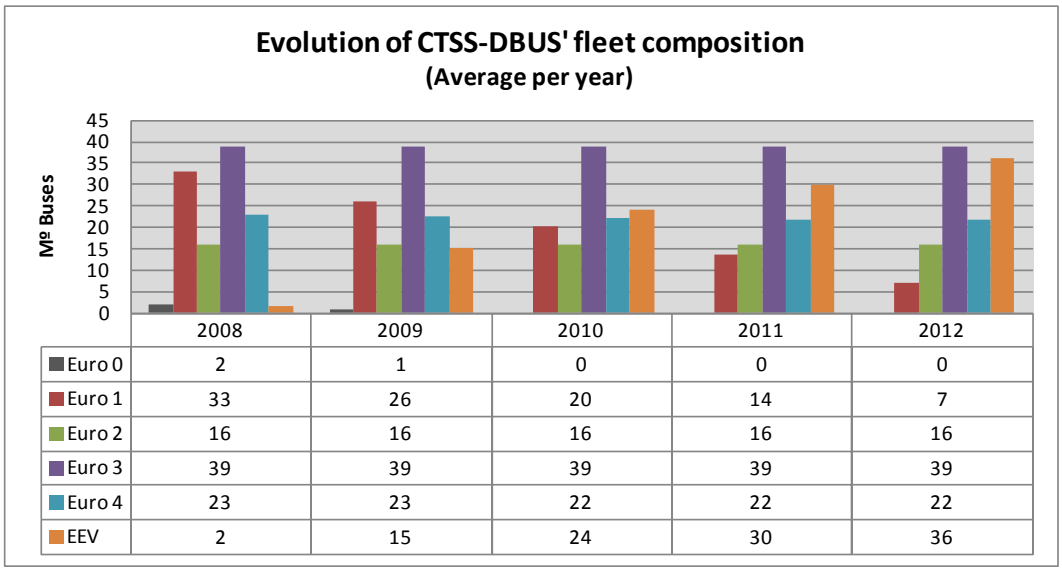
- 100 buses on B16 (November 2008 to January 2009): running on a minimum blend of 16% biodiesel.
- 50 buses on B20 (February 2009 onwards): running on a minimum blend of 20% biodiesel.
- B30, B50, B80 (September 2009 onwards): a high number of buses were tested with high blends of biodiesel. The testing periods lasted 6 months followed by the application on the rest of the fleet.
- 70 buses on ≥ B20: (November 2010 onwards) running on a minimum blend of B20
- 95 buses on B30 and 15 buses on B50 (September 2011 onwards)
- B100 tested on 6 buses (September 2011 onwards)



Graph 2 -Evolution of the average fuel-mix in CTSS-DBUS fleet

As for the fleet renewal scheme, the introduction of the EEV buses at CTSS followed the next pattern:

- + 15 EEV buses introduced by month 6
- + 5 EEV buses introduced by month 12
- + 9 EEV buses introduced by month 25
- + 2 EEV buses introduced by month 36
- + 6 EEV buses introduced by month 42



	2008	2009	2010	2011	2012
Euro 0	2	1	0	0	0
Euro 1	33	26	20	14	7
Euro 2	16	16	16	16	16
Euro 3	39	39	39	39	39
Euro 4	23	23	22	22	22
EEV	2	15	24	30	36

Graph 3 -Evolution of CTSS-DBUS' fleet composition

Also, during ARCHIMEDES project, CTSS has purchase and tested one hybrid bus: from June to September 2011, the pre-serial Hybrid Bus was tested fully operational in several bus routes. Training courses has been done and since September 2011 the final Hybrid Bus that the CTSS has purchased is fully operational.

Picture 5 -Pre-serial Hybrid fully operational

As a complementary action to the introduction of bio-diesel in the city bus fleet, ADS is promoting the use of this fuel among other municipal fleets: police, public works and official vehicles. Currently there are 82 municipal vehicles are powered by biofuel blends. Also the municipality has introduced 13 hybrid cars and 7 electric vehicles among the Municipal Police, the Mobility Department and the Town Hall services, as well as 4 electric bicycles, as part of the ARCHIMEDES demonstration project.

Picture 6 -Municipal Police Hybrid car

Several marketing campaigns on the buses have been done, also press notes and information has been provided through the on-board video information system.

Promotion activities in order to expand the use of bio-diesel to private fleets and individuals have been also undertaken: promotional campaigns for recycling oil were done in September 2010 and September 2011. The closed cycle of the used cooking oil converted into biodiesel was shown to the citizens.

Picture 7 -Used Oil collecting event

B5 Inter-relationships with other measures

This measure is closely related to the other local measures directed at improving the image and quality of public transport in the city, especially the measures on High Quality Public Transport Corridors, Bus Service to Industrial Areas, Bus Traveller Information and Bus Management System. The different classes of travel plans developed within ARCHIMEDES stress the quality and positive environmental impacts of public transport.

C Planning of Impact evaluation

C1 Measurement methodology

C1.1 Impacts and indicators

C1.1.0 Scope of the impact

The implementation of this measure has improved the environmental performance of the public transport fleet in Donostia-San Sebastián. CO_2 and air pollutant emissions (CO, HC, NOx and particulate matter) have decreased by means of the introduction of clean vehicles and the use of high bio-diesel blends in a significant proportion of the CTSS buses. Although an important achievement, the impact on overall greenhouse gas emissions and air quality is, as expected, moderate, due to the high share of emissions coming from other sources, most notably car traffic.

Although, as revealed by the specific survey conducted among CTSS users, the influence of clean vehicles and alternative fuels in modal shift towards public transport is very low, this measure has contributed to the project objective of increasing public transport attractiveness to users, therefore favouring a higher share of this mode in daily mobility. Achievements in terms of emissions reduction and the corresponding health benefit have consequently increased.

The use of bio-diesel has leaded to an overconsumption of fuel, affecting the efficiency of the public transport operation. This has also resulted in increased operational costs. Nevertheless, a significant impact on the energy side is the decreased dependency on fossil fuels for the operation of this service.

Furthermore, it was also the aim of this measure to use public transport fleet operation as a showcase for testing bio-diesel's performance, in order to encourage other municipal fleets and individuals to shift to this type of fuel.

C1.1.1 Selection of indicators

NO.	EVALUATION CATEGORY	EVALUATION SUB-CATEGORY	IMPACT	INDICATOR	DESCRIPTION	DATA /UNITS
	ECONOMY					
1		**Benefits**	Operating Revenues	Operating revenues	Revenues per pkm	Euros/km, quantitative, derived or measurement
2A		**Costs**	Costs	Capital costs	Capital cost per system or unit	Euros/km, quantitative, derived or measurement
2B				Operating costs	Costs per pkm or vkm	Euros/km, quantitative, derived or measured
	ENERGY					
3		**Energy Consumption**	Fuel Consumption	Vehicle fuel efficiency	Fuel used per vkm, per vehicle type	L /100km, quantitative, derived or measurement
4				Fuel mix	Percentage of fuel used by type	Percentage, quantitative, derived or measurement
				Vehicles in municipal fleet running on bio-fuels	The number of vehicles in the municipal fleet running on bio-fuels will be accounted. They will also be classified according to its typology.	Vehicles, quantitative, measurement.
				Electric Vehicles in municipal fleet	The number of hybrid and electric vehicles in the municipal fleet will be accounted. They will also be classified according to its typology.	Vehicles, quantitative, measurement.
	SOCIETY					
		Acceptance	Public perception	Public perception level	Impact on public perception derived from the measure. Within the CBA, this indicator will be used (if possible) to estimate the influence of this measure on modal shift towards public transport.	Percentage, qualitative, collected survey.
	ENVIRONMENT					
8		**Pollution and Nuisance**	Emissions	CO2 emissions	CO2 per vkm by type	G/vkm, quantitative, derived
9				CO emissions	CO per vkm by type	G/vkm, quantitative, derived
				HC emissions	HC per vkm by type	G/vkm, quantitative, derived
10				NOx emissions	NOx per vkm by type	G/vkm, quantitative, derived
11				Particulate emissions	PM10 and/or PM2.5 per vkm by type	G/vkm, quantitative, derived

C1.1.2 Methods for evaluation of indicators

No.	INDICATOR	TARGET VALUE	Source of data and methods	Frequency of Data Collection
1	Operating revenues	Contribute to a 5% increase compared to 2006	The increase of 5% of passengers cause an increment of the operating revenues, compared to 2006	Annual
2A	Capital costs		Annual amortization of the expenses in new EEV, filling station, etc.	Annual
2B	Operating Costs	227,640€ (172,640+55,000)	Annual maintenance costs of the fleet, fuel and bio-fuel price boards and control of the consumption with the filling station controlling software: - Data collected from the financial department, price boards of fuels and bio-fuels. - Consumption per km by type of vehicle obtained from the filling station system and controlled monthly. Every cost and subcontracted services for the implementation of the measure. Ex: change of biodiesel filters, maintenance of mixing pumping station…	Once a year
3	Vehicle fuel efficiency		Fuel filling station system data reports and bus manufacturer's technical documentation. Modelling with the collection of information reported from the system software	Once per blend testing period.
4	Fuel Mix	70 buses running on B20 20 buses running on B100	Diesel – Biodiesel mixing filling station system. Modelling with the collection of information reported from the system software	Monthly
	Vehicles in municipal fleet running on bio-fuels		Municipal records	Once a year
	Electric vehicles in municipal fleet		Municipal records	Once a year
	Public perception level		Data has been collected through a yearly on-board survey conducted among the users of public transport. The survey included public perception levels in relation to this specific measure and public transport in general. A sample size of 1500 users has been used.	Once a year
8,9,10,11	CO_2, CO, HC, NOx, PM emissions	Significant reductions because of EEV vehicles purchases and Biodiesel use.	COPPERT emission model approach has been used, based on vehicle performance data, fuel mix and fleet composition.	Once a year

C1.1.3 Planning of before and after data collection

EVALUATION TASK	INDICATORS INVOLVED	COMPLETED BY (DATE)	RESPONSIBLE ORGANISATION AND PERSON
Analysis of financial accounts.	1, 2a, 2b	Months 15, 27, 39	CTSS / Mr. Eduardo González López
Collection of fuel filling station system data	3, 4	Continuously from month 3	CTSS / Mr. Eduardo González López
Collection of vehicle performance data	3, 8, 9, 10, 11	Continuously from month 3	CTSS / Mr. Eduardo González López
Collection of municipal fleet composition data and fuel use	-	Months 15, 27, 39	CTSS / Mr. Eduardo González López
Survey to estimate public perception levels	-	Months 31, 43	CTSS / Mr. Eduardo González López

C1.2 Establishing a baseline

Although the measure included the acquisition and operation of a hybrid bus, since the serial hybrid bus was received and put in service in September 2011, it has been tested in diverse routes under different operation condition, in order to find out the route that better fitted the characteristics of the vehicle. Although some monitoring and evaluation has been conducted (first analysis revealed that average fuel savings are 30 percent when compared to an equivalent bus running on diesel), neither the significance of the hybrid fleet (one single bus versus 120 "standard" buses) nor the (variable) operation have eased a sound evaluation comparable to the one undertaken for the rest of the fleet. Therefore, it should be noted that performance evaluation has focused on the use of biodiesel.

It should also be noted that, thanks to the availability of an own mixing/filling station (implemented at the early stages of the project), CTSS-DBUS has extended the use of biodiesel to its whole fleet, experimenting with different blends to better understand the implications of it use under different conditions, in a continuous search for an optimal situation in each particular case. With fuel mix continuously evolving, indicators such as "Vehicle fuel efficiency" and "Fuel Mix" have been calculated according to average values for the whole fleet.

Similarly, there are not separate accounts for each particular biodiesel blend strategy, and the overall economic dimension of the system has been evaluated.

The calculation of the pollutant emission values has been done according to the data of fuel consumption in the bus fleet. This value can be easily transformed to energy with the energy content factor of each fuel (diesel and biodiesel).

In the calculation of CO_2 savings it must be taken into account that in the closed cycle of the second generation Biodiesel (from used cooking oil), the CO_2 balance in neutral. So to calculate the CO_2 savings achieved because of the use of biodiesel, we calculate the CO_2 emissions with the amount (litres) of biodiesel used.

To calculate the local pollutants (CO, HC, NOx, PM) the energy conversion factor from Diesel and Biodiesel to energy has been considered, and the charts for each vehicle type used.

C1.3 Method for Business as usual scenario

Business as usual in this measure would mean not implementing bio-diesel blends at all in the bus fleet. Also the extensive fleet renewal with EEV buses would have not take place. Higher values in all indicators would be expected (except for fuel consumption), and emissions would continue growing during the CIVITAS period. No fossil fuel would be substituted and the CTSS would continue being totally dependent on Diesel.

For evaluation purposes, the following criteria have been used to estimate the BaU scenario:

- Economic indicators: the revenue and operation cost factors of the reference year has been actualized according to inflation levels (whether recorder or estimated, depending on the year considered): As for the capital costs, it has been considered that no further investments would have occur if the CIVITAS funds were not available
- Energy indicators: the BaU scenario regarding Energy indicators has been estimated assuming that the efficiency situation achieved in the reference year would not be

altered by the use of alternative fuels. The evolution in the content of Biodisel in the diesel fuel according to the EN590 is considered.

- Environmental indicators: the BaU scenario has been estimated assuming that no changes in the public transport fleet composition would be implemented. Therefore, emissions are calculated according to the mileage (vehicle-km) in each corresponding year, considering that all the vehicles are powered by diesel fuel. The evolution in the content of Biodisel in the diesel fuel according to the EN590 is considered.
- Society indicators: before the CIVITAS project, there was not a regular survey program to assess public perception regarding public transport services, therefore is not possible to estimate a BaU scenario for these indicators.

C2 Measure results

C2.1 Economy

Table C2.1.1: Benefits

Indicator	Before 2006	BaU 2010	After 2010	BaU 2011	After 2011
1.Operating Revenues	4,21 €/km	4,83 €/km	5,24 €/km	4,90 €/km	5,22 €/km

Indicator	Difference: 2010 –Before	Difference: 2010 – BaU	Difference: 2011 –Before	Difference: 2011 – BaU
1.Operating Revenues	1,03 €/km	0,41 €/km	1,01 €/km	0,32 €/km

The average increase in the revenues per kilometre on CTSS' public transport network is due to the fares increases and mainly to the important increase in the number of passengers of the public transport service. Compared to the BaU situation, the overall improvement of the public transport service in Donostia-San Sebastián has increased CTSS' revenues by more than 2 million Euros in 2011.

Table C2.1.2: Costs

Indicator	Before 2006	BaU 2010	After 2010	BaU 2011	After 2011
2a. Capital costs	0,25 €/km	0,21 €/km	0,22 €/km	0,20 €/km	0,21 €/km
2b. Operating costs	0,63 €/km	0,69 €/km	0,72 €/km	0,70 €/km	0,79 €/km

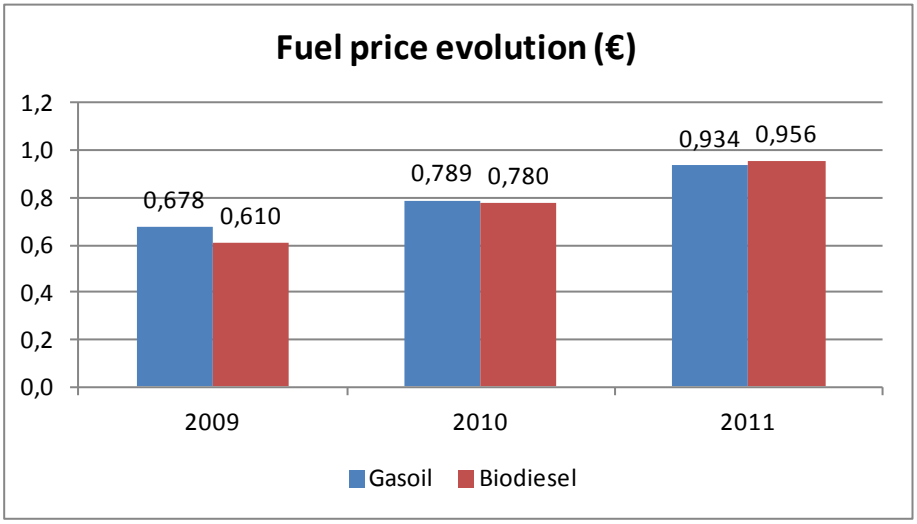
Indicator	Difference: 2010 –Before	Difference: 2010 – BaU	Difference: 2011 –Before	Difference: 2011 – BaU
2a. Capital costs	-0,03 €/km	0,01 €/km	-0,04 €/km	0,01 €/km
2b. Operating costs	0,09 €/km	0,03 €/km	0,16 €/km	0,09 €/km

The capital costs indicator is calculated as the average amortization of the bus fleet and its associated infrastructure (including the mixing/filling station). In the CIVITAS scenario the higher investment costs associated to the introduction of EVV buses has been considered.

The value for the reference year (2006) is very high because in that year a change of criteria in the depreciation period was decided (it changed form 12 years to 10 years of amortization). Until the beginning of the CIVITAS project, 3 years later, the average age of

the fleet had raised. Afterwards, during the CIVITAS period, because of the renewal of the fleet, the Capital costs indicator has risen, but it's still lower than in 2006.

As for the operating costs indicator, it can be clearly seen how the introduction of bio-fuels has increased the operation costs, mostly use to due to the overconsumption resulting of its use (see "Vehicle fuel efficiency" indicator", but also due to the higher price of biodiesel, especially in 2011 when a higher average fuel mix were used (see graph below).



Graph 4 –Fuel price evolution

C2.2 Energy

Table C2.2.1: Energy Consumption

Indicator	Before 2006	BaU 2010	After 2010	BaU 2011	After 2011
3. Vehicle fuel efficiency	52,78 l/100km	52,78 l/100km	55,46 l/100km	52,78 l/100km	55,97 l/100km
4. Fuel mix	5%	7%	23%	7%	30%
Vehicles in municipal fleet running on bio-fuels	0	0	50	0	82
Electric Vehicles in municipal fleet	0	0	9	0	20

Indicator	Difference: 2010 –Before	Difference: 2010 – BaU	Difference: 2011 –Before	Difference: 2011 – BaU
3. Vehicle fuel efficiency	2,68 l/100km	2,68 l/100km	2,49 l/100km	3,19 l/100km
4. Fuel mix	18%	16%	25%	23%
Vehicles in municipal fleet running on bio-fuels	50	50	82	32
Electric Vehicles in municipal fleet	9	9	20	11

Regarding vehicle fuel efficiency there is an overconsumption due to the lower energy content of the Biodiesel per litre comparing to conventional diesel. So that the "Vehicle fuel efficiency" tendency is to rise if the blend applied is higher (Fuel Mix indicator).

In the BAU case of the "Vehicle Fuel Efficiency" indicator, the average fuel consumption value previous to CIVITAS is taken (52,78 l/100km). It's assumed that the average consumption in the BAU would not be affected by the overconsumption that the Biodiesel blends produce in the vehicles.

For the Fuel Mix indicator, the value taken for the BAU scenario is the maximum FAME (Biodiesel) content in the DIESEL EN590 –FAME content of 7% as regulated by Directive 2009/30/EC.

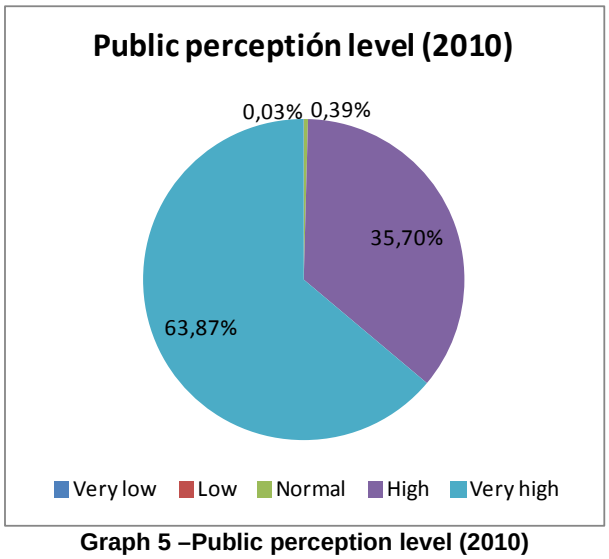
C2.3 Society

Table C2.3.1: Acceptance

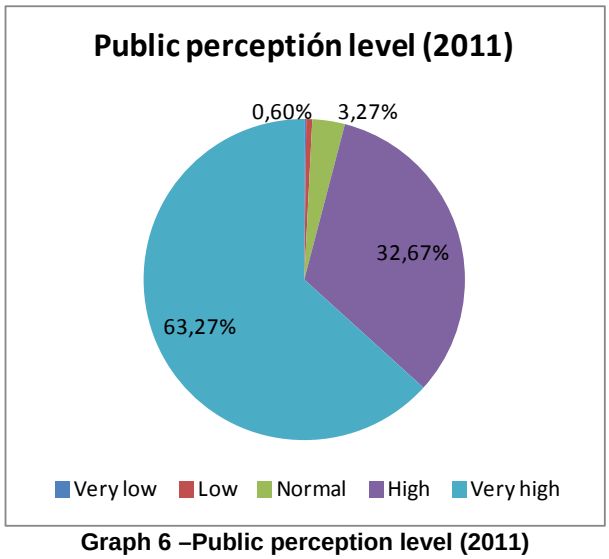
Indicator	Before 2006	BaU 2010	After 2010	BaU 2011	After 2011
Public perception level (environmental issues)	NOT AVAILABLE	NOT AVAILABLE	8,69	NOT AVAILABLE	8,96

Indicator	Difference: 2010 –Before	Difference: 2010 – BaU	Difference: 2011 –Before	Difference: 2011 – BaU
Public perception level (environmental issues)	NOT AVALIABLE	NOT AVAILABLE	NOT AVAILABLE	NOT AVAILABLE

To assess the public perception level of the different measures implemented by CTSS within CIVITAS, a survey was carried out among 1.500 users (12% of the daily passengers) of the main lines running along the CIVITAS corridor (5 & 28). The results reveal that environmental issues are perceived as very important, with an average score of 8,96.



Graph 5 –Public perception level (2010)



Graph 6 –Public perception level (2011)

Regardless this high score, only 5% of the new users of the public transport service (previously users of other means of transport for the surveyed trip) points out to environmental performance as the reason for their modal change, most often in combination with other reasons such as punctuality, convenience, etc.

C2.4 Environment

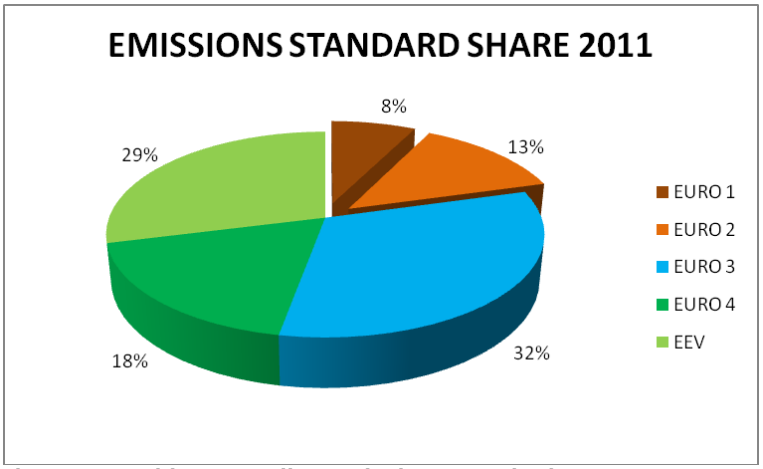
Table C2.4.1: Pollution and Nuisance

Indicator	Before (2006)	BaU (2010)	After 2010	BaU 2011	After 2011
8. CO_2 emissions	1351,06 g/km	1315,49 g/km	1144,97 g/km	1315,49 g/km	1050,37 g/km
9. CO emissions	21,83 g/km	16,09 g/km	13,05 g/km	16,14 g/km	12,31 g/km
HC emissions	5, 42 g/km	4,32 g/km	3,48 g/km	4,33 g/km	3,27 g/km
10. NOx emissions	38,75 g/km	31,26 g/km	25,30 g/km	31,36 g/km	23,86 g/km
11. Particulate emissions	1,26 g/km	0,88 g/km	0,57 g/km	0,89 g/km	0,49 g/km

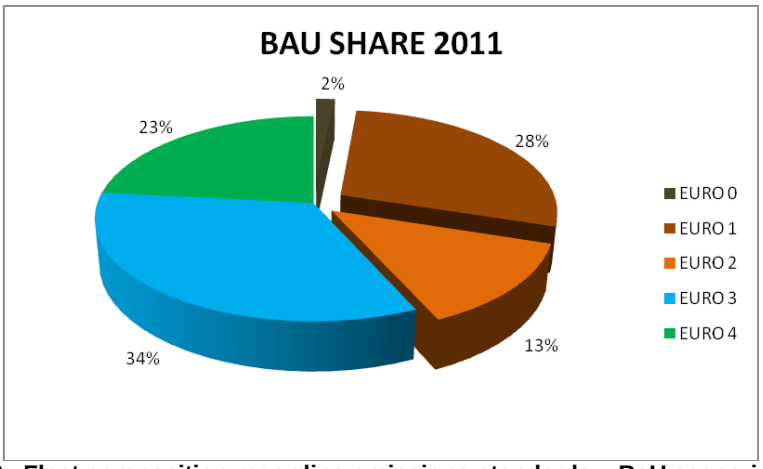
Indicator	Difference: 2010 –Before	Difference: 2010 – BaU	Difference: 2011 –Before	Difference: 2011 – BaU
8. CO_2 emissions	-206,09 g/km	-170,52 g/km	-300,69 g/km	-256,12 g/km
9. CO emissions	-8,78 g/km	-3,04 g/km	-9,52 g/km	-3,38 g/km
HC emissions	-1,94 g/km	- 0,84 g/km	-2,15 g/km	-1,05 g/km
10. NOx emissions	-13,45 g/km	-5,96 g/km	-14.89 g/km	-7,50 g/km
11. Particulate emissions	-0,69 g/km	-0,31 g/km	-0,77 g/km	-0,40 g/km

As referred above, the calculation of the BAU case has been done assuming that the offered service in each corresponding year is the same as in the CIVITAS scenario in terms of total Kms per year. But in the case that the CIVITAS measures would have not been applied, the total fuel consumption would have been fully Diesel. The values of CO_2 emissions are obtained taking into account the 7% content of Biodisel in the Diesel EN590.

For the BAU values of CO, HC, NOx and PM, is supposed that no EEV have been purchased during the CIVITAS period, so the share of emissions standards in the fleet is worse than the real one as it's shown in the following graphics. In the BAU scenario calculations, also the Fuel Efficiency value before CIVITAS is used:

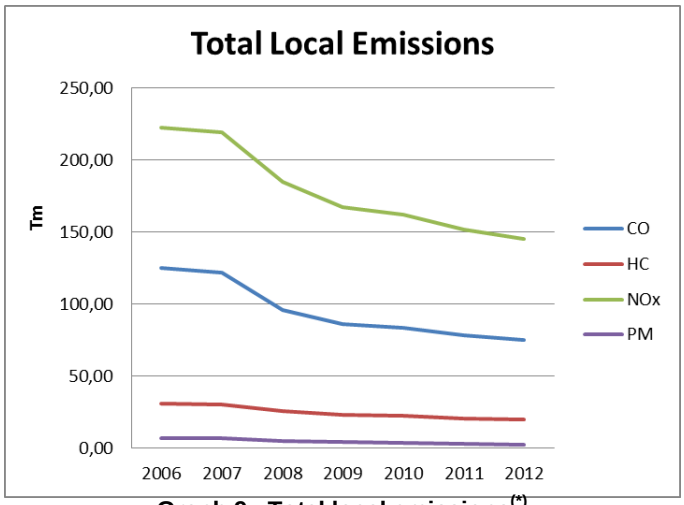


Graph 7 –Fleet composition regarding emissions standards – CIVITAS scenario (2011)

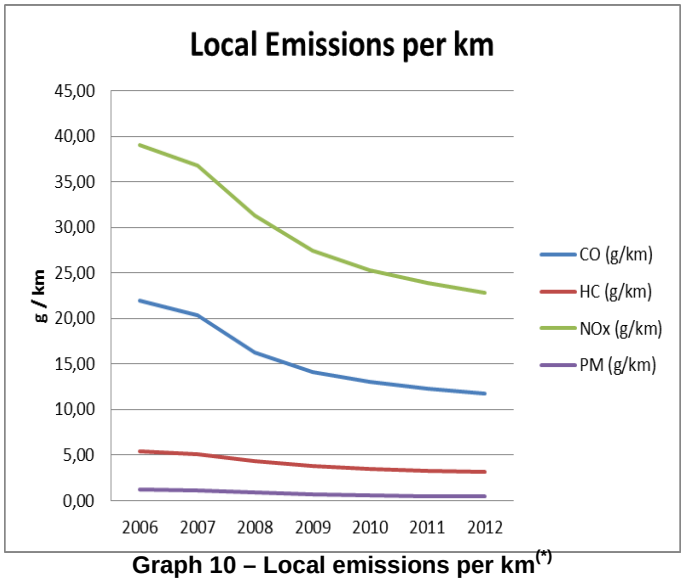


Graph 8 –Fleet composition regarding emissions standards – BaU scenario (2011)

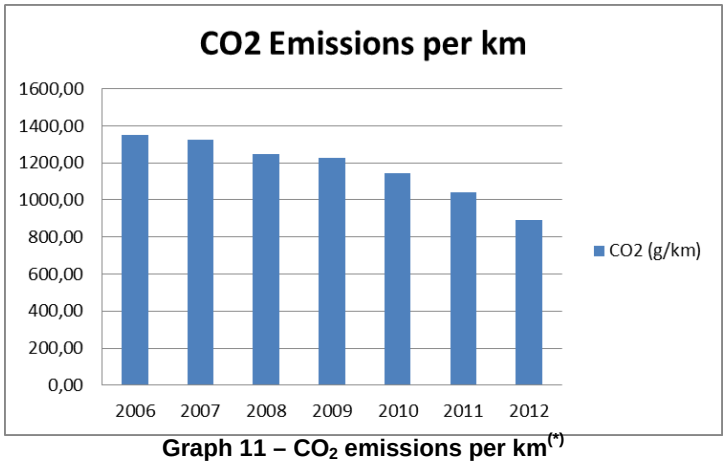
Due to the high renewal of the fleet since the beginning of CIVITAS, and moreover because of the purchasing of EEV buses, and retiring of old Euro 0 and Euro 1 buses, the level of Local Emissions has decreased. And all these despite of the increasing of total number vehicles in the fleet and kilometres per year.



Graph 9 –Total local emissions(*)



Graph 10 – Local emissions per km(*)



Graph 11 – CO_2 emissions per km(*)

(*) 2012 values estimated according to current fleet composition and vehicle-km offered

In 2011, the relative reduction of all pollutant emissions is above 20%, ranging from 20,15% for CO_2 emissions to the 45,33% reduction achieved for particulate matter. In absolute terms, the use of biofuel has meant a reduction of 1.707 tonnes of CO_2 emissions in 2011. While local pollutants emission saving nearly reached 81,3 tonnes in the same year (24,3 tonnes of CO; 6,7 tonnes of HC; 47,7 tonnes NOx and 2,57 tonnes PM).

C2.5 Cost benefit analysis

The CBA of this measure will focus on the effect of new EEV buses and the use of bio-fuels. Therefore, costs and benefits will relate to the impacts derived from the use of this enhanced technology. The impacts associated to improved operation and priority measures will be omitted from this analysis and addressed in the CBA corresponding to measure 16. It was intended to include in the analysis the modal shift towards public transport influenced by this measure. A specific survey was designed for that purpose. Nevertheless, as already mentioned above, none of the surveyed users who declared to be previous users of other means of transport points out to environmental performance as the reason for their modal change.

Also, the extension of the use of bio-fuels to other municipal fleet and among citizens in general will not be covered in the analysis. Neither will be the use of hybrid buses, whose CBA could be done according to a similar scheme once it will be implemented on a more extensive scale (the CIVITAS project only considers the introduction of one hybrid vehicle as a pilot experience).

C2.5.1 Evaluation period for CBA

The evaluation period correspond with the estimated project life, which is determined according to the technical life of the new EEV vehicles that will be introduced in the municipal public transport fleet. According to CTSS criteria and suppliers' technical recommendations, the technical life of EEV vehicles is estimated in 10 years.

Following EU recommendations a discount rate of 3.5% is used for the analysis.

C2.5.2 CIVITAS and reference case

As mentioned above, the CIVITAS scenario refers to the generalized use of biodiesel in CTSS-DBUS' fleet, including the implementation of a mixing/filling station, as described in

this report. Also the introduction of 31 EVV in CTSS-DBUS fleet is considered. As well as the economic implications of the promotional campaigns regarding cleaner vehicles and alternative fuels.

The main parties affected by the measure and a brief description of their implications are identified in the following table:

Agent	Implications
Public Transport Operator	Have subcontracted the study, purchase the biofuel and EEV vehicles, as well as bore part of the costs derived from the promotional activities. Operation and maintenance of the public transport fleet has been altered, being this a CTSS responsibility.
Administration	The Municipality has bore part of the costs derived from the promotional activities. Aldo, since biofuels are affected by lower taxes than fossil fuels, the Administration revenues have been lowered in accordance to the level of fuel substituted.
Society	Donostia-San Sebastian citizens, especially those living around the CIVITAS corridors, benefit from an improvement on air quality due to the reduced emissions (air pollutants) of biodiesel powered and EEV vehicles. Also, the overall society benefit from a reduction in green-house gasses emissions (reduced global warming)

A reference case is required for comparison with the CIVITAS measure. The BaU scenario is used for that purpose, which would mean not implementing biodiesel blends at all in CTSS' bus fleet. No fossil fuel would be substituted and the CTSS would continue being totally dependent on Diesel. Also the extensive fleet renewal with EEV buses would have not take place. Emissions would continue growing during the evaluation period.

The following section undertakes a description on how the impacts have been assessed and monetised for its further analysis.

C2.5.3 Method and values for monetisation

Prior to its monetization, the main impacts of the measure are synthesized in the following table in the form of cost and benefits affecting the above referred parties:

Agent	Cost	Benefit
Public transport operator	– Study costs – Capital costs (EEV vehicles and infrastructure) – Operation and maintenance (public transport fleet)(1) – Promotion activities costs	– (Less taxes)(2) – Increased revenues(3) – Improved public image(4)
Administration	– (Less taxes) (2)	
Society		– Better air quality – Less carbon emissions
Car Users		– Time savings(4)
Public transport users		– Time savings(4)

(1) The use of bio-diesel increases fuel consumption and higher biodiesel blends require higher maintenance costs.

(2) It is the same amount acting as cost of benefit, depending on the party considered. It is therefore omitted from the calculation.

(3) Only the share of it corresponding to this measure

(4) Difficult to assess: omitted.

Following is a description on how the impacts have been assessed and monetised, including the reference values used for its conversion to money values where applicable:

- Capital costs: The capital costs are calculated as the average amortization of the bus fleet and its associated infrastructure (pumping station, etc.). The higher investment costs associated to the introduction of EVV buses has been considered. Following CTSS' standard criteria, a 10 years depreciation period has been considered. In addition, the costs corresponding to technical studies during the preparation phase and promotional activities have been accounted.

  For the reference case it has been considered that no further investments would have occurred if the CIVITAS funds were not available.

- Operation and maintenance costs: these costs include the annual personnel salaries and costs of CTSS' workshop, and the annual expenses in fuel and bio-fuel.

  The estimation of the reference case has been done assuming that the offered service in each corresponding year is the same as in the CIVITAS scenario in terms of the total number of kms per year. But in the case that the CIVITAS measures would have not been applied, the total fuel consumption would have been fully Diesel. Also, it is assumed that after the CIVITAS project finishes there would not be changes in the fleet composition and offered service. Therefore, operation and maintenance costs would only be affected by inflation in the future years.

- CO_2 and pollutant emissions: pollutant emission values have been estimated according to the data of fuel consumption in the bus fleet, which is transformed to energy with the energy content factor of each fuel (diesel and biodiesel).

  To calculate the local pollutants (HC, NOx, PM) the energy conversion factor from Diesel and Biodiesel to energy has been used, according to each vehicle type.

  The reference case has been estimated assuming that the offered service in each corresponding year is the same as in the CIVITAS scenario in terms of the total number of kms per year. But in the case that the CIVITAS measures would have not been applied, the total fuel consumption would have been fully diesel. In this case, the values of CO_2 emissions are obtained taking into account the 7% content of Biodisel in the Diesel EN590. While for HC, NOx and PM, it is supposed that no EEV have been purchased during the CIVITAS period, so the share of emissions standards in the fleet is worse than the one in the CIVITAS scenario.

  The following sources have been used for the monetisation of these impacts:

Pollutant	Cost factor	Value year	Source
CO_2	25 €/tonne (2010) 40 €/tonne (2020)	-	IMPACT 2008 (Central value)
HC	400 €/tonne	€ 2000	IMPACT 2008 (CAFÉ)
NOx	2600 €/tonne	€ 2000	IMPACT 2008 (CAFÉ)
PM	119900 €/tonne	€ 2000	IMPACT 2008 (HEATCO Metropolitan / Urban)

C2.5.4 Life time cost and benefit

Capital costs:

- CIVITAS scenario: amortization of the current bus fleet and its associated infrastructure (pumping station, etc.). The higher investment costs associated to the introduction of EVV buses has been considered. Also the costs corresponding to technical studies during the preparation phase and promotional activities have been accounted.

- Reference case: amortization of the "before CIVITAS" fleet (without new EVV buses). No further investments are considered.

Table C2.5.1 Capital cost in the evaluation period (not discounted)

	Cases for comparison	Cost (e.g. €200,000)
Year 1	CIVITAS measure	1.155.783,00
	Reference case (or BAU)	1.144.394,00
Year 2	CIVITAS measure	1.328.847,00
	Reference case (or BAU)	1.275.358,00
Year 3	CIVITAS measure	1.395.508,00
	Reference case (or BAU)	1.341.803,00
Year 4	CIVITAS measure	1.364.237,00
	Reference case (or BAU)	1.300.961,00
Year 5	CIVITAS measure	1.405.164,11
	Reference case (or BAU)	1.339.989,83
Year 6	CIVITAS measure	1.447.319,03
	Reference case (or BAU)	1.380.189,52
Year 7	CIVITAS measure	1.490.738,60
	Reference case (or BAU)	1.421.595,21
Year 8	CIVITAS measure	1.535.460,76
	Reference case (or BAU)	1.464.243,07
Year 9	CIVITAS measure	1.581.524,59
	Reference case (or BAU)	1.508.170,36
Year 10	CIVITAS measure	1.628.970,32
	Reference case (or BAU)	1.553.415,47

Operation and maintenance costs:

- CIVITAS scenario: annual personnel salaries and costs of CTSS' workshop, and the annual expenses in fuel and bio-fuel according to the current fleet composition.

- Reference case: annual personnel salaries and costs of CTSS' workshop, and the annual expenses in fuel and bio-fuel according to the "before CIVITAS" fleet composition.

Table C2.5.2 Operation and maintenance costs in the evaluation period (not discounted)

	Cases for comparison	Cost (e.g. €200,000)
Year 1	CIVITAS measure	4.468.221,00
	Reference case (or BAU)	3.999.505,24
Year 2	CIVITAS measure	3.998.398,00
	Reference case (or BAU)	4.070.619,38
Year 3	CIVITAS measure	4.631.668,60
	Reference case (or BAU)	4.396.585,46
Year 4	CIVITAS measure	5.075.219,95
	Reference case (or BAU)	4.534.124,72
Year 5	CIVITAS measure	5.176.724,35
	Reference case (or BAU)	4.624.807,22
Year 6	CIVITAS measure	5.280.258,84
	Reference case (or BAU)	4.717.303,36
Year 7	CIVITAS measure	5.385.864,01
	Reference case (or BAU)	4.811.649,43
Year 8	CIVITAS measure	5.493.581,29
	Reference case (or BAU)	4.907.882,42
Year 9	CIVITAS measure	5.603.452,92
	Reference case (or BAU)	5.006.040,06
Year 10	CIVITAS measure	5.715.521,98
	Reference case (or BAU)	5.106.160,87

Costs from environmental emissions:

- CIVITAS scenario: estimated according to the data of fuel consumption in the bus fleet, according to the current fleet composition, which is transformed to energy with the energy content factor of each fuel category (diesel and biodiesel) to estimate CO_2 emissions. While for local pollutants conversion factors corresponding to each fuel category and vehicle type have been used.

- Reference case: similar approach, but considering that the offered service in each corresponding year is operated solely with fully diesel powered buses. Also it is considered that that no EEV buses have been purchased during the CIVITAS period.

Table C2.5.3 Costs from environmental emissions (not discounted)

	Cases for comparison	Values (e.g. €200,000)
Year 1	CIVITAS measure	1.637.288,15
	Reference case (or BAU)	1.739.854,71
Year 2	CIVITAS measure	1.388.446,75
	Reference case (or BAU)	1.590.026,22
Year 3	CIVITAS measure	1.291.255,49
	Reference case (or BAU)	1.753.252,01
Year 4	CIVITAS measure	1.178.195,40
	Reference case (or BAU)	1.783.690,35
Year 5	CIVITAS measure	1.188.534,92
	Reference case (or BAU)	1.796.652,79
Year 6	CIVITAS measure	1.198.874,43
	Reference case (or BAU)	1.809.615,23
Year 7	CIVITAS measure	1.209.213,95
	Reference case (or BAU)	1.822.577,67
Year 8	CIVITAS measure	1.219.553,46
	Reference case (or BAU)	1.835.540,11
Year 9	CIVITAS measure	1.229.892,98
	Reference case (or BAU)	1.848.502,55
Year 10	CIVITAS measure	1.240.232,50
	Reference case (or BAU)	1.861.464,99

C2.5.5 Compare the lifetime costs and benefits

Table C2.5.4 Lifetime cost/benefit of CIVITAS measure (discounted)

	Capital cost	Operation and maintenance cost	Costs from environmental emissions	Total cost	Total Benefit	Cumulated cost
Year 1	1.155.783,00	4.468.221,00	1.637.288,15	7.261.292,15	0,00	7.261.292,15
Year 2	1.283.910,14	3.863.186,47	1.341.494,44	6.488.591,06	0,00	6.488.591,06
Year 3	1.302.721,65	4.323.712,20	1.205.400,82	6.831.834,67	0,00	6.831.834,67
Year 4	1.230.463,61	4.577.557,61	1.062.664,75	6.870.685,97	0,00	6.870.685,97
Year 5	1.224.519,34	4.511.216,20	1.035.739,51	6.771.475,06	0,00	6.771.475,06
Year 6	1.218.603,79	4.445.836,25	1.009.420,10	6.673.860,15	0,00	6.673.860,15
Year 7	1.212.716,82	4.381.403,84	983.696,33	6.577.816,99	0,00	6.577.816,99
Year 8	1.206.858,28	4.317.905,24	958.558,00	6.483.321,52	0,00	6.483.321,52
Year 9	1.201.028,05	4.255.326,90	933.994,94	6.390.349,89	0,00	6.390.349,89
Year 10	1.195.225,98	4.193.655,50	909.997,00	6.298.878,47	0,00	6.298.878,47
Total	12.231.830,66	43.338.021,22	11.078.254,03	66.648.105,91	0,00	66.648.105,91

(*) A discount rate of 3.5% has been used for the analysis

Table C2.5.5 Lifetime cost/benefit of the reference measure/case (discounted)

	Capital cost	Operation and maintenance cost	Costs from environmental emissions	Total cost	Total Benefit	Cumulated cost
Year 1	1.144.394,00	3.999.505,24	1.739.854,71	6.883.753,95	0,00	6.883.753,95
Year 2	1.232.229,95	3.932.965,58	1.536.257,21	6.701.452,75	0,00	6.701.452,75
Year 3	1.252.587,46	4.104.259,58	1.636.679,51	6.993.526,54	0,00	6.993.526,54
Year 4	1.173.392,28	4.089.520,72	1.608.786,50	6.871.699,51	0,00	6.871.699,51
Year 5	1.167.723,72	4.030.252,30	1.565.679,11	6.763.655,14	0,00	6.763.655,14
Year 6	1.162.082,55	3.971.842,85	1.523.647,47	6.657.572,86	0,00	6.657.572,86
Year 7	1.156.468,62	3.914.279,91	1.482.668,11	6.553.416,64	0,00	6.553.416,64
Year 8	1.150.881,81	3.857.551,22	1.442.717,93	6.451.150,96	0,00	6.451.150,96
Year 9	1.145.322,00	3.801.644,68	1.403.774,20	6.350.740,87	0,00	6.350.740,87
Year 10	1.139.789,04	3.746.548,38	1.365.814,52	6.252.151,93	0,00	6.252.151,93
Total	11.724.871,44	39.448.370,45	15.305.879,26	66.479.121,16	0,00	66.479.121,16

(*) A discount rate of 3.5% has been used for the analysis

C2.5.6 Summary of CBA results

For the summary of CBA results the changes in benefits and costs between the two scenarios are assessed. In this case there are no benefits associated to them. But emission savings are a benefit resulting from the implementation of the CIVITAS measure. Therefore they are considered as such in this summary.

The corresponding Net and Cumulative Cash Flow is also considered in the following summary.

Table C2.5.6 Lifetime changes in costs and benefit (discounted)

	Changes in Costs	Changes in benefits	Net cash flow	Cumulative cash flow
Year 1	480.104,76	102.566,56	-377.538,19	-377.538,19
Year 2	-18.098,92	194.762,77	212.861,69	-164.676,50
Year 3	269.586,82	431.278,69	161.691,88	-2.984,63
Year 4	545.108,22	546.121,76	1.013,53	-1.971,09
Year 5	537.759,52	529.939,60	-7.819,92	-9.791,01
Year 6	530.514,65	514.227,36	-16.287,28	-26.078,30
Year 7	523.372,13	498.971,78	-24.400,35	-50.478,65
Year 8	516.330,49	484.159,93	-32.170,55	-82.649,20
Year 9	509.388,27	469.779,25	-39.609,02	-122.258,22
Year 10	502.544,06	455.817,52	-46.726,54	-168.984,75
Total	4.396.609,99	4.227.625,24		

The change of Net Present Value of the introduction of biofuel and clean vehicles in CTSS' fleet is -168.984,75€, which means that the NPV of this measure is lower than the one associated to the use of diesel. Nevertheless, the change in NPV is very small.

The benefit to cost ratio (BCR) is 0,96 which means that costs are larger than benefits. Nevertheless, this figure is very close to 1 which can be considered a positive result.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	20 buses with B100 and rest of the fleet (100) with B20: average blend of 0,33	*
2	Purchasing of 37 EEV buses by month 40	***
3	Purchasing of 1 Hybrid Bus	**
NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%) ** = Achieved in full * = Exceeded**		

C4 Upscaling of results

There are two ways of up-scaling the measure 4:

1. Implementing 100% Biodiesel to the 100% of the bus fleet.
2. Applying the measure to other City and Regional bus fleets.

In the 1st case there would be a serious limitation with the risks related to the use of B100. This should be cleared along the CIVITAS period with the results of the Task 1.5.

If this would be possible, the results would be:

- More than 3.000.000 litres of Gas oil substituted by biodiesel per year.
- More than 7505000 tons of CO_2 saved per year.

In the 2nd case, the same benefits of the measure in the CTSS would be extensive to other fleets. Of course the savings in particle emissions, CO_2 and Gas-oil will be higher according to the higher number of vehicles shifting to bio-fuels.

One important risk of this up-scaling is that the Biodiesel suppliers must be able to afford the demand on his product. The Biodiesel manufacturers during 2008 have been working much lower than their production capacity, because of the imports but the production capacity should be analyzed to be sure they can answer a higher demand.

C5 Appraisal of evaluation approach

It is considered that the evaluation approach is in concordance with the measure objectives, and data collection procedures adequate.

The main difficulties refer to the emission modelling. There is still no clear agreement on the most suitable procedure for measuring-modelling the emissions, and so the evaluation.

Anyway, the data collected is being a very interesting source of information for the evaluation of the overall results of the measure.

C6 Summary of evaluation results

The measure has succeeded in its main objective, which is the improvement of the environmental performance of the public transport fleet in Donostia-San Sebastián. CO_2 and air pollutant emissions (CO, HC, NOx and particulate matter) have considerably decrease by means of the introduction of clean vehicles and the use of high biodiesel blends in a significant proportion of the CTSS buses.

In 2011, the relative reduction of all pollutant emissions is above 20%, ranging from 20,15% for CO_2 emissions to the 45,33% reduction achieved for particulate matter. In absolute terms, the use of biofuel has meant a reduction of 1.707 tonnes of CO_2 emissions in 2011. While local pollutants emission saving nearly reached 81,3 tonnes in the same year (24,3 tonnes of CO; 6,7 tonnes of HC; 47,7 tonnes NOx and 2,57 tonnes PM).

As already expected, the use of biofuels has led to increased fuel consumption. Which together with the increased requirements for maintenance have resulted in higher operation

and maintenance costs. Nevertheless, a significant impact on the energy side is the decreased dependency on fossil fuels for the operation of this service.

The Cost-Benefit analysis of the measure has resulted in a BCR of 0,96 which means that costs are larger than benefits. Nevertheless, this figure is very close to 1 which can be considered a positive result.

As for the public perception of the measure, a survey among public transport users has revealed that environmental issues are perceived as very important, with an average score of 8,96. Regardless this high score, only 5% of the new users of the public transport service (previously users of other means of transport for the surveyed trip) points out to environmental performance as the reason for their modal change, most often in combination with other reasons such as punctuality, convenience, etc.

C7 Future activities relating to the measure

The future plans in the application of Biodiesel are totally dependent on the final balance and the future situation of the Biodiesel:

- Purchasing price
- Overconsumption costs

If this overcosts (comparing to conventional Diesel) remain, CTSS will not be able to continue with the use of Biodiesel unless there is a subvention similar to CIVITAS Archimedes.

Also according to the experience with the hybrid bus purchased in the CIVITAS period, CTSS will plan the following purchases and will consider buying more units. That will depend, not only on the results of the experience, but also will depend on the availability of other suppliers, the price difference with the conventional buses and the development of the hybrid technology.

D Process Evaluation Findings

D0 Focused measure

1	1	Most important reason
4	2	Second most important reason
3	3	Third most important reason

D1 Deviations from the original plan

The deviations from the original plan comprised:

- **Deviation 1 - Economy indicators 1, 2a, 2b** – Instead of using the units "€/pkm" to calculate the costs indicators, "€/km" units have been used. With these units, this indicator is easier to use, as well as eases the dissemination of results.
- **Deviation 2 – Fuel Mix objective** – One of the measure objectives, regarding Fuel Mix, was the operation of 20 buses with a B100 blend of biodiesel. This objective was dismissed after a testing period due to the combination of technical problems (B100 blends caused early saturation of engine filters) and economical reasons (mainly due to overconsumption). Nevertheless, the overall objective regarding the average use of biodiesel (33%) has been exceeded by means of a generalized use of B30 and B50 blends.

D2 Barriers and drivers

D2.1 Barriers

The main barriers encountered for the development of the measure are:

Preparation phase

- **Involvement/Communication:** are reluctant to the use of biofuel on their vehicles and do not provide the operator with the needed guarantees for engine components. The main reason for it is that bus manufacturers are not confident about the quality of biofuel mixes supplied to operators, thus don't support its use.
- **Institutional:** complementing the above, there is a need for a clearer regulation regarding the quality standard applicable to biofuels.

Implementation phase

- **Technological:** There is a lack of know-how as regards of biofuel performance and lack of previous experiences that would provide sound results on biofuels operation under different circumstances (step topography, extreme weather conditions, etc.).The main impact is the uncertainty concerning certain decision, like the real limits of bio-fuel mix, influence of climate conditions, topography, etc.

Operation phase

- **Technological:** Problems aroused regarding the compatibility with engine technologies (EGR, Common Rail, EEV...). As well as with engine and injection pump suppliers.

D2.2 Drivers

As for the drivers, the main ones affecting the measure are:

Preparation phase

- **Political/Strategic:** The environmental implications of the use of alternative fuels have helped achieve the required political support for its development.
- **Institutional:** Although the regulatory framework it is not complete, the existence of the EURO Directives regarding engine technology and vehicle emissions are becoming more restrictive over time, fostering the use of cleaner vehicles and alternative fuels.
- **Organizational:** the existence of an already implemented and improved fleet maintenance program so there were no adjustments needed for the requirements of the bus manufacturer when asking them about using Biodiesel on their buses.

Implementation phase

- **Financial:** The availability of CIVITAS funding has been a significant opportunity to develop these measures.
- **Technological:** Fast and relatively not expensive implementation process. a. The use of bio-fuels does not require a costly and time consuming preparation phase. New vehicles are able to use bio-fuels without any technological intervention on them.

D2.3 Activities

In order to handle the above referred barriers and/or to make use of the drivers, the following activities were taken during the implementation of the measure:

Preparation phase

- **Technological:** Provide a proper starting point with previously cleaned fuel tanks, special filters and new and reliable mixing pumping Station..

Implementation phase

- **Organizational:** The lack of existing know-how has been approached by the creation of an environment in favour of innovation among all staff levels in the company, involving a wide range of workers in the development of pilot experiences through all their phases.

- **Operation phase**
  - **Involvement/Communication:** Continuous contact with biodiesel supplier and bus manufacturer during the testing periods, controlling any deviations in the results.
  - **Problem related:** In order to avoid unexpected engine related problems as well as to gain the confidence of bus manufacturers regarding the quality of biofuels, a minimum number of biofuel suppliers are approached.

D3 Description of organisations and risks

D.3.1 Measure partners

Following there is a brief description of all project partners and its level of involvement with the measure:

- **CTSS - Municipal Public Transport Company -** Control the implementation of the biodiesel in the bus fleet. Control of maintenance of buses running in biodiesel. Leading role.
- **Department of Mobility - City of Donostia-San Sebastian -** Legal barriers to the development of incentive measures that would favour the users of bio-diesel are being studied. Promotion of biofel among municipal fleet. Principal role.
- **Municipal Police Department -** Introduction of hybrid vehicles in their fleet. Occasional role.

D.3.2 Stakeholders

- **Bus manufacturers -** Continuous contact during the testing periods, controlling any deviations in the results, as well as potential technical implications in engines and components.
- **Biofuel suppliers -** Continuous contact to guarantee quality standards in the provided biofuel, as well as to control performance and assess results.

D4 Recommendations

D.4.1 Recommendations: measure replication

- **Blending - pumping station –** It is highly recommended to accompany the introduction of biofuels in the bus fleet by the implementation of an own mixing/filling station. The availability of an own filling-mixing station favours experimentation with increased biofuel mixes, which leads to a better understanding of the implications of it use under different conditions, easing the achievement of an optimal situation in each particular case,
- **Maintenance –** A proper preventive maintenance of fuel tanks, filters and pumps is highly recommended, since the use of biodiesel has revealed to have implications in the performance of these components.
- **Fuel quality –** In order to avoid potential engine problems, the quality of the fuels purchased should be ensured regularly in order to assure that high quality fuels are used, limiting the potential implications on engine components
- **Increase patterns –** A step-by-step increasing pattern regarding the percentage of biofuel in the mix is recommended, especially in older vehicles in order to avoid premature saturation of fuel filters
- **Compatibility -** Special biodiesel compatibility control with the injection pipes when using blends of more than 20% should be undertaken.
- **Climate restrictions –** It is recommended that biodiesel blends are decreased when temperatures are below 0 °C.

D.4.2 Recommendations: process

- **Staff involvement -** Involving all staff levels in the pilot experiences is highly recommended in order to create an adequate framework for innovation.
- **Stakeholder's involvement –** Commitment to partnership from bus manufacturer and fuel-biofuel supplier. Steady communication channels with local stakeholders are essential for that purpose.

E Summary time schedule

Task No.	Task name	YEAR 1												YEAR 2												YEAR 3												YEAR 4											
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
11.1.3	Study of alternative fuel options												XE1																	E2													E3							
1.5	Public Transport Bio-Fuels and Clean Vehicles				PX								E1						P											PE2																		
1.6	Municipal Fleet Bio Fuels and Clean vehicles												PE1						X											E2													E3						
Evaluation tasks																																																
Workshop for process evaluation																			x											x													x						
Process evaluation report																				x											x													x					
Deliverables																																																
M12.1 Draft MLEP								X																																								
D12.1 Final MLEP																												X																				
D12.2 Baseline and first results Temp																																		X														
D12.3 Draft results Temp																																													X			
D12.4 Final result temp																																																X