Measure title: **CLEAN AND ENERGY EFFICIENT PUBLIC TRANSPORT FLEET IN BRESCIA**

City: **Brescia** *Project:* **MODERN** *Measure number:* **01.06**

M01.06 – Executive summary

The main purpose of this measure was to renew the Local Public Transport (LPT) fleet, purchasing new clean and energy efficient vehicles. The measure foresaw a series of actions aimed at improving LPT both from the emissions and the service offer to citizens point of view, trying to solve the problems related to the busses overcrowding, increasing the fleet punctuality and then increasing the number of passengers offering more comfortable vehicles.

The new vehicles (which substitute the older ones) were activated on the bus line n.1, which crosses the city from north to south, serving the most important university poles, many schools, the train and the extra-urban bus stations, where the main criticalities were detected. The measure mainly consists of actions related to the purchase and the equipment of the new busses. Specific actions were addressed to the bus drivers, in order to increase their awareness about the new vehicles (especially the 18 m long ones) which represent an absolute novelty for the city of Brescia, from the technical and the driving point of view (as a matter of fact, many problems are related to the difficulties in driving the new 18 m vehicles on the roundabouts). Other specific activities concerned the dissemination about the actions implemented within the measure.

In order to evaluate the objective achievement, a set of indicators were collected to monitor the objective achievements, to check the environmental care, to evaluate the pollutant emissions and to know the accuracy of time keeping and the average occupancy.

The general goal to renew the fleet was exceeded thanks to the implementation of coordinated actions such as the CNG vehicles purchase (45% of the fleet in 2008; 59% in 2011), their introduction into the bus network (54,86% of km travelled in 2008; 73,37% in 2011) and the promotional campaigns which let citizens know about the new service and its advantages.

In order to replicate elsewhere the measure, it would be important to highlight the necessity of a strong integration among the measure implementation, the information campaigns and the measure monitoring, in order to make users aware of the reasons why the actions are undertaken (for example, a good level of information about the initiative carried out in Line 1 was important for users in order to make them understand the reduction of buses frequency and not to see this choice as a worsening of public transport service).

Another important issue was the direct involvement of stakeholders (namely the citizens of the city of Brescia), also through a massive dissemination campaign, in order to widespread information throughout the Brescia territory.

A. Introduction

A1 Objectives

The measure objectives are:

(A) High level / longer term:

- To reduce air pollution, exhaust gases and noise;
- To increase the use of alternative fuels.

(B) Strategic level:

- To make public transport fleet more efficient and also more comfortable and suitable for an on demand transport system

(C) Measure level:

(1) To increase the weight of the CNG (methane gas powered) fleet in order to reduce emission from Public Transport vehicles by purchasing 40 new CNG buses – that is up to 25% of the whole fleet – and 3 CNG busses for on-demand transport services);

(2) To keep the fleet average age younger than 8 years;

(3) To minimize the buses' overcrowding in the bus lines crossing the old town and, at the same time, reduce the service frequency by substituting the 12m buses in operation with CNG 18m ones. This can lead to an increase in number of available seats even if the total number of trips of a certain bus line is decreased;

(4) To improve accuracy of time keeping ;

(5) To increase the number of passengers by 5% in the demo area;

(6) To increase the km covered by CNG bus by more than 60%.

A2 Description

The city of Brescia has decided to implement the measure in order to increase the quality level of transport system according to the local transport company BST[1] strategic level policy to improve the fleet quality with less pollutant and more comfortable vehicles. The measure objectives have then be accomplished through a PT fleet renovation based on existing available technologies. Hence, the main target of the measure is to increase the quality and the effectiveness of the public transport system both from an environmental and a service point of view.

[1] BST: Brescia Trasporti.

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In the first phase of project implementations the new vehicles introduced in the PT fleet for substituting the older ones were addressed to cover the Line 1 (Fig. 1).

Fig. 1 The Line 1 network in Brescia

This line crosses the city from north to south, passing through the historical centre. It links the most important territorial services of the city (such as the hospital and the University – Engineering and Medicine Faculties) that are located in the northern part of Brescia while the railway station and the suburban bus station are placed in the southern part of the city, just outside the historical centre. This line is also used by students of several high schools in Brescia.

The line can be considered critical from several points of view. Firstly, to respond to the high transport demand there is a high frequency of busses (about 1 bus every 5 minutes), and as a consequence "bus queuing" problems have emerged. Additionally, there is an overcrowding problem with a consequent low quality of service, that has become unsustainable from the customer point of view during peak hours (8.106.965 passengers transported in year 2008). Moreover, bus equipment needed to be modified due to overcrowding problems.

The envisaged solution has then been to introduce 18m busses, and so increasing the capacity from 92 seats (Irisbus model) or 98 (Breda model) to 149 seats / bus. In this way it is possible to reduce the number of trips and, at the same time, to keep an efficient service.

During the measure implementation, it has been faced an economic restraint that led to a decrease in the number of purchased buses, which came out to be the following:

- n.20, 18mt nCNG;
- n.6, 12mt CNG; (other 6 12m long CNG buses have already been ordered by BST, but they haven't been put into service yet. Furthermore, 3 of them have already been delivered);
- n.6, 8mt busses (of which 2 CNG and 4 Hybrids methane gas-electric).

Finally, among the new purchased buses, 2 of the 8mt long ones (hybrids) have been dedicated to the 'on demand' service addressed to disabled people (the service is called Accabus and is object of another Civitas Measure2), while the other 8mt buses have been used for ordinary PT service (for more details see the section B of this document).

[2] M06.02 – 'On-demand PT service in Brescia'.

B. Measure implementation

B1 Innovative aspects

The innovative aspect of the measure is:

- **New mode of transport exploited** – This has been the first time that the city of Brescia has introduced 18mt CNG buses among their PT fleet. The adoption of these new vehicles (substituting the older ones) cannot be considered actually a "new mode of transport", but an innovative aspect can be found in both the kind of fuel used by the busses and the different transport capacity reached by the 18m busses compared to the 12m ones. It is worth noting that BST has always given a particular attention to users opinions about the service and the environmental issues through periodic customer satisfaction surveys. Then, in case of problems emerging from these surveys, BST has always promptly reacted by adopting a new strategic approach. In this context, besides the environmental issue, also the improvement of the quality of service has been taken into consideration. To this end through the reduction of the bus frequency and, at the same time, the introduction of 18m new Clean buses characterized by a higher capacity BST has found a solution to the problems expressed by citizens in the survey.

B2 Research and Technology Development

BST made a benchmarking research on the market state of art in order to have a deeper knowledge about the following themes:

- the best seat configuration and door layout, in order to guarantee a speed-up of getting on board together with a comfortable travel for all, especially for elderly and disabled people;
- the best integration of the 18mt CNG buses with the urban transport system, both for passengers and for drivers;
- interoperability of AVM[3] hardware with the on demand software.

In order to do that, technical meetings has been organised in Modena to analyze the characteristics of the new Citelis CNG 12 mt bus and in Milan for 8,5mt bus. The choice of which type of bus would have been the optimal solution implied the identification of the required vehicle features. Therefore a market research has been done, focused on the elaboration of the technical specifications to be used used to elaborate the tender document. The following aspects have been taken into consideration:

- ✓ rules to eliminate architectural barriers;

[3] The Automatic Vehicle Monitoring (AVM) is a system that allows to monitor various parameters relating to vehicles in motion including position, stops and a flew engine parameters;

- ✓ equipment, design features and rules on "Regional Technical specifications for busses" and "Municipal Technical and Functional Requirements for Buses" for the agreement between Lombardia Region and Brescia Municipality;
- ✓ technical features of European Directive 2001/85/CE and Directive amended on 20 November 2001, in which there are features for means of transportation with more than 9 seats;
- ✓ rules about polluting emissions;
- ✓ CUNA 504-02 standard and European Directive CEE 92/97 on permissible sound levels of motor vehicles.

The selected features are coherent with user needs and the characteristics of the PT services.

B3 Situation before CIVITAS

BST has always cared about environmental and mobility needs. The company has continuously promoted the use of alternative fuels and of clean and energy efficient vehicles, in order to reduce pollution, exhaust gases and noise. Additionally, a particular attention has been given to elderly and disabled people by, for instance, offering a bus service with vehicles equipped with low floor and retractable steps.

Before CIVITAS, BST policy was to replace about 10 buses every year by introducing CNG buses, and experimenting also high-tech solutions. Moreover, in 2003 the company received the award "Environment-Friendly Innovation" for the four innovative hybrid 8 mt long buses (methane-electric).

BST experimented the application of new available technology able to turn an Euro 1 bus into a Euro 4 one. For this project BST received in 2005 another award "Environment-Friendly Innovation" for "Diesel buses turned into full methane buses". Before the CIVITAS project BST urban fleet had 73/209 CNG vehicles, and the kilometres covered with CNG buses were about 50% out of the total driven by the fleet.

The results of the customer satisfaction (periodically carried out by BST among LPT users) pointed out some overcrowding problems on line 1, for this reason – thanks to CIVITAS – it was decided to substitute all the 12mt long buses running on that line with the new 18m CNG buses (co-funded by Civitas).

B4 Actual implementation of the measure

The measure was implemented in the following stages:

Stage 1: Survey and Definition of methodology and measure concept *(from March 2009 to September 2009) – The activities were linked to the research made to select the most suitable features to be introduced on line 1.*

Stage 2: Tender and delivery of the fleet (21 buses) *(from October 2008 to September 2009) – during this period the first group of CNG 18m busses - 20 units has been purchased (Fig. 2). The acquisition was made through tender procedures scheduling the technical features defined during the research phase (stage 1). From a methodological point of view, all these activities have been formalized in official documents subscribed by the involved partners.*

In June 2009 a 12m bus (Fig. 3) has been bought in occasion of a meeting attended in Modena as special offer (zero-km vehicle). This bus wasn't characterized by the required technical features, but its purchase fitted with the company strategies and with the high/strategic level objectives of the measure (to increase the use of alternative fuels and to make public transport fleet more efficient and also more comfortable for the elder people, suitable to an on demand transport system).

The purchase of 12m busses hasn't been an occasional decision but it was part of the BST strategy (a 12m busses fleet already existed) in coherence with the Municipality and with the Lombardia Region policies that foresee a constant renewal of the fleet.

Fig. 2 Citelis 18m bus

Fig. 3 Citelis 12m bus

Stage 3: Buses equipment *(from October 2008 to December 2010) – This stage consisted in the equipment of the purchased busses (Fig. 4) and in their road test (concluded by a test minute). On each new bus the following devices were installed:*

- ✓ *AVM system (a driver console - Fig. 5 - , a system that allows a radio broadcasting (TETRA), GPS item and GPRS item)*
- ✓ *Two or three ticketing machines.*

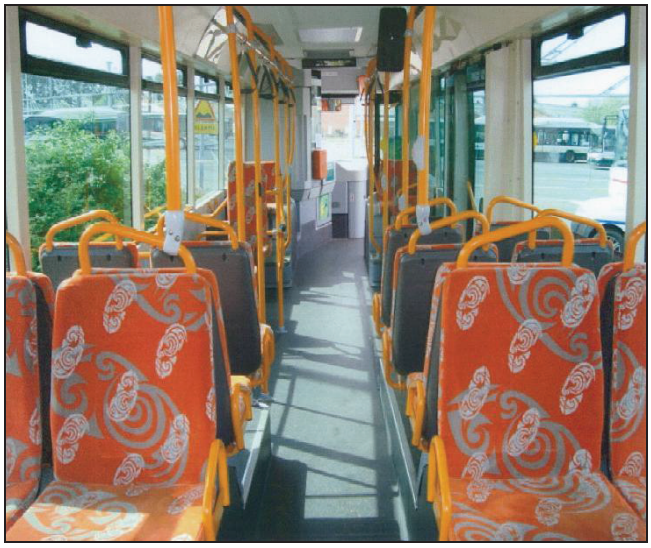


Fig. 4 Bus interior equipment

All the purchased busses were equipped. In particular, the 12 m long bus purchased in occasion of a special offer required a specific equipment (the light itinerary indicator on the front side of the bus required to be adapted to the BST fleet parameters: as a matter of fact, it differed from the other buses as the bus was originally destined to a foreign country). The road tests consisted in road holding, watertight, level of noise and braking/acceleration tests.

Stage 4: Training of actors involved *(from January 2009 to December 2010) – Internal technical training activities were attended by about 200 bus driver. The involved driver are the ones able to drive a 18m long vehicle because provided with the specific driving licence. The training consisted in the detailed description of the main new features (technical and mechanical equipment), in a trial lap on the line 1 road map and in the distribution of a brochure containing the information about controls and the technical equipment. This stage was important because no 18m busses had ever been driven before and there were potential problems in some roundabouts and in a dogleg bend near the train station.*

Fig. 5 A driver console

Stage 5: Operational lunch of the measure and system running *(from March 2009 to October 2012) – This stage consisted in putting into service and fitting the new purchased fleet. In particular, the preliminary undertaken actions have been the following:*

- ✓ *March 2009 Technical timetable review for the line 1 due to the introduction of new longer buses characterized by a lower frequency and by a higher capacity;*
- ✓ *March 2009 opening of the new CNG bus to the public on line 1 and on the school routes in order to solve the overcrowding problems;*
- ✓ *July 2009 final authorization by the Municipality to use new CNG buses for public transportation service.*

Stage 6: Tender and delivery of the fleet *(from September 2010 to December 2011[4]) – This stage was referred to the second part of the task 01.06.04 and was dedicated to the purchase of the remaining group of busses through specific tender procedures.*

The final set of purchased buses are reported in the following table. All the reported buses have already been put into service and are the ones financially reported in Civitas.

N° of new purchased buses	Type	In service since
20	18m CNG	1st March 2009
1	12m CNG	1st September 2009
2	8m Hybrid	24th February 2011
5	12m CNG	22nd March 2011
2	8m CNG	17th February 2011
2	8m Hybrid (dedicated to the on demand service addressed to disabled people "Accabus", object of the Civitas M06.02)	14th June 2011

From the evaluation process point of view it's important to remark the interest shown by the Municipality during the technical meetings (attended by the Social Policies Councillor) about the new busses to be purchased for the "On demand service" dedicated to disabled/elder people.

Despite the DOW's provision, it's important to stress the following aspects:

- *any new 8m CNG buses have been used for the Accabus service (on demand service see measure 06.02 "On demand public transport") because they were not suitable for the disabled transport needs: as a matter of fact, the methane gas tanks didn't allow the wheelchair platform to properly*

[4] *By the end of the stage, according to the DOW foreseen in December 2011, BST had not purchased the whole planned new busses, because of some difficulties due to PT budget reduction regional laws. This is the reason why BST required to extend the stage.*

move, therefore hybrid 8m buses were used instead of CNG. 8m long buses were already present in the BST fleet (before Civitas). These short vehicles were dedicated to the On demand services called Accabus (for disabled/elder people), to the Bussola service (which links two peripheral parkings) and to the bus service in the smallest downtown roads.

- *Because of the economical crisis (which led to the reduction of the transport company budget) less buses than the DOW's provision have been bought within Civitas. Therefore, this stage can be considered concluded, but it's important to say that in the last few days of the Civitas BST purchased other 6 new CNG buses (12m long) project. These buses haven't been financially reported in Civitas, therefore they haven't been included in the amount of buses purchased during the project. It's important to credit the commitment of BST for pursuing the fleet renewal, notwithstanding the economic crisis.*

Fig. 6 - 8,5m busses

B5 Inter-relationships with other measures

The measure has potential interactions with M.06.02 "On demand public transport service in Brescia", in particular because both of the measures belong to the same BST policy aiming "to improve the public transport service quality with less pollutant and more comfortable vehicles", and for this reason 3 of the 8mt busses purchased within this measure have then been used for the on demand services.

C. Evaluation – methodology and results

From the evaluation point of view it's important to remind that the main objective of the measure consists on the one hand in renewing the fleet to reduce pollutant emissions (incrementing progressively the number of methane gas powered buses), on the other in keeping high the transport service quality level, especially for the most loaded bus lines (such as line 1 which crosses the city from North to South). As a matter of fact, line 1 is characterized by overcrowding problems and it suffered also punctuality problems. This is the reason why specific indicators were chosen to monitor the whole fleet, while others were related to line 1 only (see the list of indicators reported below).

C1 Measurement methodology

The indicators have been divided into two macro-categories: main indicators and complementary indicators.

"Main" indicators are able to evaluate the measure efficiency in terms of objectives achievement. In addition "complementary" indicators were introduced in order to asses specific issues and to better understand the measure performance.

C1.1 Impacts and Indicators

Table C1.1: Indicators.

No.	Impact	Indicator	Data used	Comments
1.	Operating revenues	Average Operating revenues	Total income generated from fares and tickets divided by total passengers. Indicator directly provided by Brescia Trasporti	Main Indicator; First data collection after the OP: year 2009
2.	Operating costs	Average operating cost	Total operating cost (raw, service and personnel) divided by total passengers. Indicator directly provided by Brescia Trasporti	Main Indicator; First data collection after the OP: year 2009
3.	Fuel consumption	Vehicle fuel efficiency	Tot fuel consumed per year and by type of vehicles (lt diesel; m^3 cng); Tot km travelled by fleet per year; Fleet composition (BST database)	Main Indicator; First data collection after the OP: year 2009
4.	Emissions	CO emissions	Number of vehicles, Km travelled by fleet per year and CO emissions per year	Related to all fleet; complementary Indicator;

No.	Impact	Indicator	Data used	Comments
			(kg). (BST database)	First data collection after the OP: year 2009
5.	Emissions	NOx emissions	Number of vehicles, Km travelled by fleet per year and NOx emissions per year (kg). (BST database)	Related to all fleet; complementary Indicator; First data collection after the OP: year 2009
6.	Emissions	Small particulate emissions	Number of vehicles, Km travelled by fleet per year and SP emissions per year (kg). (BST database)	Related to all fleet; complementary Indicator ; First data collection after the OP: year 2009
7.	Emissions	% Km clean bus	Km travelled by each kind of busses (BST database)	Main Indicator; First data collection after the OP: year 2009
8.	Emissions	NCG busses/total fleet	Fleet composition by type of fuel (BST database)	Main Indicator; First data collection after the OP: year 2009
9.	Noise	Noise perception	Measurement of noise perception for a bus driver at work.	Complementary Indicator; First data collection after the OP: year 2009
10.	Service reliability	Accuracy of time keeping	Data come from the tele-data collectors situated in the town centre. (BST database)	Main Indicator Referred only to Line 1; First data collection after the OP: year 2009
11.	Vehicle occupancy	Average occupancy	Number of passengers of the line1 recorded by the validation machines located	Main Indicator Referred only to Line 1;

No.	Impact	Indicator	Data used	Comments
			on board. Number of trips covered by line1 busses	First data collection after the OP: year 2009
12.	PT quality increase	Environmental care	Customer Satisfaction questionnaires results	Complementary Indicator First data collection after the OP: May 2009
13.	Fuel consumption	Average fleet age	Average age of the fleet	Complementary Indicator; First data collection after the OP: year 2009

Detailed description of the indicator methodologies:

- **Indicator 1** (AVERAGE OPERATING REVENUES) – Ratio of total income generated from fares and tickets divided by the total passengers.
- **Indicator 2** (AVERAGE OPERATING COST) – Ratio of total operating costs incurred by the fleet (or line1) divided by the total passengers.
- **Indicator 3** (VEHICLE FUEL EFFICIENCY) – Vehicle fuel efficiency for each type of vehicle composing the fleet measured in MJ/v*vkm. In particular, the fleet composition is referred to the fleet which is active at the end of each year, considering the dismissing of the older vehicles.
- **Indicator 4** (CO EMISSIONS) – The calculation of the CO emission has been performed using an internal model (similar to COPERT) based on fuel consumption by each vehicle composing the fleet from Jan to Dec 2008 and on the emission factors for the specific pollutant agent. In particular, the fleet composition is referred to the fleet which is active at the end of each year, considering the disuse of the older vehicles.
- **Indicator 5** (NOx EMISSIONS) –The description of this indicator is similar to the description reported above (see Indicator 4).
- **Indicator 6** (SMALL PARTICULATE EMISSIONS) – The description of this indicator is similar to the description reported above (see Indicator 4).
- **Indicator 7** (% KM CLEAN BUS) – It's the percentage between the cover clean km and the total km.
- **Indicator 8** (N. CLEAN BUSES) – Number of NCG busses/number of complete fleet
- **Indicator 9** (NOISE PERCEPTION) – Measurement of noise perception for a bus driver at work

- **Indicator 10** (ACCURACY OF TIME KEEPING) – Number of percentage of PT on line1 that arrive within an acceptable interval (3min) around the planned times given by timetable.
- **Indicator 11** (AVERAGE OCCUPANCY) – Passengers per trip of Line 1. Number of passengers recorded + 60min ticket recorded per trip in the given period (3monthly).
- **Indicator 12 (**ENVIRONMENTAL CARE) – The data is collected in Customer Satisfaction questionnaires each 4 months with interviews to the users. The related question is: "Brescia Trasporti takes care for the pollution's reduction."
- **Indicator 13** (AVERAGE FLEET AGE**) –**This indicator is linked to the indicator n. 3 "Vehicle fuel efficiency", as younger busses have new technologies that save fuel.

It's important to stress that indicators 1 (Average Operating revenues), 2 (Average operating cost), 3 (Vehicle fuel efficiency), 4 (CO emissions), 5 (Emissions), 6 (Small particulate emissions), 7 (% Km clean bus), 8 (NCG busses/total fleet), 9 (Noise emission), 12 (Environmental care) e 13 (Average fleet age) - which are related to the calculation of the operative costs/revenues, the fuel efficiency, the pollutant emissions, the km travelled by clean vehicles, the number of methane gas powered vehicles, the levels of noise perception, the environmental care and the average age- are referred to the whole fleet (in particular to the fleet which is active at the end of each year, considering the disuse of the older vehicles);indicators 10 and 11 - which express the service punctuality and the overcrowding on board - are referred to the line1, which was set as "demo area" of the measure.

C1.2 Establishing a Baseline

The Municipality of Brescia is historically characterized by a unitary public transport service management. The local public transport system in Brescia, since the beginning of the Sixties, has been based exclusively on busses (previously there were also tram and trolley busses). Since 2001 LPT has been managed by Brescia Trasporti SpA (BST), after the asset-stripping experienced by ASM Brescia SpA.

Brescia Trasporti is part of Brescia Mobilità SpA (Metropolitan Mobility Company), which deals with people/freight mobility processes and traffic management.

Since July 2004 transport Company has managed TPL service both in Brescia and in the 14 neighbour Municipalities.

Recently the recurrent substitution of the older busses has been made introducing methane gas powered vehicles instead of the diesel ones. Methane gas powered vehicles can be refuelled directly at the bus depot, where there's a methane gas compressing/filling station (one of the few examples in Italy), owned by the company itself.

Methane gas powered busses, which are newer and less polluting, cover the major part of the service, while the oldest vehicles are used mainly during peak hours.

As the operative phase of the measure was set on March 2009 (when the new busses were put into operation), year 2008 has been chosen as Baseline. In 2008 the fleet was composed by 110 diesel powered busses and by 89 methane gas powered (total number of vehicles: 119). It's important to specify that before 2008 no 18mt bus had ever been purchased. As a matter of fact, vehicles were 95% 12 m long and 5% 8 m long. Minibuses are used for the On demand service "Accabus", for the "Bussola" (which links two peripheral parking) and for the bus service in the smallest downtown roads.

The original main goal of the Measure was the purchase of 40 new methane gas powered busses. The first 20 18 m busses substituted in full the busses running on Line1, which is one of the most important (and loaded) bus line in Brescia and which strongly structure the mobility network of the city. This is the reason why specific indicators were chosen to monitor the whole fleet, while others were related to line 1 only.

The following tables show the baseline situation of the indicators according to the two categories mentioned above: indicators referred to the whole fleet (Table 1) and indicators referred to Line1 only (Table 2).

Indicators related to the whole fleet	BASELINE (2008)
1) average operating revenues	A = 0,269 €/passengers
2) average operating costs	A = 0,585 €/passengers
3) fuel efficiency of the fleet (MJ/v*vkm)	0,4628
4) CO emissions (g/ v*vkm)	0,4138
5) NOX emissions (g/ v*vkm)	1,2639
6) Small particulate emissions(g/ v*vkm)	0,0147
7) % Km clean bus	54,86 % of kms travelled by clean busses/total kms
8) NCG busses/total fleet	45% of clean busses / total busses;
9) Noise perception	Average noise level: 72,8 db(A)
12) Environmental care	Result of customer satisfaction 2008/I: 6,79/10 Result of customer satisfaction 2008/II: 7,08/10 Result of customer satisfaction 2008/III: 7,19/10
13) Average fleet age	9 years

Table 1 – Baseline for the indicators related to the whole fleet

Indicators related to the Line 1	BASELINE (2008)
10) Accuracy of time keeping	89,9% of trips
11) Average occupancy	86,89 passengers/trip

Table 2 - Baseline for the indicators related to Line 1.

C1.3 Building the Business-as-Usual

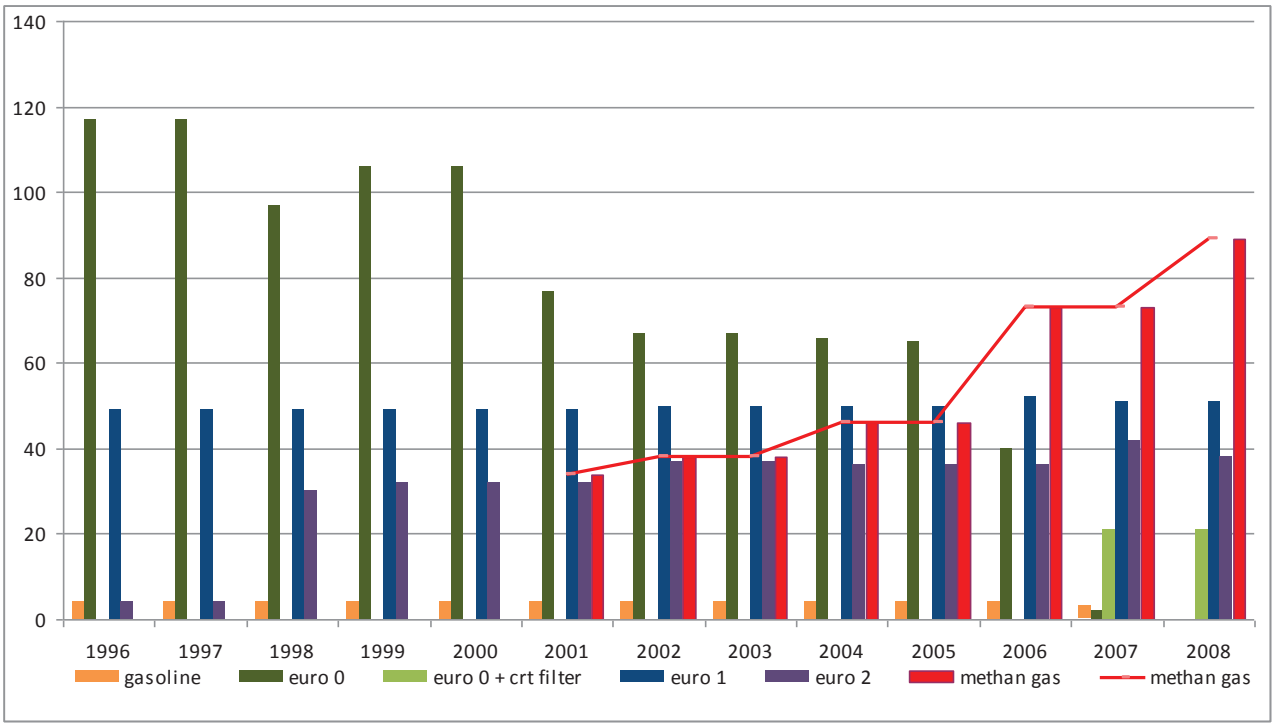
BaU scenario is built following mainly two approaches: when consolidated historical data series were available, the projection of the trend curve has been made; otherwise assumptions have been taken basing on both the technical manager declarations and the fleet composition trend. It's important to highlight that the methodological assumptions, on which the BaU scenario has been built, take inspiration from the historical policies adopted by the transport company, as they are able to clarify the BaU context without the Civitas initiative. Therefore, the "transport" approach has been as much as possible simplified.

The BaU construction has been based on the following two aspects:

- the consolidated Brescia Trasporti policy to renew the fleet introducing CNG busses (since the end of the Nineties);
- an in depth examination of the Line1, which is one of the most important bus lines in Brescia.

In this direction, it's very important to underline that both aspects can be considered as complementary one to the other (and not alternative): on the one hand, emphasis is given to the measure impacts in the overall fleet renewal - through the monitoring of indicators n.1 (Average Operating revenues), n.2 (Average operating cost), n.3 (Vehicle fuel efficiency), n.4 (CO emissions), n.5 (Emissions), n.6 (Small particulate emissions), n.7 (% Km clean bus), 8 (NCG busses/total fleet), n. 9 (Noise emission), n.12 (Environmental care) e n.13 (Average fleet age) ; on the other hand, the focus on Line1 - through the calculation of indicators n.10 "Accuracy of time keeping" and n.11 "Average occupancy" - can provide precious information to better understand the local context, with a view to the measure up-scaling (for more details see the section C4).

The first aspect is well synthesized by the fleet renewal historical trend, which surely modifies the relative pollutant emissions (see the following Graph 1).



Graph 1 Brescia Trasporti fleet renewal historical trend

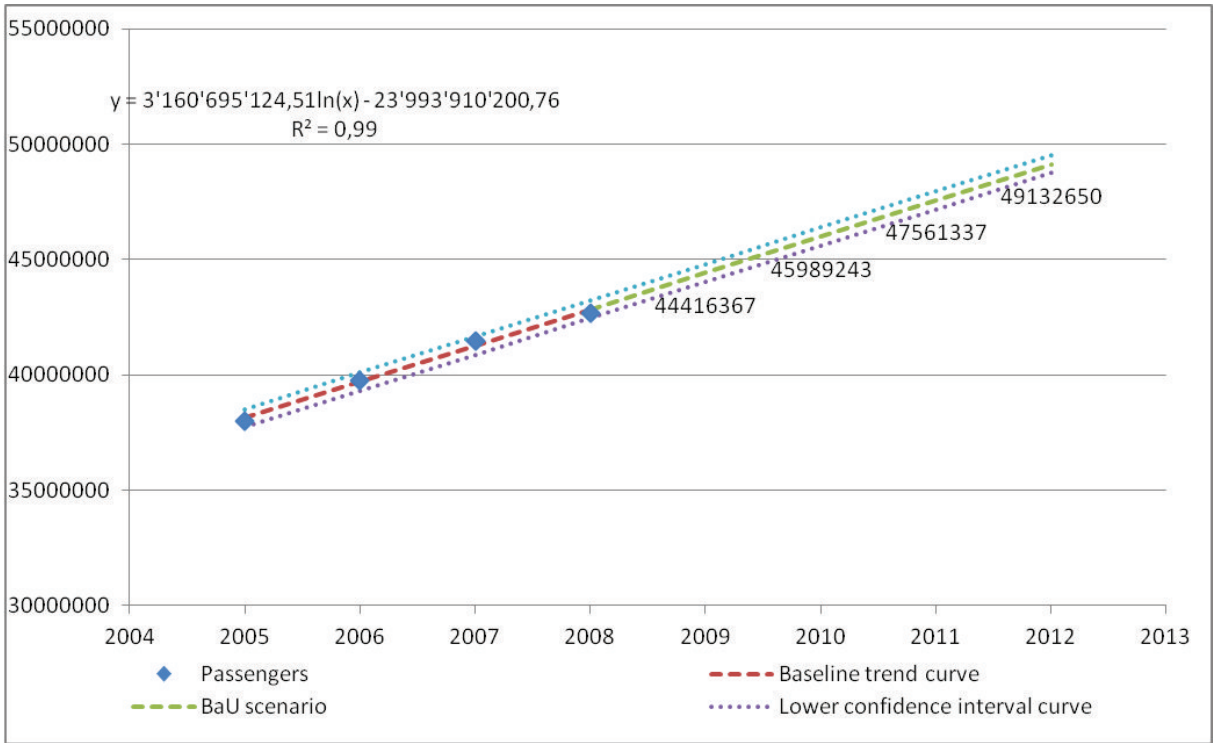
The second aspect is particularly interesting for the evaluation of the measure effectiveness, in relation to the metro start up in 2013, when, thanks to the CIVITAS funding, all the diesel busses will be disused and the fleet will be entirely composed by CNG methane powered busses (including 2 new generation 8mt busses).

It's important to underline that in the BaU social and economic conditions have been taken into consideration.

As regards **the economic indicators n.1** "Average Operating revenues" and n.**2** "Average operating cost", the historical series of the indicator is not available, therefore the following considerations have been made: in terms of total operating revenues the BaU scenario in 2012 can be considered similar to

the Baseline situation (2008),while as regards the total operating costs, it's possible to assume an yearly increase by 1% (due to an average increase of the fuel cost, keeping constant the mileage of the fleet). Analysing the historical fleet renewal trend (Graph 3), new busses are usually purchased every 2-3 years. In 2008 Brescia Trasporti purchased new busses, therefore costs and revenues in 2012 can equal those in 2008.

In 2012 the total number of passengers could have been different from those in 2008, therefore the data projection, using the historical data series up to 2008, provided the estimation of the bus network passengers in 2012. The obtained BaU values for the total number of passenger year 2012 are reported in Graph 2.



Graph 2 BaU scenario of the total number of bus network passengers a year, basing on the historical data series

Indicators related to the whole fleet	BaU (2012)
1) average operating revenues	0,234 €/passenger
2) average operating costs	0,524 €/passenger

Table 3 - BaU for the indicators related to the whole fleet

As regard **indicators n.3** (Vehicle fuel efficiency), n.**4** (CO emissions), n.**5** (Emissions), n.**6** (Small particulate emissions), n.**7** (% Km clean bus), historical series were not available, therefore the following considerations have been made:

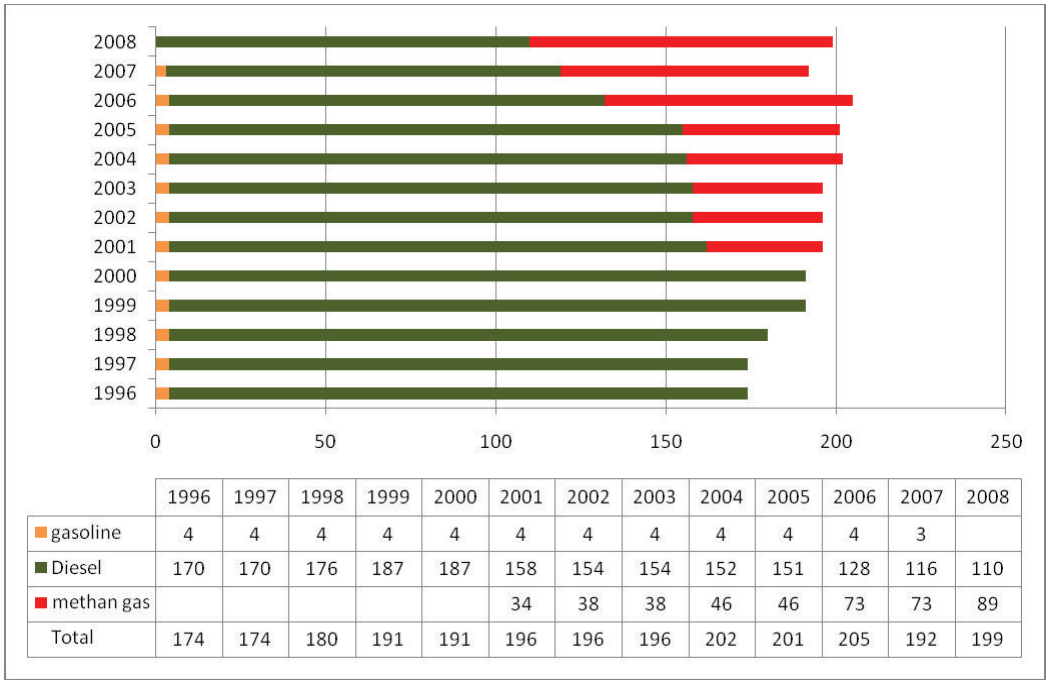
- the bus urban network was substantially modified in 2004, when it was extended to the suburban area of Brescia. Therefore, since 2004 the total number of km travelled by the whole fleet can be considered constant, because the fleet itineraries, frequency or capacity didn't vary considerably;
- the km covered by each kind of vehicle has been set constant;
- the fleet composition has been estimated in 2012, keeping the same kind of vehicles of the baseline situation but varying the number of vehicles.

As a consequence of the methodological assumptions mentioned above, in the BaU scenario, the energy and the fuel consumption are constant respect to the baseline situation, while the emissions slightly increase.

Indicators related to the whole fleet	BaU (2012)
3) fuel efficiency of the fleet (MJ/ v*vkm)	0,535
4) CO emissions (g/ v*vkm)	0,4635
5) NOX emissions (g/ v*vkm)	1,6121
6) Small particulate emissions(g/ v*vkm)	0,0156
7) % Km clean bus	54,86 % of kms travelled by clean busses/total kms

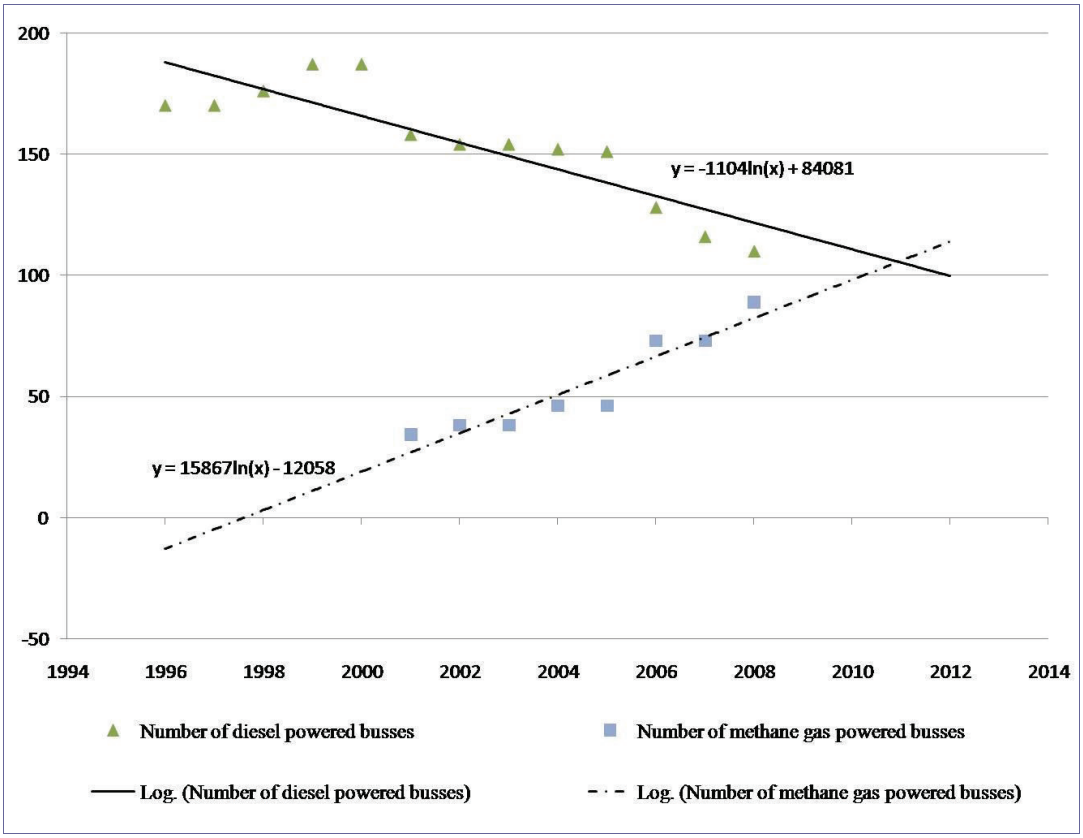
Table 4 - BaU for the indicators related to the whole fleet

Aiming at estimating the **indicator n.8** (NCG busses/total fleet), the only variable parameter is the number of busses composing the fleet. The estimation of the fleet in 2012 has been done projecting the historical trends (Graph. 3) for each kind of bus.



	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
gasoline	4	4	4	4	4	4	4	4	4	4	4	3	
Diesel	170	170	176	187	187	158	154	154	152	151	128	116	110
methan gas						34	38	38	46	46	73	73	89
Total	174	174	180	191	191	196	196	196	202	201	205	192	199

Graph 3 Evolution of the Brescia Trasporti bus fleet composition (historical data series)



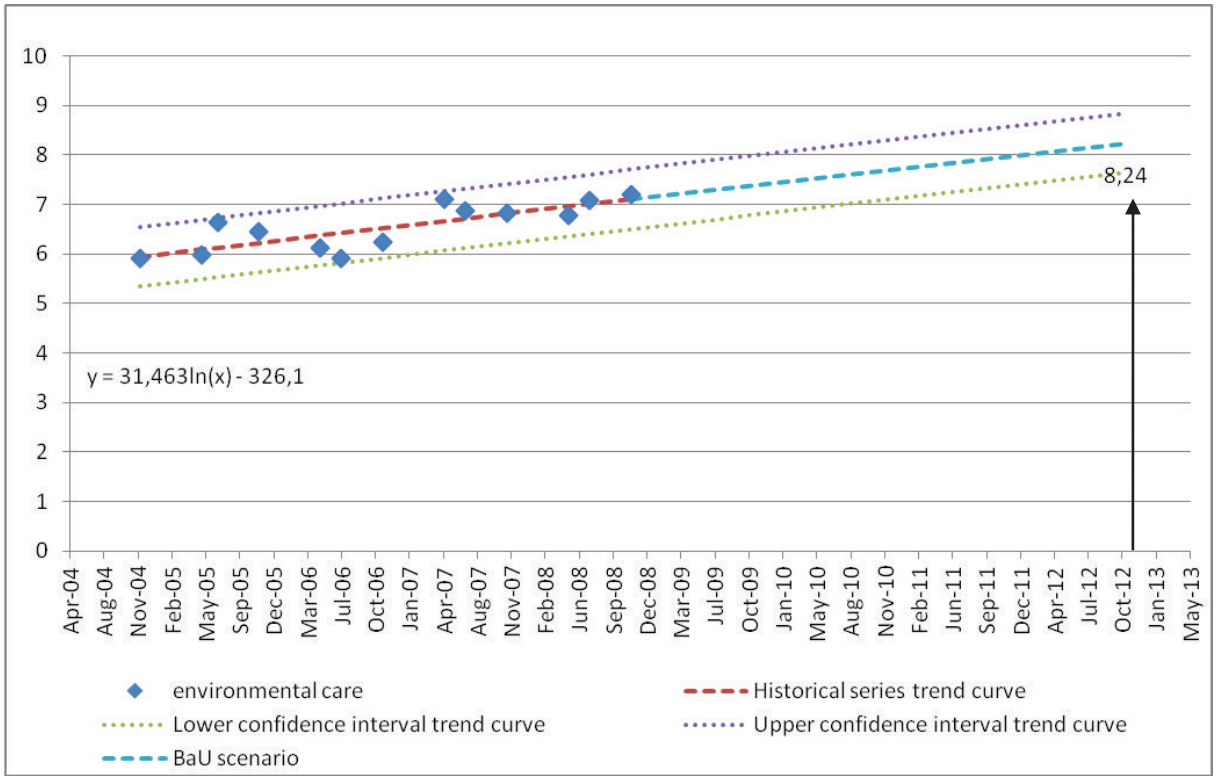
Graph 4 Evolution of the Brescia Trasporti bus fleet composition

The BaU scenario for the **indicator 9 (Noise perceived by driver)** equals the Baseline value, because the estimated fleet renewal doesn't significantly influence the average noise produced by the fleet.

Indicators related to the whole fleet	BaU (2012)
8) NCG busses/total fleet	53% of clean busses / total busses
9) Noise perception	72,8 db

Table 5 - BaU for the indicators related to the whole fleet

As regards the environmental care, the historical series of the results obtained for the customer satisfaction survey are available, therefore, in order to calculate the BaU scenario of the indicator n.12 in 2012, it's possible to project the historical trend (see Graph 4).



Graph 5 – BaU scenario for the indicator 12 "Environmental care", expressed as judgement on a 0 to 10 scale. It derives from the customer satisfaction survey results.

As regard the average fleet age (indicator 13), the following considerations have been made: the BST historical policy is to keep the fleet younger than 10 years. The purchase of new vehicles for the fleet renewal are made in alternate years and depending on the availability of financial contributions (such as for example the Lombardia Regional funding). BaU scenario in 2012 can be set on 9,5 years. This value takes into consideration the following events:

- since July 2004 also the suburban area has been served by the bus network;
- in 2008 (baseline year) new vehicles have been purchased, therefore, the average age is lower than usual and is 9 years.
-

Indicators related to the whole fleet	BaU (2012)
12) Environmental care	8,24/10 (Nov 2012)
13) Average fleet age	9,5 years

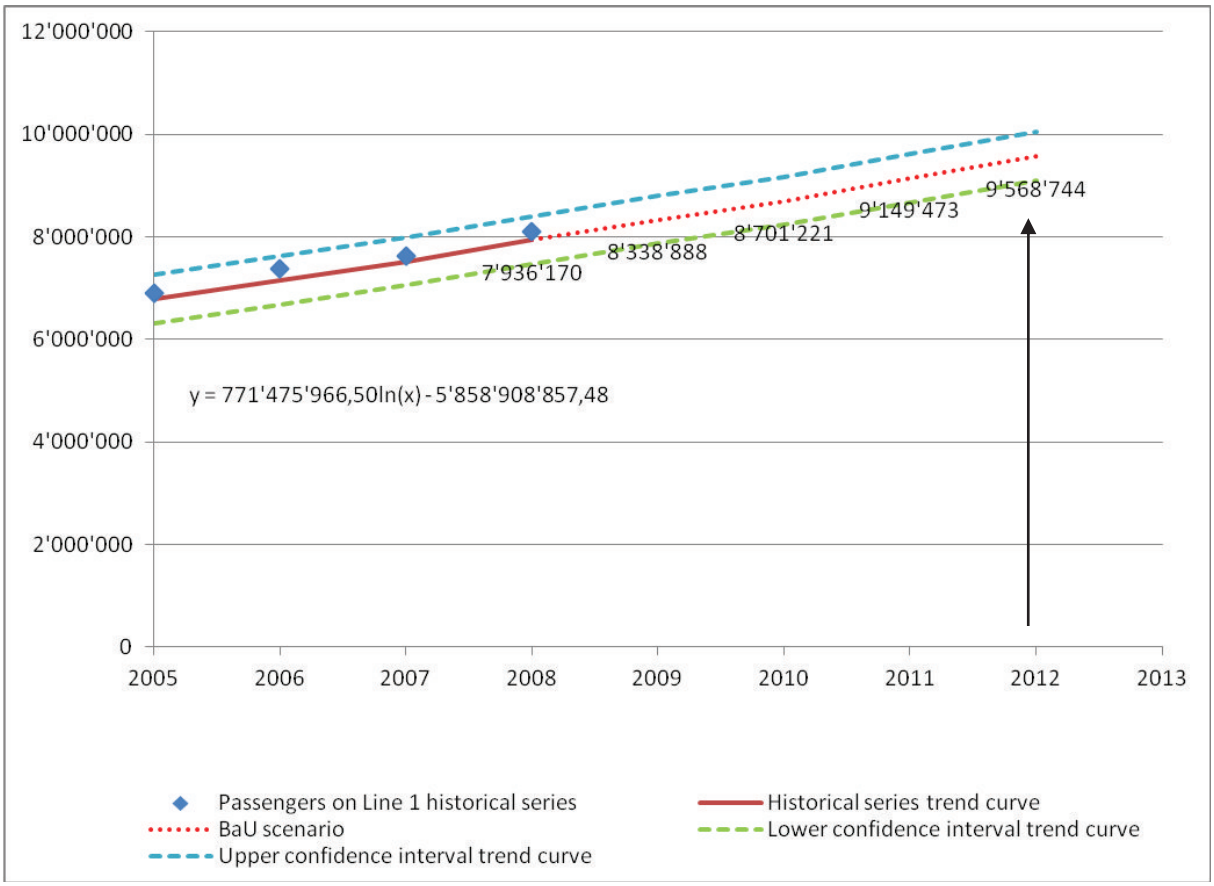
Table 6 – BaU scenario for the indicators related to the whole fleet

Indicator n.10 (accuracy of time keeping), referred to Line 1, evaluates the busses punctuality during their passages in the city centre. As it's not possible to estimate the BaU scenario in 2012 basing on historical data series, the following assumption has been taken: bus punctuality mainly depends on function of the bus frequency and capacity (excluding the traffic congestion which can be considered a non-governable external factor). As it has been assumed that without CIVITAS itineraries, frequencies

and capacities wouldn't have changed compared to the baseline situation, it's possible to say that indicator n.10 in 2012 can equal or be, at worst, lower than the baseline value.

In this specific case, the value equals the baseline one, because Line 1 runs on a dedicated lane, therefore it's less conditioned by delays due to external factors than other lines.

As regard indicator n.11 (average occupancy), the BaU scenario can be estimated basing on the line 1 passenger historical trend projection (Graph 5) and assuming the same number of rides registered in the Baseline year.



Graph 6 BaU scenario of the number of Line 1 passengers

Indicators related to the Line 1	BaU (2012)
10) accuracy of time keeping	89,9 %
11) average occupancy	102,56 passengers/ride

Table 7 – BaU scenario for the indicators related to the bus Line 1

C2 Measure results

The results are presented under sub headings corresponding to the areas used for indicators – economy, energy, environment, transport and society.

C2.1 Economy

Table C2.1.1: Results obtained for the Indicators corresponding to area "economy"

Indicator	Before (year 2008)	After (years 2009-2011)	BaU (years 2009-2011)	Difference: After –Before	Difference: After – B-a-U
1) average operating revenues	A= 0,269 €/passenger	**year 2009:** A= 0,259 €/passenger	**year 2009:** A= 0,259 €/passenger	- 0,01 €/passenger	0 €/passenger
		year 2010: A= 0,257 €/passengers	**year 2010:** A= 0,250 €/passenger	- 0,012 €/passenger	+ 0,007 €/passenger
		year 2011: A= 0,281 €/passengers	**year 2011:** A=0,241 €/passenger	+ 0,012 €/passenger	+ 0,04 €/passenger
2) average operating costs	A = 0,585 €/passenger	**year 2009:** A = 0,572 €/passenger	**year 2009:** A= 0,562 €/passenger	+ 0,013 €/passenger	+ 0,01 €/passenger
		year 2010: A = 0,574 €/passenger	**year 2010:** A= 0,548 €/passenger	- 0,011 €/passenger	+ 0,026 €/passenger
		year 2011: A = 0,613 €/passenger	**year 2011:** A= 0,536 €/passenger	+ 0,028 €/passenger	+ 0,077 €/passenger

The average operating revenues (indicator 1) increased from year 2008 to year 2011.

In 2011 (42.006.599 passengers) an overall decrease of LPT passengers is observed respect to the ex ante situation (in 2008 there were 42.692.823 passengers).

The operating revenues are calculated in relation to bus fares (occasional + systematic users)

In 2009-2010 there was a slight decrease of the occasional users. In 2011 the ticket fare increate from 1,00€ to 1,20€) with a general decreasing of the number of passengers (about -1.3%, in the year 2010/2011)

On the contrary, at the same time, passengers transported on Line 1 register an increasing trend, even if on this Line the frequency of the busses was reduced thanks to the introduction (within this Civitas measure) of vehicles with higher capacity (18mt long buses).

It important to highlight that in 2011 higher fuel costs of diesel and of methane significantly influenced the operative costs, that were also influenced by higher costs in general maintenance of the vehicles.

C2.2 Energy

Table C2.2.1: Measure results for the indicators of the category "Energy"

Indicator	Before (year 2008)	After (years 2009-2012)	BaU	Difference: After –Before	Difference: After – B-a-U
3) fuel efficiency of the fleet (MJ/ v*vkm)	0,4628	**year 2009:** 0,8215	**year 2009:** 0,43	+ 0,3587	+ 0,3915
		year 2010: 0,8536	**year 2010:** 0,45	+ 0,3908	+ 0,4036
		year 2011: 1,038	**year 2011:** 0,49	+ 0,5752	+ 0,548
13) Average fleet age	9 years	**year 2009:** 8,4 years	**year 2009:** 9,5 years	- 0,6	- 1,1
		year 2010: 9,3 years	**year 2010:** 9,5 years	+ 0,3	- 0,2
		year 2011: 9,9 years	**year 2011:** 9,5 years	+ 0,9	+ 0,4

Comments concerning indicators n. 3 and 13 are reported under the following "C.2.3 Environment" subheading.

C2.3 Environment

Table C2.3.1: Measure results for the indicators of the category "Environment"

Indicators	Before (year 2008)	After (years 2009/2012)	BaU	Difference: After –Before	Difference: After – B-a-U
4) CO emissions *(g/* v*vkm*)*	0,4138	**year 2009:** 0,6678	**year 2009:** 0,3885	+ 0,254	+ 0,279
		year 2010: 0,7011	**year 2010:** 0,4033	+ 0,2873	+ 0,2978
		year 2011: 0,8817	**year 2011:** 0,4296	+ 0,468	+ 0,452
5) NO_X emissions *(g/* v*vkm *)*	1,2639	**year 2009:** 2,069	**year 2009:** 1,1688	+ 0,8051	+ 0,900
		year 2010: 2,1284	**year 2010:** 1,2537	+ 0,8645	+ 0,8747
		year 2011: 2,4548	**year 2011:** 1,4065	+ 1,1909	+ 1,0483

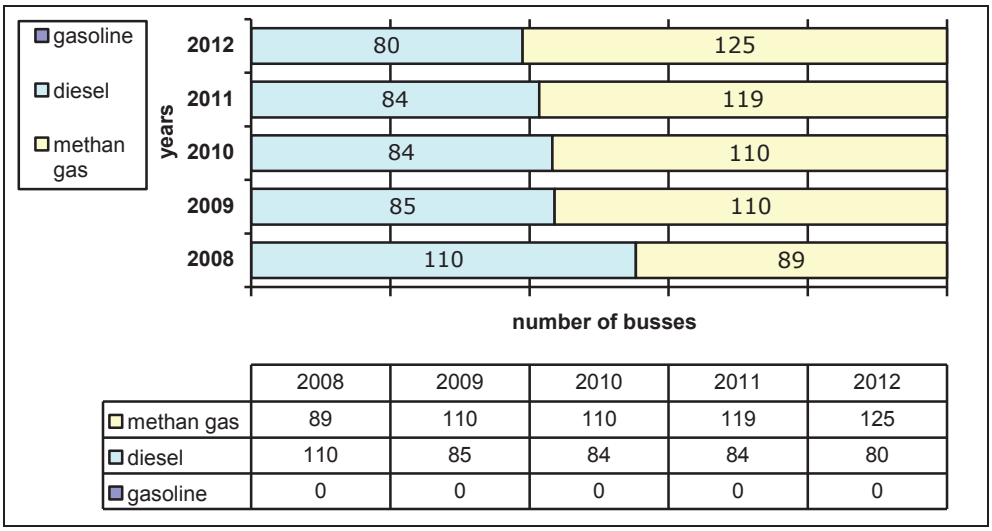
Indicators	Before (year 2008)	After (years 2009/2012)	BaU	Difference: After –Before	Difference: After – B-a-U
6) Small particulate emissions (g/ v*vkm)	0,0147	**year 2009:** 0,0356	**year 2009:** 0,0139	+ 0,0209	+ 0,0217
		year 2010: 0,0383	**year 2010:** 0,0144	+ 0,0236	+ 0,0239
		year 2011: 0,0485	**year 2011:** 0,0151	+ 0,0338	+ 0,0334
7) % Km clean bus *(% of km travelled by clean busses/total km)*	54,86 %	**year 2009:** 67,31 %	**years 2009:** 54,86 %	+ 12,45	+ 12,45
		year 2010: 70,73 %	**year 2010:** 54,86 %	+ 15,87	+ 15,87
		year 2011: 73,37%	**year 2011:** 54,86 %	+ 18,51	+ 18,51
8) NCG busses/total fleet *(% of clean busses / total busses)*	45%	**year 2009:** 56%	**year 2009:** 44%	+ 11%	+ 12 %
		year 2010: 57%	**year 2010:** 47%	+ 12%	+ %10
		year 2011: 59%	**year 2011:** 50%	+ 14%	+ 9%
9) Noise perception	Average sound level: 72,8 db(A)	**year 2009:** Average sound level: 72,5 db(A) – (referred to 18 mts busses).	**year 2009:** 72,8 db(A)	- 0,3	- 0,3
		year 2010: Average sound level: 72,5 db(A) – (referred to 18 m busses)	**year 2010:** 72,8 db(A)	- 0,3	- 0,3
		year 2011: Not Assessable	**year 2011:** 72,8 db(A)	Not Assessable	Not Assessable

Indicators concerning the LPT fleet fuel efficiency (indicator n. 3 expressed in MJ/v*vkm) and the pollutant gas emissions (indicators n. 4, 5 and 6 expressed in g/v*vkm) are calculated basing on the mileage run by each kind of bus, in relation to its fuel type.

In particular, observing their trend, an overall increase of the emissions was registered, mainly because of the increasing age of the fleet (indicator 13), that, notwithstanding the Civitas contribution to the methane gas powered fleet renewal remains higher than 9 years..

The after data collection goes up to 2011 because was made on annual basis: therefore the renewal of the fleet which took place in 2012 (see the following graph) was taken into consideration. According to the provisional information provided by the Transport Company, the purchase of new vehicles and the dismissing of old vehicles foreseen in 2012 should contribute in improving the average fleet age.

In particular, BST (out of Civitas contribution) in 2012 has already purchased 6 new CNG buses (12 m long buses).



	2008	2009	2010	2011	2012
methan gas	89	110	110	119	125
diesel	110	85	84	84	80
gasoline	0	0	0	0	0

Graph 7 Brescia Trasporti fleet renewal from 2008 to 2012

Regarding the whole fleet fuel consumption and gas emissions registered an overall worsening (in the fleet there are still EURO 1 buses that for eg. produced 2.0032gCO/v*vkm in 2010; the same consideration can be done also concerning other pollutants).

Notwithstanding Brescia Trasporti effort in progressively introducing a clean fleet from the data is evident that many diesel buses are still circulating.

A general consideration should be done if we compare an "EURO 0+crt filter" bus with a CNG bus:

- NOx emission produced by "EURO 0+crt filter" is about 120 times higher than CNG
- Small particulate produced by "EURO 0+crt filter" is about 23 times higher than CNG

Only the CNG component of the fleet (which has been the actual object of the Civitas contribution), had an opposite trend: fuel consumption and the emissions decreased, notwithstanding the significant increase of the methane gas powered busses mileage (indicator n.7).

BUS METHANE GAS	**2008**	**2009**	**2010**	**2011**
Km travelled per year	4.658.436	5.558.100	5.845.398	5.946.317
CO emissions (g/ v*vkm)	0,1854	0,1500	0,1500	0,1387
NOx emissions (g/ v*vkm)	0,0279	0,0225	0,0225	0,0208
Small particulate emissions (g/ v*vkm)	0,0002	0,0002	0,0002	0,0002

Table 8 Pollutant gas emissions produced by the methane gas vehicles composing the Brescia Trasporti fleet

Without the Civitas contribution, considering the recent reduction to the LPT funding for the fleet renewal, the situation would have been even worse, because many new busses wouldn't have been purchased, limiting the actions for the emissions reduction, to the crt filters installation on the oldest vehicles.

This consideration (which is not easily quantifiable) wasn't taken into account in the BaU scenario, which was built basing only on the projection of the historical fleet composition by type of fuel. This is the reason why the BaU scenario can be considered slightly better than the actual ones.

Analyzing the results obtained for indicator n. 8 (% of clean busses/total busses), alongside the achievement of the goal of increasing the methane gas powered vehicles, it's possible to recognize the transport company policy to speed up as much as possible the purchase of the new vehicles (the number of CNG busses respect to the whole fleet increased by 11% already in 2009) and the implementation of the 18m busses for the renewal of the whole Line 1.

C2.4 Transport

Table C2.4.1: Measure results for the indicators of the category "Transport"

Indicator	Before (year 2008)	After (years 2009/2010)	BaU (2008-2012)	Difference: After – Before	Difference: After – B-a-U
10) accuracy of time keeping *(% of trips)*	average value: 89,9%	**year 2009:** average value: 86,3% of trips	**years 2009:** average value: 89,9 % of trips	- 3,6	- 3,6
		year 2010: average value: 90,0% of trips	**years 2010:** average value: 89,9 % of trips	+ 0,1	+ 0,1
		year 2011: average value: 90,6% of trips	**years 2011:** average value: 89,9 % of trips	+ 0,7	+ 0,7
11) average occupancy (passengers/ride)	86,89	**year 2009:** 101,74	**year 2009:** 89,37	+ 14,85	+ 12,37
		year 2010: 110,86	**year 2010:** 93,25	+ 23,97	+ 17,61
		year 2011: 110,38	**year 2011:** 98,06	+ 23,49	+ 7,82

As regard indicator n.10 (accuracy of time keeping), referred to the line 1, it's interesting to remark the following phenomenon: considering the monthly average values referred to two monitoring bus stations (next to the General Hospital and to the Train Station), a higher time accuracy is observed at the Hospital station (near to the terminus, from which line 1 departs), while a lower time accuracy is observed at the Train station (often 10% lower). This delay can be observed especially at the beginning of the project, when the new 18m vehicles were introduced, probably because of the difficulties in the manoeuvres on road.

Other reasons linked to the delay along the lines could be the following:

- the presence of lanes dedicated to the bus circulation is scarce, therefore busses suffer from the traffic congestion or drawbacks;
- presence of moving road works for the metro line station building (just along the line 1 layout) which caused many line deviations or wastes of time especially in 2009 and 2010;
- being the most important bus line, each bus station along the Line 1 is used by the users, causing more time for the passengers' transport through the use of 18m vehicles.

Indicator n. 11 (average occupancy) is function of the bus frequency and capacity. The introduction of 18m busses brought to a higher number of available seats respect to the previous kind of busses which were 12m long.

Kind of bus (length)	Seating capacity	Standing room	Total
18 m	32	124	156
12 m	24	67	91

Table 9 Technical features characterizing some kind of buses composing the Brescia Trasporti fleet

The higher seating capacity on the 18m long vehicles allows to reduce the overcrowding problems increasing the number of passengers per ride (since 2009).

Even if the bus frequency is reduced, new buses offer a more comfortable service to the users (improved seating, air-conditioning, less vibration).

C2.5 Society

Table C2.5.1: Measure results for the indicators of the category "Society"

Indicator	Before (year 2008)	After (years 2009/2010)	BaU (2009/2010)	Difference: After – Before	Difference: After – B-a-U
12) environmental care *(Results of the customer satisfaction)*	2008/I: 6,79/10 2008/II: 7,08/10 2008/III: 7,19/10	**year 2009:** 2009/I: 7,04/10 2009/II: 7,33/10 2009/III: 7,04/10	**year 2009:** 2009/I: 7,25/10 2009/II: 7,30/10 2009/III: 7,39/10	+ 0,25/10 + 0,25/10 -0,15/10	- 0,17/10 + 0,03/10 - 0,35/10
		year 2010: 2010/I: 7,33/10 2010/II: 7,27/10 2010/III: 7,19 /10	**year 2010:** 2010/I: 7,54/10 2010/II: 7,58/10 2010/III: 7,68/10	+ 0,25/10 + 0,19/10 0/10	- 0,21/10 - 0,31/10 - 0,49/10
		year 2011: 2011/I: 7,54/10 2011/II: 7,27/10 2011/III:7,10 /10	**year 2011:** 2011/I: 7,82/10 2011/II: 7,87/10 2011/III:7,96/10	+ 0,75/10 + 0,19/10 - 0,09/10	+ 0,26/10 - 0,60/10 - 0,86/10

Users' judgement about the BST care for environment is generally positive and this is confirmed by a slight substantial increase of the values of the indicator n.12.

Summary of the main CBA results (ref. Annex 3)

The CBA was out on comparing the scenario 0 (Reference case or BaU), which keeps unchanged the fleet operating in 2008 and foresees the gradual substitution of the older buses with 12 m CNG ones, and scenario 1 (Civitas measure), which foresees the purchase and the activation, on line 1 of new CNG 18m long buses.

The purchase of buses described in the Civitas scenario (Scenario 1) is re-paid in approx. 4 years (NPV>0 at 2012), due to fact that Line 1 offers a better transport service. The new buses on that line have lower maintenance costs and produce lower emissions in comparison to scenario 0.

For more details about the CBA methodological assumptions and calculation see Annex 3.

C3 Achievement of quantifiable targets and objectives

No.	Target	Rating
1	To increase the weight of the CNG fleet (40 new CNG buses – that is up to 25% of the whole fleet and 3 CNG buses for On demand transport service) in order to reduce emission of Public Transport. *This objective can be considered achieved in full. The indicators able to express this achievement are the following:* *ind. 8 (CNG busses/total fleet)* *Before (year 2008) = 45%* *After (year 2011) = 59%* *ind. 7 (% kms travelled by clean buses respect to the total amount of kms travelled by the fleet)* *Before (year 2008) = 54,86 %* *After (year 2011) = 73,37 %* *Specific indicators referred to the emissions are:* *ind. 4 (CO emissions – g/v*vkm)* *Before (year 2008) = 0,4138* *After (year 2011) = 0,8817* *ind. 5 (NOx emissions g/* v*vkm *)* *Before (year 2008) = 1,2639* *After (year 2011) = 2,4548* *ind. 6 (Small Particulate emissions – g/* v*vkm*)* *Before (year 2008) = 0,0147* *After (year 2011) = 0,0485* *As explained in the comments to the "C.2.3 Environment" subheading, even if the fuel consumption and the gas emissions registered an overall worsening, if the only CNG component of the fleet is considered (which has been the actual object of the Civitas contribution), then the observed trend is opposite: the fuel consumption and the emissions decreased*	**
2	To keep the fleet younger than 8 years;	N.A.

No.	Target	Rating
	The achievement of this objective is expressed by the following indicator: *ind. 13 Average fleet age* *Before (year 2008) = 9 years* *After (year 2011) = 9,9 years* *According to the provisional information provided by the Transport Company, the purchase of new vehicles and the dismission of old vehicles foreseen in 2012 should contribute in improving the average fleet age. In particular, BST (out of Civitas contribution) in 2012 has already purchased 6 new methane gas powered 12 m long buses and likely will purchase 3 new diesel powered busses and dispose 5 diesel powered old busses.*	
3	To acquire CNG 18 metres busses in order to minimize overcrowding on the busses (because of the increase of passengers); *This objective is measured referring to the Line 1 of the bus network, as the 18m long busses run on that line. The goal can be considered achieved in full because introducing longer vehicles, the busses capacity increased. Therefore, the average occupancy increased without worsening the bus overcrowding. The indicator able to express the objective achievement is the following:* *ind. 11 (average occupancy – **related to the line 1** where the 18m long busses have been introduced)* *Before (year 2008) = 86,89 passengers/ride* *After (year 2011) = 110,38 passengers/ride*	**
4	To improve accuracy of time reducing passages of the busses and to decrease the passage of the busses in the old town reducing trips and increasing seats *This objective is measured referring to the Line 1 of the bus network, as the 18m long busses will run on that line. The goal can be considered achieved in full because introducing longer vehicles, the bus frequency has been reduced, therefore also the passages in the city centre.* *ind. 10 (accuracy of time keeping – **related to the line 1** where the 18m long busses have been introduced)* *Before (year 2008) = 89,9% of trips* *After (year 2011) = 90,6% of trips*	**
5	To increase the number of passengers by 5% in the demo area. *This objective is measured referring to the Line 1 of the bus network, which is the demo area that has been taken as reference. Looking at the data used for the calculation of indicator n.11, it's possible to see that the number of passengers on line 1 increased, but the target hasn't achieved; therefore this objective can be considered not achieved.* *From ind. 11 (average occupancy – **related to the line 1** which is our demo area)* *Before (year 2008) = 8'106'965 passengers* *After (year 2011) = 8'179'108 passengers*	O
6	To increase the km covered by CNG bus by more than 60% *ind. 7 (% kms travelled by clean buses respect to the total amount of kms travelled by the fleet)* *Before (year 2008) = 54,86 %* *After (year 2011) = 73,37 %*	***
NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%) ** = Achieved in full * = Exceeded**		

C4 Up-scaling of results

The measure could be theoretically up-scaled as CNG buses are only one part of the fleet. However the complete reorganization of the bus network is foreseen, by 2013.

In this reorganisation of the network is supposed to maintain mainly the already existing clean fleet: CNG buses (including CNG buses bought during Civitas + 6 CNG buses already bought and no put into service yet) and Hybrid buses.

For sure "EURO 0+crt filter" buses will be substituted in the network reorganization therefore benefits related to the emissions are quantifiable as follows:

- NOx emission produced by CNG buses are 1/120 lower than "EURO 0+crt filter" buses
- Small particulate produced by CNG buses are 1/23 lower than "EURO 0+crt filter" buses

C5 Appraisal of evaluation approach

The indicators were selected at the beginning of Civitas project and they were divided into different categories: Economy, Environment, Transport and Society.

The two indicators included in the category "Economy" were useful to manage the CBA for this measure. Several indicators were included in the Environment category in order to analyze the emissions related to the use of the renewed fleet.

Ind. N. 12 "environmental care" was selected in order to achieve the perception by the population, of the attention that BST give at the environment.

The indicators that estimate the whole emissions were useful to make several consideration in relation to the BaU and the up scaling construction. At the start up of the metro line by 2013 the fleet will be composed mainly by methane powered and hybrid busses, reducing significantly the total number of busses of the fleet.

C6 Summary of evaluation results

The key results are as follows:

- **Key result 1** – There was a shifting from 45% of CNG busses/total fleet (in 2008) to 59% in 2011 and % Km travelled by clean buses respect to the total amount of kms travelled by the fleet, with an increasing of around 18% from 2008 to 2011, getting up to over 73% of Km travelled by CNG buses in 2011.
- **Key result 2** – Even if the fuel consumption and the gas emissions registered an overall worsening, if the only CNG component of the fleet is considered (which has been the actual object of the Civitas contribution), then the observed trend is opposite: the fuel consumption and the emissions decreased.
- **Key result 3** – Thanks to the measure implementation 20 CNG 18 metres busses have been purchased in order to minimize overcrowding on the busses (because of the increase of passengers); this objective is measured referring to the Line 1 of the existing bus network, as the 18m long busses run on that line. This goal can be considered achieved in full because

introducing longer vehicles, the busses capacity increased. Therefore, the average occupancy increased without worsening the bus overcrowding.

- **Key result 4** – Thanks to the use of longer vehicles (reducing trips and increasing seats), the bus frequency in the peak hour and also the passages in the city centre have been reduced; therefore the problem of the vehicles queuing could be considered solved problem. This objective is measured referring to the Line 1 of the bus network, as the 18m long busses are on that line.

C7 Future activities relating to the measure

The possible activities related to the measure, which can be carried out at the end of Civitas are:

- The purchase of 6 new CNG buses was done during the last few days of the project (due to that they weren't financially reported in Civitas) and they are going to be equipped and than put into service by the end of the year.
- by the end of 2012 other 3 Diesel buses will be purchased and 5 old diesel buses will be dismissed.

These future activities are an important part of the company policy, carried out in years, in order to guarantee a more modern and competitive public transport service. This almost-consolidated tendency won't stop with the end of Civitas project; as a matter of fact the start up of the metro is foreseen in 2013, therefore it will be given a new image of public transport in Brescia.

D.

D Process Evaluation Findings

D.0 Focused measure

This measure is a focused measure.

The reasons are the following:

- the possibility of carrying out a good Cost Benefit Analysis;
- the measure fits into the city policy towards sustainable urban transport and towards sustainability in general.

D1 Deviations from the original plan

No significant deviation from the original work-plan was encountered, the only noteworthy exception consists in the reduction of the buses purchased,

In the last few days of the Civitas BST purchased other 6 new CNG buses (12m long) project. These buses haven't been financially reported in Civitas, therefore they haven't been included in the amount of buses purchased during the project.

D2 Barriers and drivers

D2.1 Barriers

Process barriers are events or overlapping conditions that stimulates the process to obtain the measure objectives/goals as described in section A1 of this Measure Evaluation Report.

In the sequel main barriers, which have been picked out during the measure, are pointed out, in relation with the specific phase of the measure.

Implementation/operation phase

- **Barrier 1: Financial barrier – budget law -** Because of the "budget law" ("Patto di stabilità") and the financial crisis, BST reduced the purchase of new buses.

Preparation phase

- **Barrier 2: Technological barriers - design -** the design of the road infrastructures has been a technological barrier; as a matter of fact, this one has caused problems for the 18 meters busses transit by particular intersections or roundabout.

D2.2 Drivers

In the sequel main drivers, which have been picked out during the measure, are pointed out:

Preparation/implementation phase

- **Driver 1: Political / strategic driver - needs** - Brescia Trasporti constant care for environment and mobility needs, led the company to increase the use of alternative fuels and of clean and energy efficient vehicles, in order to reduce pollution, exhaust gases, noise.

- **Driver 2: Involvement / communication driver - information -** Brescia Trasporti constant increase the level of the information (accessibility and up-grade) in order to promote public transport and to rationalize and improve the accessibility of the service.

- **Driver 3: Technological driver – alternative fuel -** The possibility of alternative fuels use, according the new technology offered and experimentation, has been an important driver for the city of Brescia and also for Brescia Trasporti.

D2.3 Activities

Significant recovery action hasn't been necessary, as this measure is proceeding as scheduled in the project.

D3 Participation

D.3.1 Measure partners

The partners related to this measure are Brescia Trasporti and Brescia Municipality.

Brescia Trasporti is the transportation public company of the Municipality of Brescia, and has a well-know leadership at the national level in terms of a high-quality, competitive, modern transport service. Within the MODERN project, the role of Brescia Trasporti concerns the operation of the public transport service, the dissemination of the culture of sustainable mobility and the promotion of CNG fuel.

Brescia Municipality is involved in a series of integrated relationships with social actors present on the territory with the aim to design the development of the city and of its economy and welfare through an increasing participation of all the stakeholders and (as the maximum possible extent) of the citizens.

D3.2 Participation of stakeholders

In this measure stakeholders are represented by **inhabitants** of the city of Brescia. Their direct involvement has been possible through administering them a four-monthly customer satisfaction survey, interviewing 1200 actual and potential users. An important event was organized on 19th February 2009: a presentation of the 20 new CNG busses to the authorities was done, by means of a press conference during a trial trip on the line 1. The municipality of Brescia has presented to the citizens the acquisition of the new clean busses, carried out thanks to Civitas funding. Another stakeholder is represented by the busses provider.

D4 Recommendations

Based on the lessons learned from the implementation of the measure, the following recommendation can be drawn:

D.4.1 Recommendations: measure replication

- **Recommendation 1: Action to Fleet renew –** in order to have more clean fleet, it's essential to act on buses (for example, through equipping existing vehicles with specific filters) or to purchase new ones to replace the older diesel powered ones.

- **Recommendation 2: Participation –** it's important to highlight the necessity of strong integration among measure implementation, information campaigns and measure monitoring, in order to make users aware of the reasons why the actions are undertaken (for example, a good level of information about the initiative carried out in Line 1 is important for users in order to better understand the reduction of buses frequency and not to see this one as a worsening of public transport service).

D.4.2 Recommendations: process

- **Recommendation 3: good choice –** in Brescia has been purchased a km 0 bus already equipped but not as requested by Italian law in force; this choice penalized Brescia. Therefore it's recommended to keep attention to km 0 vehicles purchase.

- **Recommendation 4: geometry of roads** - is strongly recommended to consider the geometry of roads and intersections infrastructure before the purchase and putting into operation the busses.

Annex 1: Data used for the BaU building

- **Indicator 1 (Average Operating revenues) and indicator 2 (Average operating cost).**

These indicators have no historical data series, therefore the BaU scenario has been built using other data series, such as the bus fleet composition (1996-2008) and the total number of total PT passengers (2005-2008).

Bus fleet composition

years	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**
methane gas powered						34	38	38	46	46	73	73	89
euro 2	4	4	30	32	32	32	37	37	36	36	36	42	38
euro 1	49	49	49	49	49	49	50	50	50	50	52	51	51
euro 1+crt filter													
euro 0	117	117	97	106	106	77	67	67	66	65	40	2	
euro 0+ crt filter												21	21
gasoline powered	4	4	4	4	4	4	4	4	4	4	4	3	
TOT	**174**	**174**	**180**	**191**	**191**	**196**	**196**	**196**	**202**	**201**	**205**	**192**	**199**

Total number of total PT passengers:

	Passengers
2005	38.008.558
2006	39.760.208
2007	41.459.439
2008	42.692.823

- **Indicator 3 (Vehicle fuel efficiency), Indicator 4 (CO emissions), Indicator 5 (Emissions), Indicator 6 (Small particulate emissions), Indicator 7 (% Km clean bus), Indicator 8 (NCG busses/total fleet)**

  These indicators have no historical data series, therefore the BaU scenario has been built using other data series, such as the bus fleet composition (1996-2008) already reported at the previous bullet point (ind. 1 and 2)

- **Indicator 11 (Average occupancy)**

  This indicator has no historical data series, therefore the BaU scenario has been built using other data series, such as the total number of passenger on the line 1 (2005-2008)

Year	Passengers on line 1
2005	6'910'885
2006	7'378'402
2007	7'635'049
2008	8'106'965

- **Indicator 12 (environmental care)**

  The historical data series used for the calculation of the BaU is the judgment to the question included in the standard customer satisfaction survey "environmental care"

Survey date	Judgement to the question "environmental care"
Nov-04	5,9
May-05	5,98
Jul-05	6,63
Nov-05	6,45
May-06	6,12
Jul-06	5,9
Nov-06	6,24
May-07	7,11
Jul-07	6,87
Nov-07	6,83
May-08	6,79
Jul-08	7,08
Nov-08	7,19

Annex 2: Ex ante and Ex Post data collection

- **Indicator 1 (AVERAGE OPERATING REVENUES)** – All data are related to each line. All the new 18 meters CNG buses are operated on Line 1; so only this Line will be investigated. CNG vehicle-km results from kilometres recorder reading, done monthly, even if the final report is annual. The data reliability is maximised due to an objective data collection. Ratio of total income generated from fares and tickets divided by the total vehicle-km per year.

$$A = B / C$$

where: A = Average operational revenue for the service (€/passengers)

B = Total operational revenue for the service, including revenues coming from tickets/fares sale (€)

C = Total passenger

EX ANTE SITUATION (year 2008):

A= 0,269 €/passengers

AFTER SITUATION:

year 2009: **A= 0, 259 €/passengers**

year 2010: **A= 0,257 €/passengers**

year 2011: **A= 0,281 €/passengers**

- **Indicator 2 (AVERAGE OPERATING COST)** – All data are related to each line. All the new 18 meters CNG buses are operated on Line 1; so only this Line will be investigated. CNG vehicle-km results from kilometres recorder reading, done monthly, even if the final report is annual. The data reliability is

maximised due to an objective data collection. Ratio of total operating costs incurred by the fleet (or line 1) divided by the total vehicle-km (or line 1) per year.

$$A = B / C$$

where: A = Average operational costs for the service (€/passengers)
B = Total operational costs for the service, including cost items related to raw materials/consumer goods (such as spare parts, fuel, lubrifacants, oils, tyres) and external services (such as maintenance costs for mechanics, body works, engines, gears, tyres, vehicles fee and electric energy) (€)
C = Total passengers

EX ANTE SITUATION: (year 2008)

A = 0,585 €/passengers

AFTER SITUATION:

year 2009: **A= 0, 572 €/passengers**

year 2010: **A= 0, 574 €/passengers**

year 2011: **A= 0, 613 €/passengers**

- **Indicator 3 – (VEHICLE FUEL EFFICIENCY)** - Provided data useful for the calculation of the indicator are the following:
  A = Fuel consumption by type of vehicle (MJ);
  B = Tot km travelled per year (vkm);
  C = Number of vehicles by type (v)
  D = Vehicle fuel efficiency by type = A/(B*C) (MJ/v*vkm)

  The Fleet is composed by gas-oil busses and CNG busses; the gas-oil consume results come from the sum of the restocking done during the year (in depot are located tanks; after each load the data is recorded). The data of CNG consumes can be read on the counters located in the existing CNG station; the same data is also available in the manager's bills periodically recorded. This data are already periodically collected and elaborated once a year. Younger busses have new technologies that save fuel.

  Period of data collection: **EX-ANTE** January-December 2008

Available data:
Vehicles: running fleet from January to December 2008 (tot 199 bus: 89 cng and 110 diesel)
Km: km travelled by fleet from January to December 2008. The km travelled by fleet are read from the bus tachygraph.
Fuel consumption: diesel and methane gas (lt/year) converted into MJ using calorific power for gasoil (41 MJ/kg) and for methane gas (34,45 MJ/mc).

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 2**	**Bus METHAN GAS**	
Fuel type	gasoil	gasoil	gasoil	Methan gas	**TOTAL**
(C) N. bus (v)	21	51	38	89	**199**

Mileage and fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 2**	**Bus METHAN GAS**	**TOTAL**
(B) Km travelled in 2008 (vkm)	745.367	1.769.299	1.318.801	4.658.436	**8.491.903**
Consumption factor (km/l)	2,0176	2,0176	2,0176	1,467	
Fuel consumption by type (l)	369.432	876.932	653.648	3.175.485	
Fuel consumption by type (kg or l)	308.476	732.239	545.796	3.175.485	
(A) Fuel consumption by type (MJ)	12.647.521	30.021.784	22.377.653	109.395.447	**Average (MJ/v*vkm)**
(D) Vehicle fuel efficiency (MJ/v*vkm) = A/(B*C)	**0,8080**	**0,3327**	**0,4465**	**0,2639**	**0,4628**

AFTER DATA COLLECTION:

Period of data collection: January-December 2009

Available data:

Vehicles: running fleet from January to December 2009 (tot 195 bus: 110 CNG and 85 diesel)

Km: km travelled by fleet from January to December 2009. The km travelled by fleet are read from the bus tachygraph.

Fuel consumption: diesel and methane gas (l/year) converted into MJ using calorific power for gasoil (41 MJ/kg) and for methane gas (34,45 MJ/ m^3).

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**methane bus**	**TOT**
Fuel type	diesel	diesel	diesel	diesel	**methane**	
C = N. bus (v)	21	12	14	38	**110**	**195**

Mileage and fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**Bus METHANE GAS**	**TOTAL**
(B) km travelled in 2009 (vkm)	520.811	470.463	508.843	1.199.516	5.558.100	**8.257.733**
Consumption factor (km/l)	2,0176	2,0176		2,0176	1,467	
Fuel consumption by type (Kg or l)	215.542	194.705	210.589	496.429	3.788.753	
(A) Fuel consumption by type (MJ)	8.837.215	7.982.901	8.634.140	20.353.603	130.522.526	**Average (MJ/v*vkm)**
(D) Vehicle fuel efficiency (MJ/v*vkm) = A/(B*C)	**0,8080**	**1,4140**	**1,2120**	**0,4465**	**0,2135**	**0,8215**

Period of data collecting: January-December 2010

Available data:

Vehicles: running fleet from January to December 2010 (tot 194 bus: 110 CNG and 84 diesel)

Km: km travelled by fleet from January to December 2010. The km travelled by fleet are read from the bus tachygraph.
Fuel consumption: diesel (lt/year); methane gas (m^3/year) converted into MJ using calorific power for gasoil (41 MJ/kg) and for methane gas (34,45 MJ/mc).

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**methane bus**	**TOT (N)**
Fuel type	diesel	diesel	diesel	diesel	**methane**	
C) N. bus (v)	21	11	14	38	**110**	**194**
% of tot bus	11%	6%	7%	20%	57%	

Mileage and fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**Bus METHANE GAS**	**TOTAL**
(B) km travelled in 2010 (vkm)	439.633	326.443	467.615	1.185.138	5.845.398	**8.264.227**
Consumption Factor (km/l)	2,0176	2,0176	2,0176	2,0176	1,467	
Fuel consumption by type (l)	217.899	161.798	231.768	587.400	3.984.593	
Fuel consumption by type (kg or l)	181.946	135.101	193.526	490.479	3.984.593	
(A) Fuel consumption by type (MJ)	7.459.772	5.539.144	7.934.575	20.109.635	137.269.230	**Average (MJ/v*vkm)**
(D) Vehicle fuel efficiency (MJ/v*vkm)	**0,8080**	**1,5426**	**1,2120**	**0,4465**	**0,2135**	**0,8536**

Period of data collecting: January-December 2011
Available data:
Vehicles: running fleet from January to December 2011 (tot 203 bus: 119 CNG and 84 diesel)
Km: km travelled by fleet from January to December 2011. The km travelled by fleet are read from the bus tachygraph.
Fuel consumption: diesel and methane gas l/year) converted into MJ using calorific power for gasoil (41 MJ/kg) and for methane gas (34,45 MJ/m^3).

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1 +CRT**	**Atobus EURO 2**	**Atobus EURO 2+CRT**	**methane bus**	**TOTAL**
Fuel type	diesel	diesel	diesel	diesel	diesel	**methane**	
C = N. bus (v)	21	11	14	9	29	**119**	**203**
% of tot bus	11%	6%	7%	4%	14	**59%**	

Mileage and fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**Atobus EURO 2+CRT**	**Bus METHANE GAS**	**TOTAL**
(B) km travelled in 2011 (vkm)	416.351	222.225	419.223	149.254	951.163	**5.946.317**	**8.104.533**
Consumption Factor (km/l)	2,0176	2,0176	2,0176	2,0176	2,0176	1,467	
Fuel consumption by type (l)	206.360	110.143	207.783	73.976	471.433	4.053.386	
Fuel consumption by type (kg - l)	172.310	91.970	173.499	61.770	393.646	4.053.386	
(A) Fuel consumption by type MJ	7.064.719	3.770.754	7.113.451	2.532.569	16.139.505	139.639.142	**Average (MJ/ v*vkm)**
(D) Vehicle fuel efficiency (MJ/v*vkm)	**0,8080**	**1,5426**	**1,2120**	**1,8854**	**0,5851**	**0,1973**	**1,038**

- **Indicator 4 (CO EMISSIONS)** – In order to calculate the emissions data used are, in general: number of busses by type, kms travelled by fleet (read from the bus speedometer) referred to the emission standard (Euro 0, Euro 1, Euro 2, eev.), the fuel consumption per year by type (litres of gasoil and methane gas) and the emission factors provided by the Italian law according to the type of busses. This data are already collected and elaborated once a year.

Period of data collecting: **EX-ANTE** January-December 2008
The calculation of the CO emission has been performed using an internal model (similar to COPERT) based on fuel consumption by fleet from Jan to Dec 2008 and on the emission factors for the specific pollutant agent. The emission factors (expressed in g/kwh) also considered for the gasoil fleet are taken from

European council directives which introduced the EURO standards emissions; The emission factor used for the methane gas fleet comes from the emission tests made by the manufacturer.
The detailed steps made in order to calculate the CO emissions per year are the following:

Calculation of CO emissions per year (kg)	Bus EURO 0+crt	Bus EURO 1	Bus EURO 2	Bus METHANE GAS
Fuel consumption by type (l)	369.432	876.932	653.648	3.175.485
Calorific power by type (kcal/l)	8.157	8.157	8.157	8.250
Kcal consumed by the fleet (kcal)	3.146.456.552	7.468.834.052	5.567.123.373	26.197.748.466
Kwh consumed by the fleet (kwh)	3.649.890	8.663.848	6.457.863	30.389.388
CO emission factors (g/kwh)	2,24	4,5	4	2,53
CO emissions per year (kg)	**8.176**	**38.987**	**25.831**	**76.885**

The main steps for the calculation of the indicator are the following:

Calculation of CO emission	Bus EURO 0+crt	Bus EURO 1	Bus EURO 2	Bus METHANE GAS	FLEET AVERAGE
Number of vehicles (v)	21	51	38	89	
Km travelled by fleet per year (vkm)	745.367	1.769.299	1.318.801	4.658.436	
CO emissions per year (kg)	8.176	38.987	25.831	76.885	
CO emissions (g/v*vkm)	0,5223	0,4321	0,5154	0,1854	**0,4138**

AFTER DATA COLLECTION:

Period of data collection: January-December 2009
The calculation of the CO emission has been performed using an internal model (similar to COPERT) based on fuel consumption by fleet from Jan to Dec 2009 and on the emission factors for the specific pollutant agent. The emission factors (expressed in g/kwh) also considered for the gasoil fleet are taken from European council directives which introduced the EURO standards emissions; the emission factor used for the methane gas fleet comes from the emission tests made by the manufacturer.
The detailed steps made in order to calculate the CO emissions per year are the following:

CO EMISSIONS	bus EURO 0+crt	Bus EURO 1	Bus EURO 1+CRT	Bus EURO 2	Bus METHANE GAS
Fuel consumption by type (l)	258.134	233.180	252.202	594.526	3.788.753
Calorific power by type (kcal/l)	8517	8517	8517	8517	8250
kcal consumed by the fleet (kcal)	2.198.526.609	1.985.989.974	2.148.005.467	5.063.579.387	31.257.208.589
kwh consumed by the fleet (kwh)	2.550.291	2.303.748	2.491.686	5.873.752	36.258.362
CO emission factors (g/kwh)	2,24	4,50	0,90	4,00	2,53
CO emission per year (kg)	5.713	10.367	2.243	23.495	91.734

The main steps for the calculation of the indicator are the following:

Calculation of CO emission	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Bus EURO 2	Bus METHANE GAS	FLEET AVERAGE
number of vehicles (v)	21	12	14	38	110	
km travelled by fleet per year (kmv)	520.811	470.463	508.843	1.199.516	5.558.100	
CO emission per year (kg)	5.713	10.367	2.243	23.495	91.734	
CO emission (g/v*vkm)	0,5223	1,8363	0,3148	0,5154	0,1500	**0,6678**

Period of data collection: January-December 2010

The calculation of the CO emission has been performed using an internal model (similar to COPERT) based on fuel consumption by fleet from Jan to Dec 2010 and on the emission factors for the specific pollutant agent. The emission factors (expressed in g/kwh) also considered for the gasoil fleet are taken from European council directives which introduced the EURO standards emissions; the emission factor used for the methane gas fleet comes from the emission tests made by the manufacturer.
The detailed steps made in order to calculate the CO emissions per year are the following:

Calculation of CO emission per year	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+CRT	Bus EURO 2	Bus METHANE GAS

Fuel consumption by type (l)	217.899	161.798	231.768	587.400	3.984.593
Calorific power by type (kcal/l)	8517	8517	8517	8517	8250
kcal consumed by the fleet (kcal)	1.855.845.688	1.378.030.844	1.973.967.563	5.002.884.787	32.872.892.638
kwh consumed by the fleet (kwh)	2.152.781	1.598.516	2.289.802	5.803.346	38.132.555
CO emission factors (g/kwh)	2,24	4,50	0,90	4,00	2,53
CO emission per year (kg)	4.822	7.193	2.061	23.213	96.475

The main steps for the calculation of the indicator are the following:

Calculation of CO emission	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Bus EURO 2**	**Bus METHANE GAS**	**FLEET AVERAGE**
number of vehicles (v)	21	11	14	38	110	
km travelled by fleet per year (vkm)	439.633	326.443	467.615	1.185.138	5.845.398	
CO emission per year (kg)	4.822	7.193	2.061	23.213	96.475	
CO emission (g/v*vkm)	0,5223	2,0032	0,3148	0,5154	0,1500	**0,7011**

Period of data collection: January-December 2011

The calculation of the CO emission has been performed using an internal model (similar to COPERT) based on fuel consumption by fleet from jan to dec 2011 and on the emission factors for the specific pollutant agent. The emission factors (expressed in g/kwh) also considered for the gasoil fleet are taken from European council directives which introduced the EURO standards emissions; The emission factor used for the methan gas fleet comes from the emission tests made by the manufacturer.
The detailed steps made in order to calculate the CO emissions per year are the following:

CO EMISSIONS	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Bus EURO 2**	**Bus EURO 2+CRT**	**Bus METHANE GAS**
Fuel consumption by type (l)	206.360	110.143	207.783	73.976	471.433	4.053.386

Calorific power by type (kcal/l)	8517	8517	8517	8517	8517	8250
kcal consumed by the fleet (kcal)	1.757.564.169	938.089.971	1.769.687.892	630.053.687	4.015.193.929	33.440.433.027
kwh consumed by the fleet (kwh)	2.038.774	1.088.184	2.052.838	730.862	4.657.625	38.790.902
CO emission factors (g/kwh)	2,24	4,50	0,90	4,00	0,80	2,53
CO emission per year (kg)	4.567	4.897	1.848	2.923	3.726	98.141

The main steps for the calculation of the indicator are the following:

Calculation of CO emission	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Bus EURO 2**	**Bus EURO 2+CRT**	**Bus METHANE GAS**	**FLEET AVERAGE**
number of vehicles (v)	21	11	14	9	29	**119**	
km travelled by fleet per year (vkm)	416.351	222.225	419.223	149.254	951.163	**5.946.317**	
CO emission per year (kg)	4.567	4.897	1.848	2.923	3.726	98.141	
CO emission (g/v*vkm)	0,5223	2,0032	0,3148	2,1763	0,1351	0,1387	**0,8817**

- **Indicator 5 (NOx EMISSIONS)**

EX ANTE: (year 2008)

Below the main passages for the calculation of the NOx emissions per year (kg) and of the actual indicator are reported:

Calculation of NOx emissions per year (kg)	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 2**	**Bus METHAN GAS**
Fuel consumption by type (l)	369.432	876.932	653.648	3.175.485
Calorific power by type (kcal/l)	8.157	8.157	8.157	8.250
Kcal consumed by the fleet (kcal)	3.146.456.552	7.468.834.052	5.567.123.373	26.197.748.466

Kwh consumed by the fleet (kwh)	3.649.890	8.663.848	6.457.863	30.389.388
NOx emission factors (g/kwh)	14,4	8	7	0,38
NOx emissions per year (kg)	**52.558**	**69.311**	**45.205**	**11.548**

Calculation of NOx emission	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 2**	**Bus METHAN GAS**	**FLEET AVERAGE**
Number of vehicles (v)	21	51	38	89	
Km travelled by fleet per year (vkm)	745.367	1.769.299	1.318.801	4.658.436	
NOx emissions per year (kg)	52.558	69.311	45.205	11.548	
NOx emissions (g/v*vkm)	**3,3578**	**0,7681**	**0,9020**	**0,0279**	**1,2639**

AFTER DATA COLLECTION: (year 2009)

Calculation of NOx emission per year	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Bus EURO 2**	**Bus METHANE GAS**
Fuel consumption by type (l)	258.134	233.180	252.202	594.526	3.788.753
Calorific power by type (kcal/l)	8517	8517	8517	8517	8250
Kcal consumed by the fleet (kcal)	2.198.526.609	1.985.989.974	2.148.005.467	5.063.579.387	31.257.208.589
Kwh consumed by the fleet (kwh)	2.550.291	2.303.748	2.491.686	5.873.752	36.258.362
NOx emission factors (g/kwh)	14,40	8,00	8,00	7,00	0,38
NOx emissions per year (kg)	**36.724**	**18.430**	**19.933**	**41.116**	**13.778**

Calculation of NOx emission	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Bus EURO 2	Bus METHANE GAS	FLEET AVERAGE
number of vehicles (v)	21	12	14	38	110	
km travelled by fleet per year (vkm)	520.811	470.463	508.843	1.199.516	5.558.100	
NOX emission per year (kg)	36.724	18.430	19.933	41.116	13.778	
NOX emission (g/v*vkm)	3,3578	3,2645	2,7982	0,9020	0,0225	**2,069**

(year 2010)

Calculation of NOX emission per year	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Atobus EURO 2	Bus METHANE GAS
Fuel consumption by type (l)	217.899	161.798	231.768	587.400	3.984.593
Calorific power by type (kcal/l)	8517	8517	8517	8517	8250
Kcal consumed by the fleet (kcal)	1.855.845.688	1.378.030.844	1.973.967.563	5.002.884.787	32.872.892.638
Kwh consumed by the fleet (kwh)	2.152.781	1.598.516	2.289.802	5.803.346	38.132.555
NOx emission factors (g/kwh)	14,40	8,00	8,00	7,00	0,38
NOx emissions per year (kg)	**31.000**	**12.788**	**18.318**	**40.623**	**14.490**

Calculation of NOx emission	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Atobus EURO 2	Bus METHANE GAS
number of vehicles (v)	21	11	14	38	110
km travelled by fleet per year (vkm)	439.633	326.443	467.615	1.185.138	5.845.398
NOX emission per year (kg)	31.000	12.788	18.318	40.623	14.490
NOX emission (g/v*vkm)	3,3578	3,5613	2,7982	0,9020	0,0225

(year 2011)

Calculation of NOX emission per year (kg)	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Atobus EURO 2	Atobus EURO 2+CRT	Bus METHANE GAS

Fuel consumption by type (l)	206.360	110.143	207.783	73.976	471.433	4.053.386
Calorific power by type (kcal/l)	8517	8517	8517	8517	8517	8250
Kcal consumed by the fleet (kcal)	1.757.564.169	938.089.971	1.769.687.892	630.053.687	4.015.193.929	33.440.433.027
Kwh consumed by the fleet (kwh)	2.038.774	1.088.184	2.052.838	730.862	4.657.625	38.790.902
NOx emission factors (g/kwh)	14,40	8,00	8,00	7,00	7,00	0,38
NOx emissions per year (kg)	**29.358**	**8.705**	**16.423**	**5.116**	**32.603**	**14.741**

Calculation of NOx emission	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Atobus EURO 2**	**Atobus EURO 2+CRT**	**Bus METHANE GAS**	**FLEET AVERAGE**
number of vehicles (v)	21	11	14	9	29	119	
km travelled by fleet per year (vkm)	416.351	222.225	419.223	149.254	951.163	5.946.317	
NOX emission per year (kg)	29.358	8.705	16.423	5.116	32.603	14.741	
NOX emission (g/v*vkm)	3,3578	3,5613	2,7982	3,8086	1,1820	0,0208	**2,4548**

- **Indicator 6 (SMALL PARTICULATE EMISSIONS)**

  EX ANTE: (year 2008)

Below the main passages for the calculation of the NOx emissions per year (kg) and of the actual indicator are reported:

Calculation of SP emissions per year	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 2**	**Bus METHAN GAS**
Fuel consumption by type (l)	369.432	876.932	653.648	3.175.485
Calorific power by type (kcal/l)	8.157	8.157	8.157	8.250
Kcal consumed by the fleet (kcal)	3.146.456.552	7.468.834.052	5.567.123.373	26.197.748.466
Kwh consumed by the fleet (kwh)	3.649.890	8.663.848	6.457.863	30.389.388
SP emission factors (g/kwh)	0,02	0,36	0,15	0,003

SP emissions per year (kg)	**73**	**3 119**	**969**	**91**

Calculation of SP emission	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 2**	**Bus METHAN GAS**	**FLEET AVERAGE**
Number of vehicles (v)	21	51	38	89	
Km travelled by fleet per year (vkm)	745.367	1.769.299	1.318.801	4.658.436	
SP emissions per year (kg)	73	3 119	969	91	
SP emissions (g/v*vkm)	0,0047	0,0346	0,0193	0,0002	**0,0147**

AFTER DATA COLLECTION:

(year 2009)

Calculation of SP emission per year	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Atobus EURO 2**	**Bus METHANE GAS**
Fuel consumption by type (l)	258.134	233.180	252.202	594.526	3.788.753
Calorific power by type (kcal/l)	8517	8517	8517	8517	8250
Kcal consumed by the fleet (kcal)	2.198.526.609	1.985.989.974	2.148.005.467	5.063.579.387	31.257.208.589
Kwh consumed by the fleet (kwh)	2.550.291	2.303.748	2.491.686	5.873.752	36.258.362
SP emission factors (g/kwh)	0,020	0,360	0,020	0,150	0,003
SP emission per year (kg)	**51**	**829**	**50**	**881**	**109**

Calculation of NOx emission (g/vkm)	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Atobus EURO 2	Bus METHANE GAS	FLEET AVERAGE
number of vehicles (v)	21	12	14	38	110	
km travelled by fleet per year (vkm)	520.811	470.463	508.843	1.199.516	5.558.100	
SP emission per year (kg)	51	829	50	881	109	
SP emission (g/v*vkm)	0,0047	0,1469	0,0070	0,0193	0,0002	**0,0356**

(year 2010)

Calculation of SP emission per year	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Atobus EURO 2	Bus METHANE GAS
Fuel consumption by type (l)	217.899	161.798	231.768	587.400	3.984.593
Calorific power by type (kcal/l)	8517	8517	8517	8517	8250
Kcal consumed by the fleet (kcal)	1.855.845.688	1.378.030.844	1.973.967.563	5.002.884.787	32.872.892.638
Kwh consumed by the fleet (kwh)	2.152.781	1.598.516	2.289.802	5.803.346	38.132.555
SP emission factors (g/kwh)	0,020	0,360	0,020	0,150	0,003
SP emission per year (kg)	**43**	**575**	**46**	**871**	**114**

Calculation of SP emission	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+crt	Atobus EURO 2	Bus METHANE GAS	FLEET AVERAGE
number of vehicles (v)	21	11	14	38	110	
km travelled by fleet per year (vkm)	439.633	326.443	467.615	1.185.138	5.845.398	
SP emission per year (kg)	43	575	46	871	114	

SP emission (g/v*vkm)	0,0047	0,1603	0,0070	0,0193	0,0002	**0,0383**

(year 2011)

Calculation of SP emission per year (kg)	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Atobus EURO 2**	**Atobus EURO 2+CRT**	**Bus METHANE GAS**
Fuel consumption by type (l)	206.360	110.143	207.783	73.976	471.433	4.053.386
Calorific power by type (kcal/l)	8517	8517	8517	8517	8517	8250
Kcal consumed by the fleet (kcal)	1.757.564.169	938.089.971	1.769.687.892	630.053.687	4.015.193.929	33.440.433.027
Kwh consumed by the fleet (kwh)	2.038.774	1.088.184	2.052.838	730.862	4.657.625	38.790.902
SP emission factors (g/kwh)	0,020	0,360	0,020	0,150	0,220	0,003
SP emission per year (kg)	**41**	**392**	**41**	**110**	**1.025**	**116**

Calculation of SP emissions	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Bus EURO 2**	**Bus EURO 2+CRT**	**Bus METHANE GAS**	**FLEET AVERAGE**
number of vehicles (v)	21	11	14	9	29	119	
km travelled by fleet per year (vkm)	416.351	222.225	419.223	149.254	951.163	5.946.317	
SP emission per year (kg)	41	392	41	110	1.025	116	
SP emission (g/v*vkm)	0,0047	0,1603	0,0070	0,0816	0,0371	0,0002	**0,0485**

- **Indicator 7 (% KM CLEAN BUS)** – It's the percentage between the cover clean km and the total km. Both the data are read from the bus tachygraph.
  Period of data collecting:
  EX-ANTE January-December 2008
  Kilometres travelled by CNG bus and electrical bus from Jan. to Dec. 2008 in relation to the total kilometres.

Mileage and fuel consumption	Autobus EURO 0+crt	Autobus EURO 1	Atobus EURO 2	Autobus a METANO	TOTALE (KM/ANNO)
km traveled in 2008	745.367	1.769.299	1.318.801	4.658.436	**8.491.903**
% of tot km	8,78%	20,84%	15,53%	54,86%	

AFTER DATA COLLECTION:

(year 2009)

Kilometres travelled by CNG bus and electrical bus from Jan to Dec 2009 in relation to the total kilometers.

Mileage and fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Atobus EURO 2**	**Bus METHANE GAS**	**TOT (km/year)**
km travelled in 2009	520.811	470.463	508.843	1.199.516	**5.558.100**	**8.257.733**
% of tot km	6,31%	5,70%	6,16%	14,53%	67,31%	

(year 2010)

Kilometres travelled by CNG bus and electrical bus from Jan to Dec 2010 in relation to the total kilometres.

Mileage and fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Bus EURO 2**	**Bus METHANE GAS**	**TOT (km/year)**
km travelled in 2010	439.633	326.443	467.615	1.185.138	**5.845.398**	**8.264.227**
% of tot km	5,32%	3,95%	5,66%	14,34%	70,73%	

(year 2011)

Mileage and Fuel consumption	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+crt**	**Atobus EURO 2**	**Atobus EURO 2+CRT**	**Bus METHANE GAS**	**TOT (km/year)**

km travelled in 2011	416.351	222.225	419.223	149.254	951.163	**5.946.317**	**8.104.533**
% of tot km	5,14%	2,74%	5,17%	1,84%	11,74%	73,37%	

- **Indicator 8 (N. CLEAN BUSES)**

EX-ANTE January-December 2008

Number of CNG bus and electrical bus from Jan to Dec 2008 in relation to the total fleet.

Fleet composition	Autobus EURO 0+crt	Autobus EURO 1	Atobus EURO 2	methane bus	TOT (N)
Fuel type	diesel	diesel	diesel	methane	
N. autobus	21	51	38	**89**	**199**
% of tot bus	11%	26%	19%	**45%**	

AFTER DATA COLLECTION:

(year 2009)

Period of data collection: January-December 2009
Number of CNG bus and electrical bus from Jan to Dec 2009 in relation to the total fleet.

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**methane bus**	**TOT (N)**
Fuel type	diesel	diesel	diesel	diesel	**methane**	
N. bus	21	12	14	38	**110**	**195**
% of tot bus	10%	6%	7%	19%	56%	

(year 2010)

Period of data collecting: January-December 2010
Number of CNG bus and electrical bus from Jan to Dec 2010 in relation to the total fleet.

Fleet composition	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+CRT	Atobus EURO 2	methane bus	TOT (N)
Fuel type	diesel	diesel	diesel	diesel	methane	
N. bus	21	11	14	38	110	194
% of tot bus	10%	5%	7%	20%	57%	

(year 2011)

Fleet composition	Bus EURO 0+crt	Bus EURO 1	Bus EURO 1+CRT	Atobus EURO 2	Atobus EURO 2+CRT	methane bus	TOT (N)
Fuel type	diesel	diesel	diesel	diesel	diesel	methane	
N. bus	21	11	14	9	29	119	203
% of tot bus	10%	5%	7%	4%	15	59%	

- **Indicator 9 (NOISE PERCEPTION)** –
  EX ANTE: (year 2008) **the measure is referred to all the busses of the fleet**

Measurement of noise perception for a bus driver at work. Average sound level = 72,8 db(A) (maximum 80 db(A) according to D.L. n.81 of 9/4/2008 title VIII cap I e II)

AFTER DATA COLLECTION:

(year 2009); the measure is referred only to 18mt busses

Average sound level = 72,5 db(A) (maximum 80 db(A) according to D.L. n.81 of 9/4/2008 title VIII cap I e II)

(year 2010); the measure is referred only to 18mt busses

The same of 2009, because no new busses are acquired
(year 2011); the measure isn't repeated.

- **Indicator 10 (Accuracy of time keeping)** - Number of percentage of PT on line1 that arrive within an acceptable interval (3min) around the planned times given by timetable. Data are monthly collected by the tele-data collector. Only downtown passes are detected. Accuracy of time keeping of line 1 will be investigated for the bus stops located in the city centre.

2008 Line1	Measurement point code		tot trips	Recorded trips	%
Jan	OSP	MBEL	1559	1426	91,5%
	STA	MAZ	1546	1442	93,3%
Feb	OSP	MBEL	2352	2093	89,0%
	STA	MAZ	2307	2027	87,9%
Mar	OSP	MBEL	2025	1922	94,9%
	STA	MAZ	1995	1821	91,3%
Apr	OSP	MBEL	2689	2547	94,7%
	STA	MAZ	2639	2383	90,3%
may	OSP	MBEL	1071	1008	94,1%
	STA	MAZ	1056	968	91,7%
Jun	OSP	MBEL	1845	1680	91,1%
	STA	MAZ	1816	1612	88,8%
Jul	OSP	MBEL	1905	1802	94,6%
	STA	MAZ	1894	1766	93,2%
Ago	OSP	MBEL	1408	1313	93,3%
	STA	MAZ	1363	1179	86,5%
Sep	OSP	MBEL	2619	2417	92,3%
	STA	MAZ	2569	2226	86,6%
Oct	OSP	MBEL	2938	2640	89,9%
	STA	MAZ	2902	2449	84,4%
Nov	OSP	MBEL	2575	2278	88,5%
	STA	MAZ	2564	2177	84,9%
Dec	OSP	MBEL	1771	1525	86,1%
	STA	MAZ	1753	1366	77,9%

Average time keeping accuracy 89,9%

AFTER DATA COLLECTION:

(year 2009);

2009 **Line 1**			**Tot bus rides**	**Bus rides on schedule**	**%**
Jan	OSP	MBEL	2359	2191	92,9%
	STA	MAZ	2321	2052	88,4%
Feb	OSP	MBEL	2607	2402	92,1%
	STA	MAZ	2584	2287	88,5%
Mar	OSP	MBEL	1983	1492	75,2%
	STA	MAZ	2002	1733	86,6%
Apr	OSP	MBEL	1649	1491	90,4%
	STA	MAZ	1642	1455	88,6%
May	OSP	MBEL	1803	1606	89,1%
	STA	MAZ	1802	1564	86,8%
Jun	OSP	MBEL	1655	1463	88,4%
	STA	MAZ	1630	1324	81,2%
Jul	OSP	MBEL	1597	1329	83,2%
	STA	MAZ	1554	1109	71,4%
Aug	OSP	MBEL	1428	1308	91,6%
	STA	MAZ	1360	1104	81,2%
Sep	OSP	MBEL	1858	1669	89,8%
	STA	MAZ	1829	1477	80,8%
Oct	OSP	MBEL	1892	1690	89,3%
	STA	MAZ	1914	1658	86,6%
Nov	OSP	MBEL	1796	1665	92,7%
	STA	MAZ	1803	1536	85,2%
Dec	OSP	MBEL	1214	1072	88,3%
	STA	MAZ	1214	993	81,8%

Average time keeping accuracy 86,3%

(year 2010);

2010 **Line 1**			**Tot bus rides**	**Bus rides on schedule**	**%**
Jan	OSP	MBEL	1352	1261	93,30%
	STA	MAZ	1350	1205	89,30%
Feb	OSP	MBEL	1670	1557	93,20%
	STA	MAZ	1684	1505	89,40%
Mar	OSP	MBEL	2050	1925	93,90%
	STA	MAZ	2072	1908	92,10%
Apr	OSP	MBEL	1624	1546	95,20%
	STA	MAZ	1642	1475	89,80%
May	OSP	MBEL	1851	1717	92,80%
	STA	MAZ	1829	1619	88,50%
Jun	OSP	MBEL	1580	1414	89,50%
	STA	MAZ	1621	1340	82,70%
Jul	OSP	MBEL	944	850	90,00%
	STA	MAZ	957	787	82,20%
Aug	OSP	MBEL	1276	1218	95,50%
	STA	MAZ	1267	1151	90,80%
Sep	OSP	MBEL	1834	1640	89,40%
	STA	MAZ	1857	1604	86,40%
Oct	OSP	MBEL	1861	1680	90,30%
	STA	MAZ	1883	1685	89,50%
Nov	OSP	MBEL	1785	1629	91,30%
	STA	MAZ	1820	1621	89,10%
Dec	OSP	MBEL	1602	1432	89,40%
	STA	MAZ	1626	1413	86,90%

Average time keeping accuracy 90,0%

(year 2011);

2011 **Line 1**			**Tot bus rides**	**Bus rides on schedule**	**%**
Jan	OSP	MBEL	1651	1562	94,60%
	STA	MAZ	1675	1555	92,80%
Feb	OSP	MBEL	1670	1576	94,40%

2011 Line 1			Tot bus rides	Bus rides on schedule	%
	STA	MAZ	1684	1553	92,20%
Mar	OSP	MBEL	1874	1778	94,90%
	STA	MAZ	1900	1752	92,20%
Apr	OSP	MBEL	1496	1401	93,60%
	STA	MAZ	1493	1349	90,40%
May	OSP	MBEL	1928	1809	93,80%
	STA	MAZ	1944	1788	92,00%
Jun	OSP	MBEL	1656	1495	90,30%
	STA	MAZ	1659	1442	86,90%
Jul	OSP	MBEL	1411	1273	90,20%
	STA	MAZ	1418	1197	84,40%
Aug	OSP	MBEL	1306	1230	94,20%
	STA	MAZ	1292	1144	88,50%
Sep	OSP	MBEL	1800	1591	88,40%
	STA	MAZ	1790	1503	84,00%
Oct	OSP	MBEL	1835	1643	89,50%
	STA	MAZ	1848	1644	89,00%
Nov	OSP	MBEL	1771	1601	90,40%
	STA	MAZ	1797	1616	89,90%
Dec	OSP	MBEL	1645	1475	89,70%
	STA	MAZ	1646	1468	89,20%

Average time keeping accuracy 90,6%

- **Indicator 11 (AVERAGE OCCUPANCY) -** Passengers per trip of Line 1. Number of passengers recorded + 60min ticket recorded per trip in the given period (3monthly). Data are monthly collected according to the number of passes recorded and 60min ticket issued considering a coefficient related to different elements such as missing ticket validation (as Regione Lombardia's law)

passengers on line 1 (Jan-Dec 2008) = 8.106.965

trips on line 1 (Jan-Dec 2008) = 93303

Average occupancy = 86,89

AFTER DATA COLLECTION:

(year 2009);

passengers on line 1 (Jan-Dec 2009) = 8.202.951

trip on line 1 (Jan-Dec 2009) = 80.626

Average occupancy = 101,74

(year 2010);

passengers on line 1 (Jan-Dec 2010) = 8.286.081

trip on line 1 (Jan-Dec 2010) = 74.741

Average occupancy = 110,86

(year 2011);

passengers on line 1 (Jan-Dec 2011) = 8.179.108

trip on line 1 (Jan-Dec 2011) = 74.102

Average occupancy = 110,38

- **Indicator 12 (ENVIRONMENTAL CARE)** – The data is collected in Customer Satisfaction questionnaires. The data is general and collected in Customer Satisfaction questionnaires each 4 months with interviews to the users. The related question is: "Brescia Trasporti takes care for the pollution's reduction. "The interview amount is 1200. The people interviewed are chosen in a double way: interviews at the bus stop and phone interviews. For the interviews at the bus stops, the bus stops are selected with a particular focus on terminals or on specific lines; for the phone interviews a casual extraction among the people registered in the lists of the holders of Omnibus Card is made according to the typology of trip loaded. 700 questions are proposed face to face at the bus stops and/or on the busses of Brescia Trasporti and 500 are proposed by phone interview according to the references of Brescia Trasporti. The activity has been planned associating traditional surveys (structured questions, semi structured and open ones) and innovative methodologies tested by Summa that allows to manage the information coming from indirect survey. According with the methodologies used, the witness is able to express its position or opinion about certain subject without preconceived answers and taking over all content delivered spontaneously. The obtained indications are introduced into a dynamic database and analyzed carefully, focusing on key concepts and on the additional ones, and it is possible to draw assessments and rigorous statistics, qualitative in-depth. Specific interviews will probably be carried out for Civitas MODERN trough dedicated surveys to better understand the result of all measure concerning PT implementation.

Result of customer satisfaction 2008/I : 6,79/10

Result of customer satisfaction 2008/II : 7,08/10

Result of customer satisfaction 2008/III : 7,19/10

Result of customer satisfaction 2008/I – Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 99,6% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 100% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**172**	**14,1**
Soddisfatto	**471**	**38,7**
Indifferente (né soddisfatto, né insoddisfatto)	**310**	**25,5**
Insoddisfatto	**191**	**15,7**
Molto insoddisfatto	**72**	**5,9**

Punteggio sintetico in base 10 **6,79**

Deviazione standard (±) **2,18** Errore standard (±) **0,063**

Result of customer satisfaction 2008/II - Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 99,9% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 100% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**189**	**15,6**
Soddisfatto	**547**	**45,1**
Indifferente (né soddisfatto, né insoddisfatto)	**274**	**22,6**
Insoddisfatto	**140**	**11,6**
Molto insoddisfatto	**62**	**5,1**

Punteggio sintetico in base 10 **7,08**

Deviazione standard (±) **2,10** Errore standard (±) **0,060**

Result of customer satisfaction 2008/III - Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 99,9% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 100% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**194**	**15,6**
Soddisfatto	**536**	**43,2**
Indifferente (né soddisfatto, né insoddisfatto)	**353**	**28,4**
Insoddisfatto	**128**	**10,3**
Molto insoddisfatto	**30**	**2,4**

Punteggio sintetico in base 10 **7,19**

Deviazione standard (±) **1,90** Errore standard (±) **0,054**

AFTER DATA COLLECTION:

(year 2009);

Result of customer satisfaction 2009/I : 7,04/10

Result of customer satisfaction 2009/II : 7,33/10

Result of customer satisfaction 2009/III : 7,04/10

Result of customer satisfaction 2009/I – Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 99,9% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 100% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**175**	**14,3**
Soddisfatto	**497**	**40,7**
Indifferente (né soddisfatto, né insoddisfatto)	**382**	**31,3**
Insoddisfatto	**124**	**10,1**
Molto insoddisfatto	**44**	**3,6**

Punteggio sintetico in base 10 **7,04**

Deviazione standard (±) **1,96** Errore standard (±) **0,056**

Result of customer satisfaction 2009/II - Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 99,9% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 100% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**255**	**20,9**
Soddisfatto	**543**	**44,4**
Indifferente (né soddisfatto, né insoddisfatto)	**233**	**19,1**
Insoddisfatto	**141**	**11,5**
Molto insoddisfatto	**50**	**4,1**

Punteggio sintetico in base 10 **7,33**

Deviazione standard (±) **1,96** Errore standard (±) **0,056**

Result of customer satisfaction 2009/III - Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 100% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 99,3% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**125**	**10,2**
Soddisfatto	**539**	**44,2**
Indifferente (né soddisfatto, né insoddisfatto)	**442**	**36,2**
Insoddisfatto	**74**	**6,1**
Molto insoddisfatto	**40**	**3,3**

Punteggio sintetico in base 10 **7,04**

Deviazione standard (±) **1,76** Errore standard (±) **0,050**

(year 2010);

Result of customer satisfaction 2010/I : 7,33

Result of customer satisfaction 2010/II : 7,27

Result of customer satisfaction 2010/III : 7,19

Result of customer satisfaction 2010/I – Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati

→ 100% esprime il livello di soddisfazione in relazione agli indicatori precodificati

→ 100% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**212**	**17,5**
Soddisfatto	**562**	**46,5**
Indifferente (né soddisfatto, né insoddisfatto)	**294**	**24,3**
Insoddisfatto	**99**	**8,2**
Molto insoddisfatto	**42**	**3,5**

Punteggio sintetico in base 10	**7,33**		
Deviazione standard (±)	**1,95**	Errore standard (±)	**0,056**

Result of customer satisfaction 2010/II - Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati
→ 100% esprime il livello di soddisfazione in relazione agli indicatori precodificati
→ 99,8% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**180**	**15,0**
Soddisfatto	**608**	**50,5**
Indifferente (né soddisfatto, né insoddisfatto)	**261**	**21,7**
Insoddisfatto	**105**	**8,7**
Molto insoddisfatto	**50**	**4,2**

Punteggio sintetico in base 10 **7,27**

Deviazione standard (±) **1,96** Errore standard (±) **0,056**

Result of customer satisfaction 2010/III - Specific question about BST attention to pollution

Tavola 9 **Indicatore 8: attenzione di Brescia Trasporti per la riduzione dell'inquinamento**

100% totale soggetti interpellati
→ 100% esprime il livello di soddisfazione in relazione agli indicatori precodificati
→ 99,9% valuta l'attenzione di Brescia Trasporti per la riduzione dell'inquinamento

Il grado di soddisfazione

elementi rilevati	Frequenza assoluta	Frequenza relativa (%)
Molto soddisfatto	**168**	**14,0**
Soddisfatto	**517**	**43,0**
Indifferente (né soddisfatto, né insoddisfatto)	**401**	**33,4**
Insoddisfatto	**89**	**7,4**
Molto insoddisfatto	**26**	**2,2**

Punteggio sintetico in base 10 **7,19**

Deviazione standard (±) **1,79** Errore standard (±) **0,052**

Result of customer satisfaction 2011/I : 7,54

Result of customer satisfaction 2011/II : 7,27

Result of customer satisfaction 2011/III : 7,10

Result of customer satisfaction 2011 - Specific question about BST attention to pollution

- **Indicator 13 (AVERAGE FLEET AGE)** – Collected data for the ex ante are referred to December 2008. This indicator is linked to the indicator number 3 "Vehicle fuel efficiency", as younger busses have new technologies that save fuel.

Period of data collecting: December 2008
Average fleet age:

Fleet composition	Autobus EURO 0+crt	Autobus EURO 1	Atobus EURO 2	methane bus	TOT (N)
Fuel type	diesel	diesel	diesel	methane	
N. autobus	21	51	38	89	199
EVERAGE AGE	9 years				

AFTER DATA COLLECTION:

(year 2009)

Average age of the fleet in December 2009 calculated in accordance with the regional indicative.

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**methane gas**	**TOT (N)**
Fuel type	diesel	diesel	diesel	diesel	**methane**	
N. bus	21	12	14	38	**110**	**195**
% of tot bus	11%	6%	7%	19%	56%	
EVERAGE AGE	8,4 years					

(year 2010)

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**methane bus**	**TOT (N)**
Fuel type	diesel	diesel	diesel	diesel	**methane**	
N. bus	21	11	14	38	**110**	**194**
% of tot bus	11%	6%	7%	20%	57%	
EVERAGE AGE	9,3 years					

(year 2011)

Fleet composition	**Bus EURO 0+crt**	**Bus EURO 1**	**Bus EURO 1+CRT**	**Atobus EURO 2**	**Atobus EURO 2+CRT**	**methane bus**	**TOT (N)**
Fuel type	diesel	diesel	diesel	diesel	diesel	**methane**	
N. bus	21	11	14	9	29	**119**	**203**
% of tot bus	11%	6%	7%	5%		**61%**	
EVERAGE AGE	9,9 years						

Annex 3: Cost Benefit Analysis

Evaluation period for CBA

The whole CBA is referred to the fleet running on Line 1, on which thanks to Civitas only CNG 18m long buses are used, The purchased hybrid (methane-electric) 8 long buses are used for the on demand service "Accabus" (for disabled/elder people), for the Bussola service (which links two peripheral parking) and for the bus service in the smallest downtown roads.

The present costs/benefits analysis (CBA) is referred to the Line 1 (Mompiano-Masaccio) of Brescia local public transport system. In fact, since 2009 on line 1 only the new 18 m CNG buses (length: 18 m; capacity: 149 passengers of which 32 seats) are in use. The CBA base year is 2008, during which on Line 1 20 buses were in use. After 2009, the transport offer (buses*km) is unchanged. The CBA final year (2023) falls at the end of the technical/economical life span of the busses (that doesn't necessary coincide with the average age of a fleet, that is usually estimated in 15 years).

Method and values for modification

This CBA doesn't contemplate oncoming Brescia Trasporti strategy on the occasion of the Metrobus start up foreseen in January 2013, after which Brescia buses transport system is going to be modified.

On line 1 now only the new 18 m CNG buses (length: 18 mt; capacity: 149 passengers of which 32 seats) are in use (length: 12 m; capacity: 91 passengers of which 24 seats), but in the base-year 2008, 20 buses were in use (see Table 1), with different feeding: diesel (Euro0+crt, Euro1, Euro2) or CNG. In particular, for the scenario 0 building (BaU) the buses partition into the different categories has been arranged proportionally to the 2008 whole fleet, as shown in Table 1.

TABLE 1 – Estimated types and number of buses operating on line 1 in 2008

	2008							
	Urban network fleet				Line 1 fleet			
	N. buses	%	Km	%	N. buses	Km	Av.ate (years)	Dead year
Euro0+crt Buses	21	10,6%	745.367	8,8%	2	96.228	17	2009
Euro1 Buses	51	25,6%	1.769.299	20,8%	5	228.420	13	2010
Euro2 Buses	38	19,1%	1.318.801	15,5%	4	170.260	11	2012
Methane Buses (length: 12 m)	89	44,7%	4.658.436	54,9%	9	601.413	4	2019
TOTAL	**199**	**100,0%**	**8.491.903**	**100,0%**	**20**	**1.096.321**	**9**	**-**

Source: Brescia Mobilità SpA

As a consequence of the new 18 m CNG buses use on line 1, polluting emissions and maintenance costs are decreased: in fact, runs have been reduced from 1.096.321 km to 921.576 km. Therefore, CBA has to consider the investment costs of new CNG buses and the emission/maintenance costs variation. Other operating cost (as bus drivers, for example) are considered unchanged.

The benefits, due to the passengers increase and to the CNG buses, which have less environmental impact, can equal (conventionally) the operating revenues increase (financial aspect assimilated to economical aspect).

The main economic items calculated, referring to base year, are:

- Net Present Value (NPV);
- B/C ratio;
- Investment Return Rate (IRR).

The buses polluting emission data are shown in Table 2, subdivided into different bus types, used in the CBA scenarios (diesel Euro0+crt; diesel Euro1, diesel Euro2, methane). The units of measurements are grams of carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM), referred to 1 kilowatt-hour energy consumption.

On first approximation, polluting emission quantities have been assumed the same for the different methane bus types (12 m and 18 m length).

TABLE 2 – Polluting emission factors of different bus types used in CBA

EMISSION FACTOR	EURO0+crt	EURO1	EURO2	METHANE
CO emission factor (g/kWh)	2,24	4,50	4,00	2,53
NOx emission factor (g/kWh)	14,40	8,00	7,00	0,38
PM emission factor (g/kWh)	0,02	0,36	0,15	0,003

Source: Brescia Mobilità – EURO Normative

The monetization of environmental benefits has been carried out basing on EU data, as agreed during the last Civitas meeting in Funchal; in particular, the main polluting agents (CO, NOx, PM) data (total external costs in urban zone), considered in CBA, are shown in Table 3 and are referred to Euro 2008.

TABLE 3 – Monetization of the main polluting agents (€2008/Kg)

EMISSION TYPE	ESTERNAL COST (€2008/kg)
CO emission (*)	0,003
NOx emission (**)	3,639
PM emission (**)	420,763

Source: (*) Astra – Scenario Low External Cost - 2005

(**) HEATCO, D5 Proposal for harmonised Guidelines – Brussels, 2006

Scenario 0 (Reference case or BaU)

In this scenario the Brescia Trasporti public transport system and the buses types used in 2008 on Line 1 have been considered unchanged up to the technical/economic life relevant limits. The original buses are replaced with new CNG buses (length: 12 m; estimated investment cost: 257.808 €/2009 each) to the technical/economic life limit (dead year: see Table 1).

The total investment costs of the gradual substitution of older buses with 12 m CNG buses have been estimated 5.274.756 €/2008 and the relevant residual value in 2023 has been estimated 1.881.330 €/2008.

No other actions on the transport service have been implemented in this scenario (i.e.: ride number variations, different vehicle capacities, etc.) and therefore, the number of passenger (8.106.965 passengers/year) and the operating revenues (2.291.277 €/year) are the same in the time period considered for the scenario building.

The maintenance costs have been estimated considering the annual kilometrical values, referred to the different bus types used in this scenario (original buses and new 12 m CNG buses), as shown in detail in Table 4.

TABLE 4 – SCENARIO 0: kilometrical maintenance costs for each different vehicle ages

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bus City Class Diesel 12 m (€/Km)	0,0446	0,0894	0,1775	0,1485	0,1518	0,4931	0,3241	0,2346	0,2127	0,1670	0,6387	0,2482	0,2781	0,2322	0,6741
Bus City Class Methane 12 m (€/Km)	0,0277	0,0978	0,1560	0,2507	0,1696	0,2703	0,3772	0,4672	0,1664	0,1660	0,4883	0,2192	0,2347	0,2505	1,1448

Source: Brescia Mobilità

Scenario 1 (Civitas measure)

The present Line 1 has been analysed considering only 18 m CNG buses running on the bus line itself (total vehicles: 16).

The whole investment cost in order to buy new CNG buses is 6.022.400 €/2009 (purchase year: 2009), equivalent to 5.886.999 €/2008, and the residual value of the substituted original buses has been estimated 1. 881.330 €/2008.

The transport capacity and the ride frequency are changed in comparison to the 2008 service. The operating revenues increase, estimated during the first years, as shown in Table 5, basing on the real number of passenger recorded in 2010 (8.286.081 passengers/year).

TABLE 5 – Estimated operating revenues increase due to the new transport service

	2008	2009	2010	2011	2012	2013-2023
Operating revenues (€2008)	2.291.277	+1,0%	+1,0%	+0,5%	+0,5%	as 2012

The maintenance costs have been estimated considering the yearly kilometrical values, referred to different bus types used in this scenario: original buses in 2008 (see Table 4), substituted by 18 m CNG buses (see Table 6).

TABLE 6 – SCENARIO 1: kilometrical maintenance costs for each different vehicle ages

YEAR	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Bus Citelis Methane 18 m (€/Km)	0,0613	0,1231	0,1489	0,1664	0,1826	0,3213	0,3196	0,3376	0,1979	0,1912	0,4747	0,3721	0,2361	0,2723	0,3946

Source: Brescia Mobilità

The following tables (from 7 to 10) show the detailed CBA for each year of the time horizon considered (2008-2023).

Life time cost and benefit

Table 7 Capital cost in the evaluation period (not discounted)

	Cases for comparison	Cost
Year 2008	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2009	CIVITAS measure	€5,886,999
	Reference case (or BAU)	€527.476
Year 2010	CIVITAS measure	-
	Reference case (or BAU)	€1.318.689
Year 2011	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2012	CIVITAS measure	-
	Reference case (or BAU)	€1.054.951
Year 2013	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2014	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2015	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2016	CIVITAS measure	-
	Reference case (or BAU)	-

	Cases for comparison	Cost
Year 2017	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2018	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2019	CIVITAS measure	-
	Reference case (or BAU)	€2.373.640
Year 2020	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2021	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2022	CIVITAS measure	-
	Reference case (or BAU)	-
Year 2023	CIVITAS measure	-
	Reference case (or BAU)	-

Table 8 Maintenance cost in the evaluation period (not discounted)

	Cases for comparison	Cost
Year 2008	CIVITAS measure	€262,137
	Reference case (or BAU)	€262,137
Year 2009	CIVITAS measure	€56,504
	Reference case (or BAU)	€366,595
Year 2010	CIVITAS measure	€113,419
	Reference case (or BAU)	€282,152
Year 2011	CIVITAS measure	€137,259
	Reference case (or BAU)	€433,127
Year 2012	CIVITAS measure	€153,381
	Reference case (or BAU)	€164,523
Year 2013	CIVITAS measure	€168,316
	Reference case (or BAU)	€190,075
Year	CIVITAS measure	€296,129

	Cases for comparison	Cost
2014	Reference case (or BAU)	€384,981
Year 2015	CIVITAS measure	€294,506
	Reference case (or BAU)	€272,596
Year 2016	CIVITAS measure	€311,121
	Reference case (or BAU)	€301,122
Year 2017	CIVITAS measure	€182,389
	Reference case (or BAU)	€319,401
Year 2018	CIVITAS measure	€176,182
	Reference case (or BAU)	€806,728
Year 2019	CIVITAS measure	€437,442
	Reference case (or BAU)	€181,109
Year 2020	CIVITAS measure	€342,873
	Reference case (or BAU)	€219,804
Year 2021	CIVITAS measure	€217,557
	Reference case (or BAU)	€194,743
Year 2022	CIVITAS measure	€250,972
	Reference case (or BAU)	€311,613
Year 2023	CIVITAS measure	€363,618
	Reference case (or BAU)	€306,681

Table 9 Operating revenues in the evaluation period (not discounted)

	Cases for comparison	Values
Year 2008	CIVITAS measure	€2,291,277
	Reference case (or BAU)	€2,291,277
Year 2009	CIVITAS measure	€2,314,190
	Reference case (or BAU)	€2,291,277
Year 2010	CIVITAS measure	€2,337,332
	Reference case (or BAU)	€2,291,277
Year 2011	CIVITAS measure	€2,349,018
	Reference case (or BAU)	€2,291,277

	Cases for comparison	Values
Year 2012	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2013	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2014	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2015	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2016	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2017	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2018	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2019	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2020	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2021	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2022	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277
Year 2023	CIVITAS measure	€2,360,763
	Reference case (or BAU)	€2,291,277

Table 10 Environmental emissions (not discounted)

	Cases for comparison	Values
Year 2008	CIVITAS measure	€379,625
	Reference case (or BAU)	€379,625
Year	CIVITAS measure	€12,303

	Cases for comparison	Values
2009	Reference case (or BAU)	€348,795
Year 2010	CIVITAS measure	€12,303
	Reference case (or BAU)	€110,580
Year 2011	CIVITAS measure	€12,303
	Reference case (or BAU)	€110,580
Year 2012	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2013	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2014	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2015	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2016	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2017	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2018	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2019	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2020	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2021	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2022	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026
Year 2023	CIVITAS measure	€12,303
	Reference case (or BAU)	€19,026

Summary of CBA results

The CBA has been carried out on comparing the scenario 0 (Reference case or BaU) and 1(Civitas measure) described above.

The CBA synthetical results are shown in the tables 11 and 12 reported below. All figures are referred to Euro 2008. The average yearly interest rate estimated in the CBA is 3,5%.

TABLE 11 – CBA synthetical results between Scenario 1 (Civitas measure) and Scenario 0 (Reference case or BaU) in year 2023.

SCENARIO 1 vs SCENARIO 0	
INTEREST RATE	3,5%
NET PRESENT VALUE (€ 2008)	1.602.360
BENEFITS/COSTS RATIO	1,28
I.R.R.	21,3%

In particular, the purchase of buses described in the Civitas scenario (Scenario 1) is re-paid in approx. 4 years (NPV>0 at 2012), due to the Line 1 better transport supply and to the lower maintenance and emission costs in comparison to scenario 0 (which keeps unchanged the fleet operating in 2008 and foresees the gradual substitution of the older buses with 12 m CNG ones).

TABLE 12 - CBA full results between Scenario 1 (Civitas measure) and Scenario 0 (Reference case or BaU) from 2008 to 2023

MEASURE M01.06 - CLEAN AND ENERGY EFFICENT PUBLIC TRANSPORT FLEET IN BRESCIA
COSTS/BENEFITS ANALYSIS - Scenario 1 vs Scenario 0

	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
SCENARIO 0 - With n.20 existing busses (methane+diesel; 12m) and fleet renewal with n.20 methane busses of 12m length (average bus life: 15 years)																
Investment costs	-	527.476	1.318.689	-	1.054.951	-	-	-	-	-	-	2.373.640	-	-	-	-
Residual value	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.881.330
Operating revenues	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277	2.291.277
Maintenance costs	262.137	366.595	282.152	433.127	164.523	190.075	384.981	272.596	301.122	319.401	806.728	181.109	219.804	194.734	311.613	306.681
Emissions	379.625	348.795	110.580	110.580	19.026	19.026	19.026	19.026	19.026	19.026	19.026	19.026	19.026	19.026	19.026	19.026
SCENARIO 1 - With n.16 new methane busses (18 m; average bus life: 15 years)																
Investment costs	-	5.886.999	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Residual value	-	1.881.330	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Operating revenues	2.291.277	2.314.190	2.337.332	2.349.018	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763	2.360.763
Maintenance costs	262.137	56.504	113.419	137.259	153.381	168.316	296.129	294.506	311.121	182.389	176.182	437.442	342.873	217.557	250.972	363.618
Emissions	379.625	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303	12.303
SCENARIO 1 vs SCENARIO 0																
Investment costs	-	- 5.359.523	1.318.689	-	1.054.951	-	-	-	-	-	-	2.373.640	-	-	-	-
Residual value	-	1.881.330	-	-	-	-	-	-	-	-	-	-	-	-	-	- 1.881.330
Operating revenues	-	22.913	46.055	57.741	69.486	69.486	69.486	69.486	69.486	69.486	69.486	69.486	69.486	69.486	69.486	69.486
Maintenance costs	-	310.091	168.733	295.869	11.142	21.759	88.853	- 21.910	- 9.999	137.013	630.545	- 256.334	- 123.068	- 22.823	60.641	- 56.937
Emissions	-	336.492	98.278	98.278	6.723	6.723	6.723	6.723	6.723	6.723	6.723	6.723	6.723	6.723	6.723	6.723
TOTAL	-	- 2.808.697	1.631.755	451.888	1.142.303	97.969	165.063	54.300	66.211	213.223	706.755	2.193.517	- 46.859	53.386	136.851	- 1.862.056
OVERALL TOTAL	-	- 2.808.697	- 1.176.943	- 725.055	417.248	515.216	680.279	734.580	800.790	1.014.013	1.720.768	3.914.285	3.867.426	3.920.812	4.057.663	2.195.607
TOTAL BENEFIT	-	2.550.826	1.631.755	451.888	1.142.303	97.969	165.063	76.210	76.210	213.223	706.755	2.449.850	76.210	76.210	136.851	76.210
TOTAL COST	-	5.359.523	-	-	-	-	-	21.910	9.999	-	-	256.334	123.068	22.823	-	1.938.266

INTEREST RATE	3,5%															
NET PRESENT VALUE	-	- 2.621.949	- 1.150.200	- 756.406	205.383	285.080	414.818	456.054	504.635	655.793	1.139.881	2.591.514	2.561.552	2.594.534	2.676.219	1.602.360
BENEFITS/COSTS RATIO		0,48	0,78	0,86	1,08	1,10	1,13	1,14	1,15	1,19	1,32	1,69	1,67	1,68	1,70	1,28
I.R.R.				-21,4%	7,9%	9,4%	11,5%	12,1%	12,7%	14,2%	17,5%	22,9%	22,8%	22,9%	23,0%	21,3%