

Measure title: **Transition towards clean fleets in Genoa**

City: **Genoa**

Project: **Civitas Caravel** *Measure number:* **05.01**

Introduction

A1 Objectives

Implementation of a transition strategy plan towards a clean fleet (**and clean PT services**) in order:

- to reach a more eco compatible fleet,
- to improve a sustainable public mobility,
- to promote the use of a multimodal public transport – managed by AMT - as a better ecologically alternative reducing the private traffic, the pollution and the congestion in the city and along the two valleys Val Polcevera and Val Bisagno as well as in the west and east sides.

A2 Description

To contribute to the reduction of pollution in the city, according to the above objectives and in the aim of the Civitas Caravel Project, the strategy developed and implemented by AMT includes:

- the renewal of the fleet with Euro IV and EEV buses (**Enhanced Environmentally-Friendly Vehicles**) and the installation of the particulate filters reducing pollution on the last Euro zero buses;
- the extension of ZEV - Zero Emission Vehicles ¹such as trolleybuses and metro trains (this target has become feasible due to the extension of the underground and trolleybus lines).

Also part of the strategy focuses on special projects such as a new PT service by sea, studies to introduce a tramway in Genoa, and the development of the High Mobility Corridor Network in Genoa.

The transition strategy towards a “cleaner” fleet includes also:

- the continuation of AMT’s Drinbus service (direct personalized service requested with a phone booking) with small bi-powered methane buses
- the continuation of the PT service in the S. Martino Hospital internal area with the innovative electrical buses inductively recharged
- the construction of fast inductive recharging system plant for the electric buses at the terminal of the bus route in Nervi (activity in charge of AMI).

¹ **ZEV** is the acronym of Zero Emission Vehicles. The Italian Technical Authority of the Ministry of Transport classified trolleybuses and more in general the electric vehicles as ZEV. The Euro IV and the electric vehicles (as trolleybuses) are outside CIVITAS funding since the origin of the CIVITAS CARAVEL Project. **No funds are asked to EC for the Euro IV and ZEV vehicles.**

B Measure implementation

B1 Innovative aspects

The innovative aspects of the measure are:

- **New conceptual approach.** This is based on the development and implementation of a strategy for achieving a comprehensive transition to clean vehicles and to clean public transport services in all urban transport areas considering the reality of Genoa in terms of transportation infrastructure, logistic aspects and above all, the availability of funds for investments. This integrated approach has been never developed before Caravel Project.
- **Use of new technology/ITS.** New Euro IV buses 18 meters long (never acquired before Caravel); new trolleybuses 18 metres long bi-powered with Euro IV engines (in Italy there are no trolleybuses like these due to the Euro IV engine; the other same type of trolleybuses operated in Italy are powered by Euro III engine; innovative EEV buses (please note that Genoa is one of the first cities in Italy that will operate with these buses); new AMT Automatic Vehicle Monitoring System (AVM) based on GSM/ GPRS installed on the whole fleet and in the depots.
- **New mode of transport exploited** A new and innovative mode of transport has been designed, implemented and in operation since August 2007: AMT's public transport service travelling by sea (called Navebus) from Pegli - in the west area of Genoa - to Porto Antico - in the downtown area - in less than 30 minutes paying only the price of the bus ticket.
- **New policy instrument** – To implement the transition towards clean fleets, considering the lack of public funds, for the first time in AMT's history, about 50% of the new 47 vehicles Euro IV acquired from 2005 to the end of 2007 (14 large size buses + 9 medium size buses + 7 small size buses + 17 trolleybuses bipowered) has been fully financed with AMT's own funds (normally in Italy the buses are financed with public funds).
Moreover the new 57 buses EEV (+ 5 as option) acquired in 2008, have been financed in part with AMT own funds and in part with public funds (also this is innovative for AMT, as matter of fact, as already written above, in the past any the renewal programme has been completely financed with public funds).
- **New physical infrastructure solutions**
 - Fast inductive recharging system plant for the electric buses at the terminal of the bus route in Nervi.
 - Renewal and extension of the trolleybus line (from Foce – in downtown area - to Sampierdarena – in the west part of Genoa).
 - Extension of the underground to Brignole (extension in expected in 2010 from the present east end line in the central Piazza De Ferrari to Brignole railway, the second largest Genoa station in the east side of the town).

B2 Situation before CIVITAS

The Public Transport in Genoa before CIVITAS, in charge of AMT, was managed mainly by traditional buses and also by

- a trolleybus route (7 km) launched in 1996 (an extension of 3 km is foreseen for 2007);
- 11 lifts, 2 funiculars, rack-railway;
- totally electric buses operating in the route inside the San Martino Hospital of the city;
- on demand services (Drinbus) operated with methane minibuses.

The bus fleet (more than 800) was mainly based on Euro 0, Euro 2 and Euro 3 buses

Moreover, there's a large urban railways network (19 stations + 2 new stations in 2006) managed by Trenitalia (the railway operator).

B3 Actual implementation of the measure

The measure was implemented in the following stages.

B.3.1 .Stage 1: Basic concept of the Transition Strategy Plan towards a clean fleet (and the relevant Investment Plan). First draft of the system architecture design concerning the substitution of a diesel operated bus route in Nervi with a new electric buses inductively recharge and the related infrastructures (terminal and recharging system). (from February 2005 - to January 2006)

From February 2005 to November 2005: the activities developed were mainly focused on the aspects of the project related to methane buses and electric buses inductively recharge. According to this focus, introductory analysis of technical, logistic, and economics aspects to introduce methane buses (including analysis of the state of the art of the existing methane network and of the features of the existing filling stations and first analysis of the bus routes to be covered by the methane fleet) has been done as well as the first draft of the system architecture design concerning the substitution of a diesel operated bus route in Nervi with a new electric buses inductively recharge and the related infrastructures (terminal and recharging system).

From November 2005: an elaboration of the basic concepts of the transition strategy plan has been done in terms of new sizing of the bus fleet (number and bus type/length), for the 2006-2011 period. In particular sizing has been done taking into account the requirement stated in the new Contratto di Servizio (the contract signed by the Municipality of Genoa and AMT that rules the relationship between these subjects): the required bus service production level (also considering the expected extension of the underground and of the trolley bus lines); the required target average bus age; the other required targets (concerning pollution, floor level, air conditioning, equipment for disable passengers, etc.); expected public (state/regional) funds available to renew the bus fleet; the AMT capability to provide own funds in addition to the public ones.

About the **methane buses**, two activities have been carried out:

- comparison between methane buses and Euro III, Euro IV, expected Euro V buses in terms of: performances, pollution, fuel consumption, investment cost (including refuelling systems), fuel cost (considering also the different tax level), fuel risks in terms of price and availability (considering the worldwide scenario);
- feasibility design of the required refuelling system performances (to refuel the methane bus fleet) and availability of the necessary area closed to the depot chosen to park the methane buses (Gavette depot);

- operation of small bimodal methane buses has been continued within the on demand responsive service managed.

About the **electric buses**, the demo of electric buses (named Elfo) with inductive recharging system (in San Martino Hospital) has been continued. A general maintenance programme has been studied and defined. In the last months of 2005 in one of four electric buses under the above maintenance programme, a breaking of the frame has been detected, therefore also the other buses were stopped to check if there are similar problems. Other Elfo electric buses has been modified in order to fit with the inductive recharging system, this has been done thinking to the extension of the demo activities in Nervi (the other CIVITAS area).

About **Euro IV buses** the tender to buy **9** large Euro III buses (then improved in Euro IV buses) has been assigned. Moreover it has been asked to the supplier to improve the Diesel engine of 17 bi powered 18 metres trolley buses already acquired, as well as the 9 large buses, providing Euro IV engines instead of the expected Euro III ones. Moreover some tests have been carried out to check the performances of filters to reduce the pollution of old engines.

Stage 2: Elaboration of the Transition Strategy Plan towards a clean fleet (and the relevant Investment Plan) focused on Euro IV buses (and/or EuroV/EEV buses if available) and ZEV vehicles (trolleybuses and metro trains). Procurement of the first 31 Euro IV vehicles (from February 2006 – to January 2007).

The Transition Strategy Plan towards a clean fleet (and the relevant Investment Plan 2007-2010) has been finalized (and approved by Municipality of Genoa): 292 vehicles ecologically friendly and 10 metro-trains are expected according to the Plan. **The main target of the Investment Plan is to increase the share of electric vehicles (trolleybuses and metro trains).** This target has become feasible due to the expected extension of the underground and trolleybus lines.

Table 1. AMT Investment Plan 2007-2010

AMT Investment Plan 2007-2010 (related to the Business Plan 2006-2011)						
	2007 Already ordered in 2005	2007 to be ordered	2008	2009	2010	TOTAL
Trolleybus 18 m (n°)	17					17
Bus 18 m (n°)	9		13	8	40	70
Bus 9-12 m (n°)		15	50	45	61	171
Bus small (n°)		11		20	3	34
TOT.NUMBER (n°)	26	26	63	73	104	292
TOT.VALUE (eurox10E6)		4,5	15,0	14,5	27,0	61,0
Metro trains 2 bodies (n°)				10		10
Metro train value (eurox10E6)				25,0		25,0

The other guidelines of the Investment Plan are the following.

- all the expected buses will be ordered with Euro IV engine moreover Euro V (EEV if available) standard will be required to the competitors as optional requirement, the relevant technical offer and economical quotation will be considered as an added value to choose the supplier
- for methane buses, considering the results of the activities carried out to prepare the technical and functional specification, it has been decided that it will be better (both for technical and economical reasons) to buy large size methane bus in big (or at least medium size) lots: accordingly the purchase of 48, 18 metres long

buses, has been postponed to 2009 (8 buses)/2010 (40 buses) after the CIVITAS period². This target will be feasible if in the meantime (2006-2008) the critical issues concerning the refuelling station will be solved).

- electric and/or hybrid buses and/or small methane buses will be used for special service continuing and, if needed, enlarging the present special services: the on demand responsive services (now carried out by bi powered, methane/petrol buses); the airport service (now carried out by hybrid buses).

About **Euro IV vehicles**, AMT has begun to issue the tenders to renew its fleet in accordance to its Business Plan and the relevant Investment Plan:

- **31 large clean Euro IV vehicles** have been already acquired: 14 Euro IV buses 18- metres long and 17 bimodal 18 metres long trolleybuses (their Diesel thermal engine is sized to be used in normal service and not only for emergency situations). In comparison to the Investment Plan programme, AMT has asked the supplier of the already contracted 18 meter long buses (9 thermal buses and 17 trolleybuses completely bimodal, both equipped with Euro IV engines) to provide other 5 Euro IV buses 18 meter long in addition
- an international tender has been already issued to buy **other 26 buses powered by Euro IV engines** (15 medium size buses + 11 small buses); offers from the selected suppliers have been already collected and under evaluation.

About **the electric buses** (named Elfo) with inductive recharging system:

- the break of the frame of one demo bus caused interruption in demonstration in San Martino Hospital Therefore, accordingly to the Ministry of Transport requirement, all the similar buses operated in Italy have been stopped waiting for the reparation activities asked to the supplier. The relevant Authority has done a first examination of the reparation works with negative results. Therefore the Ministry to asked the supplier further remedial measures. While waiting for the reply of the ministry about safety rules, ongoing the preparation of maintenance programme in order to be ready when demo starts again.

About **methane buses**

- operation of small bi-powered methane buses has been continued within the on demand responsive service managed by AMT.
- Municipality of Genoa started up, in collaboration with AMT and AMI, a feasibility study mainly focused on the economical scheme to finance the construction of the refuelling station and to search new funds (additional to the one expected from the Legge Finanziaria- Financial Law) for financing the methane bus purchase.

Stage 3: Launch and operation of the *new* trolleybus line. Operation of the new 23 Euro IV buses (14 buses 18 metres long in operation during 2007 + 9 medium sized buses in operation since the beginning of 2008). Procurement of 57 (+ 5 as option) EEV buses (international call for tender published in January 2008). **Enrichment of the Transition strategy Plan towards clean fleet with new innovative initiatives. (from February 2007 – to January 2008)**

At the beginning of 2007 the Business Plan, accordingly to the agreement between the two shareholders of AMT, has been updated. The Municipality of Genoa and AMT's board approved the revised Business Plan. In particular two scenarios have been considered:

² According to the Contratto di Servizio (the contract signed by the Genoa Municipality and AMT that governed the relationship between these subjects) AMT had to buy about 50 large methane buses within 2006. This had to be done provided that the relevant public funds had been done available from the Region. The Region has not provided any funds then accordingly to the above Investment Plan the target has been postponed.

no public funds (and therefore only funds coming from AMT); few public funds (to be added to the AMT ones). In both the scenarios the number of new buses are less than the ones expected in the first version of the Business Plan. Within the Caravel period about 100 clean vehicles has to acquire.

About **Euro IV** and **EEV buses** :

- all **14 new large clean Euro IV buses** (4 of them full financed by AMT's funds) have been delivered in August and are under operation in the high mobility corridor network (the delivery of all 14 buses expected for April 2007 has been postponed due to supplier's technical problems. Accordingly, a penalty payment for the delay has been requested to the supplier)..
- **valuated the bid offers of the international tender issued in the past year (2006)** to buy 26 Euro IV buses (15 medium buses size and 11 small size). **All the bid offers resulted incomplete** (the offers did not present all the requested criteria). **As a result only 9 medium buses have been ordered** (instead of 15 medium buses size) **and only 7 small size buses have been ordered** (instead of 11 small size buses). Accordingly the AMT' s clean fleet has been enriched by other new 16 Euro IV buses (full financed by AMT' s fund);
- **the entire new 9 medium Euro IV buses** have been delivered (at the end of 2007) and in operation.
- the delivery of the new 7 Euro IV buses (expected for January 2008) is in delay
- the **international tender issued in the first part of 2007** (and under evaluation phase of the bid offers) **for purchase a second lot of 20 buses Euro IV** (18 metres long with a strong preferences to whom can present buses better than Euro IV as Euro V/EEV offer) **has been stopped in December**. This is because Municipality of Genoa and AMT, have signed an agreement concerning the AMT procurement of 42 EEV buses (in part financed by public funds of Ministry of the Environment and in part financed by AMT own funds). Accordingly to this **a new international call for tender for the purchase of 57 (+5 as option) EEV buses has been published**.

About **trolleybuses**

- The work to renovate and to extend the trolleybus line (from Foce – in downtown area - to Sampierdarena – in the west part of Genoa) has been completed. The trolleybus line is under operation with the existing trolleybuses.
- For the launch of the new trolleybus line (on February 2007) a promotional campaign has been planned and implemented.
- Moreover on the occasion of the second Anniversary of the Kyoto Protocol the promotion of free travels on the trolleybuses for all day has been organized.
- 10 of the new 17 Euro IV trolleybuses 18 meters long - classified by the Technical Authority of the Ministry of Transport Zero Emission Vehicles - has been delivered.

About **methane buses**

- on going operation of bi powered methane/petrol buses within the on demand responsive service;
- on going the study carried out in collaboration with the Municipality to transform one of the AMT depots in a methane depot in order to be ready for constructing the refuelling station, to buy the buses and to train personnel is still on going, together with the design to transform in a depot a section of the central workshop for heavy maintenance activities.

About **the electric buses inductively recharged**

- the relevant reparation works have been completed with a positive outcome in the test done by the relevant Authority; accordingly the operation with Elfo buses started again in S. Martino Hospital internal area in August;
- construction work in Nervi area for terminal and ground inductive recharge system has been completed (this activity has been carried out by AMI). The operation with electric buses inductively recharged in Nervi in substituting a traditional diesel operated buses, scheduled for October, has been postponed for road works.

Moreover as a part of Transition Strategy Plan, AMT carried out new and innovative projects:

- study to widen the multimodal public transport managed by AMT introducing an experimental and **innovative public transport service travelling by sea** paying only the price of the AMT's bus ticket;
- study to evaluate another extension of the multimodal public transport services managed by AMT: the possibility to introduce a **tramway in Genoa**.

About the **innovative public transport service travelling by sea the following activities carried out:**

- *(from February to October):* finalised, launched and **under operation** - from August 1st to October 31st - **the new experimental AMT public transport service travelling by sea (called Navebus)**. The information and communication campaigns to promote the new AMT service by sea were designed and launched (including agreement with the parking service operator in Pegli for free parking for AMT's customers using Navebus in August);-realized two customer's survey (in September and in October): more than 1400 passengers per day; **about 14% is the shift estimated from private cars to this PT service;** ·
- *(from October to January)* The period of the experimental service has been extended. The extension of the service after 31 October has been requested by the Municipality of Genoa to AMT as the result of the great satisfaction of Navebus. In mean while AMT is in charge to assign the service for one year (+ another one year optional) with a tender; accordingly AMT has already published the tender (before the tender AMT carried out a feasibility study about the extension of the service with the number of trips increased) Received about 11 requests to participate (now under evaluation).

About the possibility to **introduce a tramway in Genoa**

- Municipality of Genoa has formalised the tramway network project in its Local Mobility Plan (called PUM - Piano Urbano della Mobilità)·
- Municipality of Genoa decided the preliminary specification of the project: the first stage of the tramway will be realised in Val Bisagno Valley (CIVITAS Caravel area) in project financing·
- AMT, having a strong interest to participate in this project, and waiting for the relevant tender, is elaborating a study for the bid offer of the tramway in Val Bisagno

Moreover, **also as a part of Transition Strategy Plan**, it has been decided the purchase of more than 50 particle filters reducing pollution from diesel engines (Euro 0 and Euro 2).

Stage 4 Operation with clean vehicles – Implementation of the innovative initiatives within the Transition Strategy Plan - Purchase of 57+5 as optional EEV buses - Installation of particle filters reducing pollution (from February to November 2008)

About Euro IV buses and EEV buses

- On going the operation with the new clean Euro IV buses (14 large size buses+ 9 medium size buses). The delivery of the new 7 small Euro IV buses is always in delay.
- The tender documents for the purchase of 57+5 optional EEV buses (the tender advice was published in January 2008) are now ready. These documents have been sent to the Ministry of Environment for approval, because it will co-financed with AMT the purchase of 42 out of 57+5 EEV buses. Once the Ministry of Environment will have approved the tender documents AMT will go ahead with the tender.

About trolleybuses

Completed the works concerning the further extension of the trolleybus line. With the launch of the new trolleybus extension, developed and implemented the change of the existing routes. All the new 17 Euro IV trolleybuses 18 meters long delivered and in service on the new route called line 20; with the remaining existing trolleybus fleet (12 meters long) servicing the route called line 30. To be noted that the new Euro IV trolleybuses have experienced in the early stages some technical difficulties due to their high level of technology and that Amt with the assistance of the supplier in currently solving.

In parallel was launched a broad communication campaign aiming at informing customers of the changes to the service and also promoting the new trolleybuses as comfortable and ecologically friendly vehicles. The campaign was titled "Destination Green" to remind not just customers but also the Genovese population that Public Transport is a better option for a more viable city. Moreover thousands of sunflower seeds were distributed in a confection pack titled "Destination Green - Celebrate with us our new trolleybuses, the ecologically fleet of the city".

The bid offers for the purchase and the installation of more than 50 particle filters reducing pollution from diesel engines (Euro 0 and Euro 2) assigned

About the innovative initiative within Transition Strategy Plan

- Referencing to the **new AMT PT service travelling by sea called Navebus**. Completed the tender activities for the Navebus service for the period 2008 (the tender. This tender was not assigned by AMT as per request of the Municipality of Genoa. This change of strategy came because Region Liguria is requiring a change in the current law. This change will see the Municipality of Genoa becoming responsible for the running of the service; therefore it becomes the responsibility of the Municipality of Genoa to due the tender. In this way Region Liguria could finance the service. In the meantime AMT, according to the Municipality request, has assigned temporarily the running of the service to one of the two best competitors who taken part in the tender.
- Municipality of Genoa and Regione Liguria found a solution, according to the law, by which the complete responsibility of the service Navebus remains of Amt. It's Amt's responsibility to run the tender's process. A new tender has been issued due to the fact that the previous tender has been cancelled for the reason detailed in the previous point. Waiting for the result of this new tender Amt has assigned, with a negotiated procedure, a short contract to manage the service while waiting for the result of above tender (tender's result scheduled for October).

Referencing to **tramway**. The project concerning the tramway in Val Bisagno has been modified³ for the following reasons:-

- lack of funds for an expensive project such as a tramway;
- high construction timing;
- some technical problems concerning services under the street involved in the path of the tram

Due to these problems it has been decided to go on, for the moment, with a softer project: the realization of a Busway

Moreover, on going the AMT PT service on demand (with methane buses) as well the operation with electric buses in S. Martino Hospital Area

B4 Deviations from the original plan

The original objectives of the Measure (**Inception Report 2005**) were to implement a transition strategy towards clean vehicle fleets making reference to the current situation and starting with the implementation of:

- 20 large clean Euro IV buses (on High Mobility Corridors)-
- 30 medium-sized methane buses and minibuses (for small PT service or flexible services)-substitution of a diesel operated bus route with electrically operated special buses that can be inductively recharged (electric vehicles are outside CIVITAS funding)
- 30 hybrid or bi fuel cars to be used in the car sharing measure (please see MERS 9.4)

Modification (stated in **Amendment 2007**) concerns only one of the expected actions: the methane bus supply has been postponed accordingly to the availability of relevant public funds, to the end of CARAVEL or for 2009/2010. While, within the CARAVEL period, more attention has been paid to Euro IV buses (and/or EEV buses if available) and Zero Emission Vehicles (as trolleybuses). Other Measure actions are not only confirmed but also extended.

In short, in the Working Document related to **Amendment 2007**, the transition strategy towards clean vehicle fleets will be implemented, with reference to the 2005 scenario, by:

- **77 Euro IV vehicles (if available buses better than Euro IV as Euro V/EEV) including Zero Emission Vehicles trolley-buses with Euro IV auxiliary engine**
 - 14 large (18 metres) Euro IV buses (on High Mobility Corridors)
 - 20 large (18 metres) Euro IV buses (and/or Euro V/EEV buses if available) (on High Mobility Corridors)
 - 15 big-medium (12-9 metres) Euro IV buses
 - 11 small (7 metres) Euro IV buses
 - 17 large (18 metres) ZEV trolleybuses totally bi powered (trolley + Euro IV engine);
- **21 large (18 meters) methane buses (on High Mobility Corridors) or 21 same size Euro IV (and/or Euro V/EEV buses if available) if the critical issues concerning methane (described in the following points) will be not overcome.**

³ Municipality of Genoa formalised the tramway network project in its Local Mobility Plan (called called PUM - Piano Urbano della Mobilità) and decided that the first stage of the tramway will be realised in Val Bisagno Valley (area CIVITAS Caravel) in project financing to be assigned after an international tender. Amt, having a strong interest to participate in this project, and waiting for the relevant tender, started a feasibility study for the bid offer of the tramway in Valbisagno.

At the end of 2007 the transition strategy plan has been fully defined. Respect to the engine type, the number of Euro IV has been reduced to 30 buses (60 foreseen), **whilst 57 EEV** (+5 as option) will be purchased thanks to the public funds of Ministry of the Environment for co-financing 42 of 57 (+5 as option) EEV buses.

In short, dealing with the engine type:

□ Fleet foreseen in origin (Inception Report 2005)

Euro IV buses	20
Methane (or Euro IV / Euro V / EEV if available)	21
TOTAL	98

□ Fleet foreseen in Amendment

Euro IV buses	60
ZEV (trolley buses)	17
Methane (or Euro IV / Euro V / EEV if available)	21
TOTAL	98

□ Fleet foreseen at the end of 2007

Euro IV	30
ZEV	17
EEV	57 (+5)
TOTAL	104 (+5)

Reasons of modification - in short

Methane buses have been postponed to Euro IV buses (and/or Euro V/EEV buses if available) and Zero Emission Vehicles (as trolleybuses) for the following reasons.

• **Investment costs**

- Cost of methane buses is higher (10-20% more) than Diesel buses and within the recent Legge Finanziaria 2007 (the yearly Italian law for planning public investments) few funds are dedicated to public transport fleet renewal. Even if AMT will invest its own money to buy new buses there will be not enough funds to renew the fleet accordingly with the target agreed between Municipality of Genoa and AMT; if methane buses will be bought it will be more difficult to reach the target. This scenario was not predictable when the Inception Report was prepared.
- Capacity of methane buses is lower than the one of traditional buses (due to the additional on board equipment such as the methane tanks); therefore for moving the same number of passengers a higher number of methane buses are needed.
- Cost of refuelling stations for methane buses are higher than Diesel refuelling stations (in the range of one million euro) both for fast refuelling equipment (due to the compressors) and for normal refuelling equipment (due to the higher number of refuelling points needed to guarantee an acceptable timing for refuelling operations). Funds to finance the refuelling stations for methane buses (about 1 million euro) were expected from the Municipality of Genoa but now it is clear that there are no resources to face this investment.

- Cost of depots for methane buses are higher than for Diesel buses due to the higher areas needed for safety reasons (higher distances between parking areas and refuelling station, higher distances between critical areas; such as electrical substations, and parking areas and refuelling station; bigger corridors between the columns of parked buses).
- **Maintenance cost**
 - Cost of maintenance of methane buses is higher than the one Diesel buses (this is mainly due to the additional equipments, such as tank, pipeline under pressure, etc. and it is also due to the training cost needed to skill workers that usually are not confident with methane technologies). Being the former AMT now subdivided into two companies, the new AMT⁴ is in charge of operation and AMI in charge of maintenance activities; AMI should face the higher costs for methane bus maintenance, but Ami being in a very critical economical situation cannot face this additional cost.
- **Logistic issues**
 - Due to the particular topographic situation of the city, the methane plants in Genoa are available only near the two valleys and up to now only two commercial filling stations exist. The feasibility studies carried out to evaluate the possibility to have more commercial filling stations had negative results. Due to these technical problems (low pressure network) that makes it impossible to have more methane filling stations, at present it could be possible to use only small (and probably medium) methane buses that can use the existing filling stations, whilst large buses could be used only extending the existing filling stations. Therefore at present the best size for methane buses cannot be managed in Genoa (large methane buses have better performances and minor capacity is compensated by big size).
 - Due to several reasons (mainly related to safety and economical issues) only one of the existing 6 depots could be used for methane buses (the name is Gavette). When the former AMT was subdivided into AMT and AMI, the ownership of the 6 depots has been given to AMI. AMI to face its critical economical situation has sold one of the depots (the name is Boccadasse). According to the agreement with the new owner of Boccadasse, AMT will have to move, within 2008, its buses from Boccadasse to the other nearest depots including Gavette. Therefore if the parking area of Gavette will be reduced in accordance to the methane safety rules it will be more difficult to park the fleet. This was not to predicable when the first Inception Report was prepared.
- **Infrastructure projects**
 - Genoa Municipality has spent and is spending a huge amount of money to construct and to extend the Genoa metro line and the trolley-bus network. The Municipality of Genoa has therefore focused its attention to electrical traction. Now this strategy and the relevant investments have to be justified by pushing people to use these new

⁴ Context in short:

On December 2004 AMT (Public Transport operator in Genoa – 100% property of Municipality of Genoa) was subdivided into two companies: the new AMT- Azienda Mobilità e Trasporto S.p.A. (transport operator in charge of all transport services) and Ami – Azienda Mobilità e Infrastrutture S.p.A. (Public Mobility and Infrastructure Agency and company in charge of the maintenance of AMT's buses and other activities such as real estate and parking management). Both the companies were 100% owned by Genoa Municipality. 2005 an international tender has been issued by the Municipality of Genoa to sell the 41% of AMT share to a private partner. The winner was the French Group Transdev.

At the end of 2005 the new private partner Transdev entered in AMT; therefore now AMT is 59% property of Municipality of Genoa and 41% property of Transdev. Accordingly with the agreement between the two partners, the responsibility to manage AMT has been given to Transdev. Relationship between AMT and the Municipality concerning the PT service to be operated is now managed by a contract named Contratto di Servizio. Relationship between Ami and AMT first of all for bus maintenance is managed by three a contracts named Contratti Intercompany.

transport infrastructures. Therefore AMT is changing its network by stopping the bus lines in the proximity of the metro stations and trolley-bus head terminus.

- Accordingly the new transportation network will be done by: metro, trolley-bus line and few other main lines main bus lines in the downtown; bus main lines, managed by high mobility corridors, along the two valleys and from east and west sides of the town toward downtown; small bus lines in the hills feeding the main lines. Therefore the PT services in downtown will be mainly managed by electrical vehicles (metro trains and trolley-buses) while the PT services outside downtown services will be managed by Euro IV (and/or Euro V/EEV if available) clean buses.
- Considering the above reasons and also taking into account that environmental impact of Euro IV and the expected EEV engines is quite similar to methane's and that minor cost of methane in comparison with Diesel fuel is mainly due to fiscal reasons in Italy that can change, it has been decided to postpone the methane bus supply for waiting that the above critical issues will be solved.

B5 Inter-relationships with other measures

The measure is related to other measures as follows:

- **8.1 Clean High Mobility Corridor in Genoa** - Euro IV buses (Euro V/EEV if available) will be used in the high mobility corridors.

C Evaluation – methodology and results

C1 Measurement methodology

C1.1 Impacts and Indicators

Table of Indicators.

Evaluation Category	N°	Indicator	Units	Source of data	Methodology for indicator construction (survey, modelling, etc)	Baseline date
Environment	9	CO emissions	G/vhm	AMT/ARPAL	Modelling	2005
	10	NOX emissions	G/vhm	AMT/ARPAL	Modelling	2005
	11	Small particulate emissions	G/vhm	AMT/ARPAL	Modelling	2005
	//	Clean fleet km ridden (pls. See note 1)	%	AMT	AMT accounting system (measurement and modelling)	2005
Energy	4	Fuel Mix (pls. See note 2)	%	AMT/ARE	Modelling until June 2006 From June 2006: measurement (AMT Accounting system) The data for the trolley buses is not relevant until march 2007 ARE provides the data of energy consumption converted in MJ	2005

Note 1: V-km ridden by clean vehicles in comparison with V-km ridden by the whole fleet (clean and not clean vehicles)

Note 2: Energy consumption of clean vehicles in comparison with total energy consumption (clean and not clean vehicles)

Detailed description of the indicator methodologies

Indicator	Methodology for indicator construction	
CO emissions	Arpal	<p>AMT can give to Arpal for these indicators the following data on annual basis:</p> <ul style="list-style-type: none"> - the average operated buses in the year for each type of buses and vehicles (i.e. EURO 2; Euro 3, trolleybus) - the average Km done during the year for each type of buses and vehicles - the average age for each type of buses and vehicle <p>Methodology described by Arpal for the indicators CO, NOX and small particulate emissions</p> <p>The total CO, NOX and small particulate emissions of the whole fleet of AMT buses are calculated and then divided by the number of buses and for the total number of km covered during a year by the whole fleet of buses. To do that the COPERT Model (Computer Programme to calculate Emissions from Road Transport) will be used</p>
NOX emissions		
Small particulate emission		
Clean fleet km ridden	<ul style="list-style-type: none"> • Method of measurement: AMT accounting system • Frequency and target: The survey is made every month for each type of vehicle: <ul style="list-style-type: none"> - Euro IV buses (from march 2007; data survey unit: average operated Euro IV buses, Km done) - Electric buses (data survey unit: average operated electric buses; Km done) For 2006 the data is not available and relevant because the electric 	

	<p>buses are stopped due to a breaking of the frame of one bus. According to this the relevant Authority has stopped the entirely fleet</p> <ul style="list-style-type: none"> - Trolleybus (from march 2007; data survey unit: average operated trolleybuses; km done) - Bimodal buses methane/ petrol (unit: average operated bimodal buses; Km done) - Metro (data survey unit: length of the metro line; n. of trip done) - Lift (data survey unit: n. of trip) To convert n. of trip in equivalent buses km the formula applied is: n. of trip done x 0,5 - For Montegalletto lift the formula applied is: n. of trip done X 1 - Funiculars and rack railway (unit: km done; number of trip where km done = length of the funiculars/rack railway X n. of trip done) To convert n. of trip in equivalent buses km the formula applied is: Km done X 2,5 - Other buses (unit: average operated other buses; Km done) <p>Data is collected on monthly basis; data for evaluation is delivered on annual basis</p>
<p>Fuel mix</p>	<ul style="list-style-type: none"> • Method of measurement: AMT accounting system • Frequency and target The survey of fuel consumptions for each type of vehicle is made every month. For the electricity consumption the data is available three months after the indicated month of reference: <ul style="list-style-type: none"> - All Buses except bimodal buses (data survey unit: average operated buses, km done; total fuel consumption by litre;) - Bimodal buses methane/petrol (data survey unit: average operate bimodal buses; total methane consumption in Kg and total benzene consumption by litre) - Trolleybuses (unit: average operated trolleybuses; total electricity consumption in kwh. The data is relevant from march 2007) - Metro/funiculars/rack railway (data survey unit: Km done or n. of trip done; total electricity consumption in kwh for each type of electrical vehicles) - Lift (data survey unit: n. of trip for each lift; tot Kwh consumption for all lifts) - Electric buses (data survey unit: average operated electric buses; Km done; the electricity consumption is modelling data: 1 Kwh for each Km done). For 2006 the data is not available neither relevant because the electric buses were stopped due to a breaking of the frame of one bus as already described <p>Data is collected on monthly basis (for electricity the data is received around the third month next the month of reference). The data for evaluation is delivered on annual basis</p> <p>The data of fuel mix in MJ is expected from ARE</p>

Concerning **public perception of the cleaner vehicles**, some customer satisfaction campaigns have been done. One of the questions was just about the perception of clean vehicles. The results have been good in terms of the good perception of the passengers on AMT activities to reduce pollution but the level of importance given by passengers to this issue was still low. The reason for this probably deals with the fact that there is not enough environmental culture. AMT launched information campaigns to remind not just AMT customers but also the Genoese population that Public Transport (and in particular the use of trolleybuses) is a better option for a more viable city.

C1.2 Establishing a baseline

The information for the baseline date is contained in the table below for each indicator.

C1.3 Building the business-as-usual scenario

The building the business-as-usual scenario has been defined making reference to the scenario before Caravel project therefore without buses and trolleybuses entered in operation during the project. With reference to the average operated buses in 2005 and its segmentation by the different kind of engines the level of pollution produced has estimated. **The data is reported in the following paragraph C2.3**, in the *Table 1* titled *CO, NOX and particulate emissions per each year*.

C2 Measure results

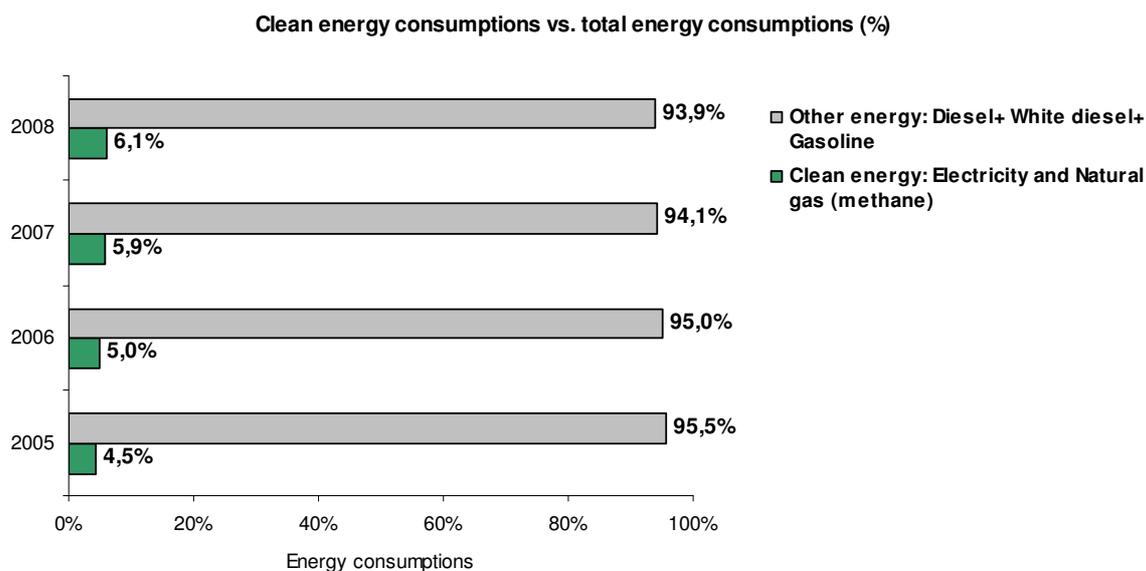
C2.2 Energy

Indicator: Fuel mix

The chosen indicator shows the energy consumptions of clean vehicles in comparison with total energy consumption (clean and not clean vehicles). More in details the indicator shows the market share for clean energy consumption - electricity and natural gas (methane) in comparison with total energy consumption (electricity, natural methane gas, gasoline, diesel, white diesel).

As Graph 1 shows, **at the end of 2008⁵, about 6% of the total energy consumption is produced using clean energy (electricity and methane)**. The increasing in the Clean energy consumption is more than + 1,5% (2008 vs. 2005). This results are related to the increasing in Km ridden by clean vehicles (+ 4,16% 2008 vs. 2005), especially subway, as well as to the fact that trolleybuses started working (for more details please see the indicator "Clean fleet Km ridden" in the following paragraph C.2.3)

Graph 1. Fuel mix: Clean energy consumptions (electricity+ methane) vs. total energy consumptions (electricity, methane, diesel, white diesel, gasoline) per year: 2005-2006-2007-2008



⁵ For 2008 data is estimated

The following table (Table 1) shows per each year the energy used per type of fuel and vehicle type as well as the market share of each type of fuel (clean and the other ones)

Table 1. Energy consumptions per type and quantitative (MJ) of fuel used per type of vehicles and the relevant market share of each type of fuel per each years

Type of Fuel per type of vehicles	2005		2006		2007		2008 (estimated data)	
	Fuel consumptions MJ	Market share %	Fuel consumptions MJ	Market share %	Fuel consumptions MJ	Market share %	Fuel consumptions MJ	Market share %
Electricity (lifts+ trolley buses+ subway + electric buses+ cableway+ rack railway)	26.174.991	4,3%	28.449.087	4,8%	33.719.360	5,7%	34.919.652	5,9%
Natural gas (bus service on demand)	492.192	0,1%	555.760	0,1%	515.535	0,1%	579.235	0,1%
Gasoline (bus service on demand + bus service for disabled people)	908.528	0,1%	1.191.522	0,2%	1.149.440	0,2%	1.151.727	0,2%
Diesel (buses)	350.741.913	57,8%	562.376.687	94,5%	557.755.488	94,0%	559.451.853	93,9%
White diesel (buses)	228.124.067	37,6%	2.304.668	0,4%	0	0,0%	0	0,0%
Total energy consumption	606.441.691	100,0%	594.877.724	100,0%	593.139.823	100,0%	596.102.467	100,0%

As this table shows, the AMT fleet uses mainly diesel and electricity.

Concerning the diesel consumption the changes occurred in 2006 are related to the fact that in April 2006 the buses stopped using white diesel. Moreover from 2007 the Euro 4 buses, characterized by lower exhaust emissions and a higher energy efficiency in fuel conversion, were progressively introduced.

Concerning the electricity, the changes occurred departing from 2006 are essentially related to an increased of the metro Km ridden. Departing from 2007 the changes occurred is also due to the re-entered in operation of the trolleybuses (20). During 2008 new 17 articulated trolleybuses put in service (in addition to those already in operation during 2007).

C2.3 Environment

Indicators: CO emissions, NOX emissions, particulate emissions

The following Table 1 details the pollution produced (g/km) by the average operated buses per year during the Caravel project period (**from 2005 to the end of 2008⁶**) refers to the whole AMT bus fleet. This means that the other kinds of AMT vehicles such as metro trains, trolleybuses, electric buses (defined as ZEV – Zero Vehicle Emissions) are not considered.

⁶ For 2008 data is estimated

The results in reduction of pollution produced by AMT buses (2008 vs. 2005) due to the implementation of the Strategy Plan are the following:

- reduction of about **16%** of CO emissions g/km. **Please noted that the target in reduction CO emissions established by the protocol of Kyoto for Italy is minus 6,5% within 2012;**
- reduction of about **4%** of Nox emission g/km;
- reduction of about **28%** in PM 10 emissions g/km.

Table 1: CO, NOX and particulate emissions per each year

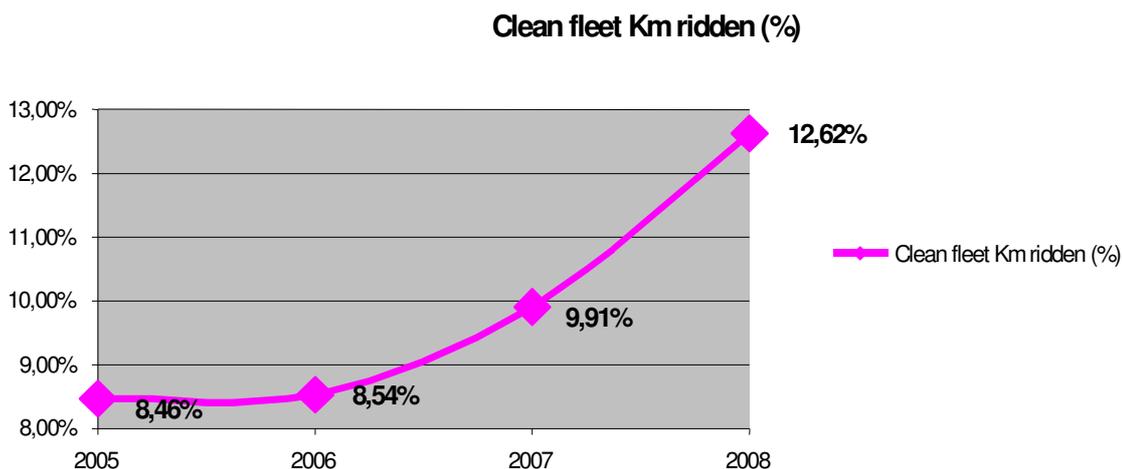
Year	Emission indicators		
	CO emissions (unit: g/Km)	NOX emissions (unit: g/Km)	Particulate emissions PM10 (unit: g/km)
2005	6,26	15,60	0,60
2006	5,84	15,56	0,52
2007	5,51	15,30	0,46
2008 (estimated data)	5,28	14,94	0,44
Reduction of emissions 2008 vs.2005	- 15,65%	- 4,27%	- 27,68%

Indicator: Clean fleet km ridden (by metro, funiculars and rack railway, lifts, trolleybuses, electric buses, methane bimodal buses, Euro 4 buses)

At the end of 2008⁷, as Graph 1 shows, **about 13% of all AMT km ridden (by clean and not clean vehicles) are produced with clean fleet.**

The increased of the Clean fleet Km ridden is about of **+ 4,16%** (2008 vs. 2005).

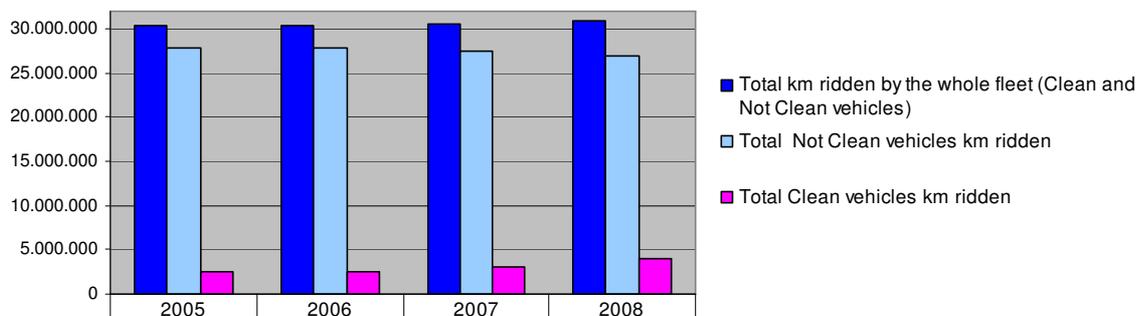
Graph 1. Clean Fleet km ridden (%) - periods 2005-2006-2007-2008



⁷ For 2008 data is estimated

As Graph 2 shows, the AMT Vkm offered increased: + 0,24% in 2006 vs. 2005; +0,37% in 2007 vs. 2006, + 1,17% 2008 vs. 2007. Respect 2005, at the end of 2008 the AMT Vkm offered increased about +2 %. The Clean fleet km ridden increased (+ 51,87% Vkm in 2008 vs. 2005) while the Not Clean fleet km ridden decreased (- 2,84% Vkm in 2008 vs. 2005).⁸

Graph 2. Total Vehicles Km ridden (by Clean and No Clean vehicles), Not Clean Vehicles Km ridden, Clean Vehicles Km ridden per each year

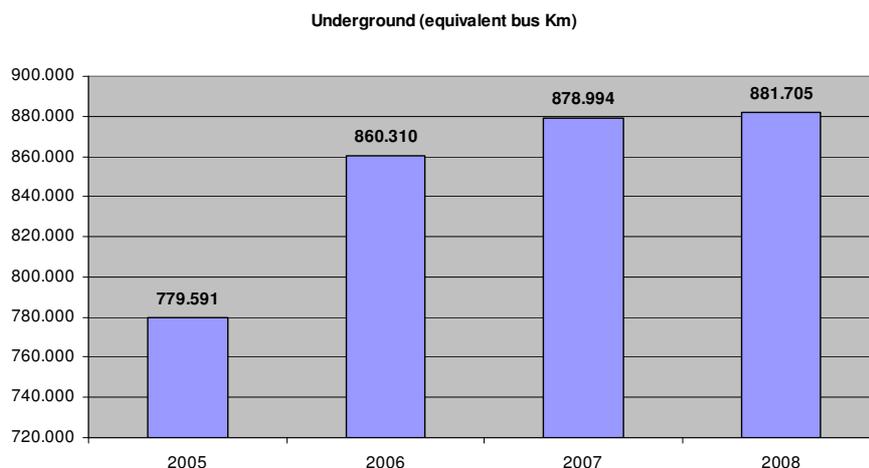


■ Total km ridden by the whole fleet (Clean and Not Clean vehicles)	30.362.594	30.434.591	30.546.122	30.903.365
■ Total Not Clean vehicles km ridden	27.795.015	27.835.631	27.518.404	27.005.926
■ Total Clean vehicles km ridden	2.567.579	2.598.961	3.027.718	3.899.447

The increment of Clean Fleet km ridden is specially due to the underground, as well as to the entered in operation of trolleybuses and Euro IV buses during 2007 and 2008.

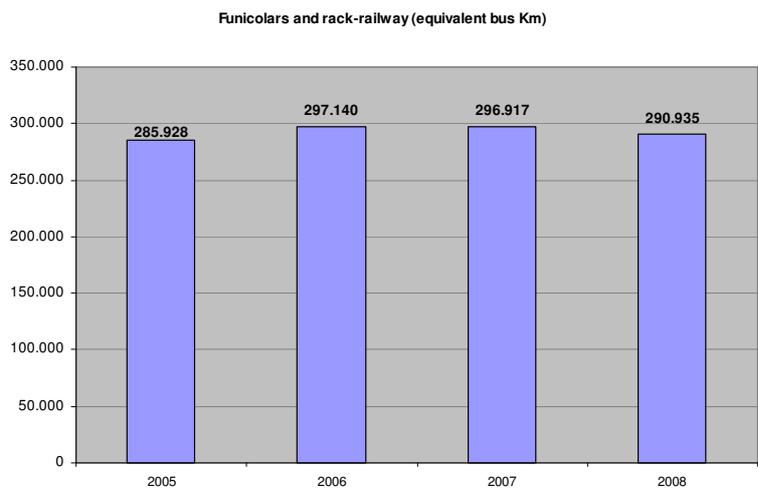
The following Graphs (from Graph 4 to Graph 7) shows for each year (2005, 2006, 2007,2008) the km ridden per each type of the multimodal transport ecologically friendly (underground; funiculars and rack railway; lifts; trolleybuses + electric buses + bimodal buses + Euro IV buses) managed by AMT.

Graph 4. Underground - equivalent bus Km ridden per each year

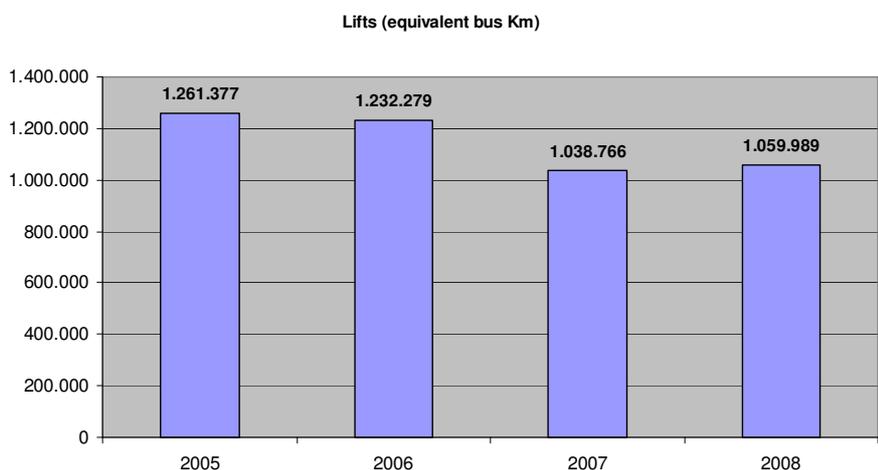


⁸ For 2008 data is estimated

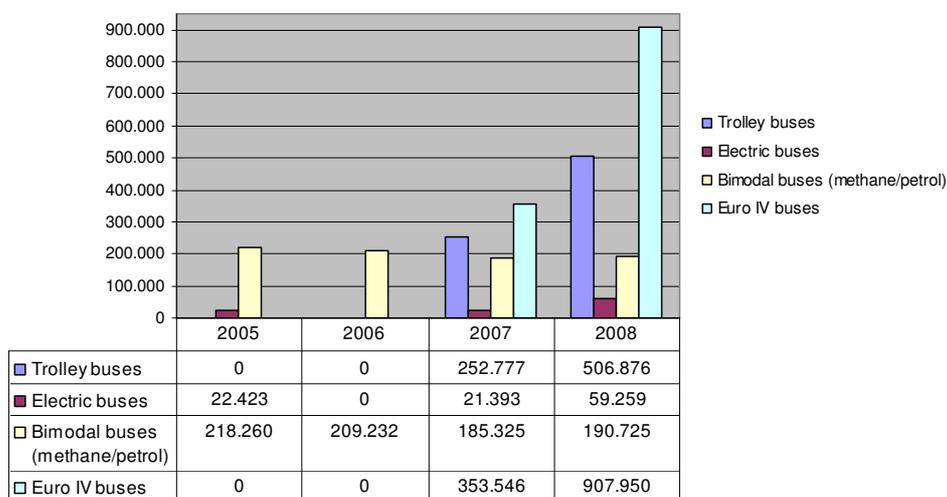
Graph 5. Funicolars and Rack - railway equivalent bus Km ridden per each year



Graph 6. Lifts - equivalent bus Km ridden per each year



Graph 7. km ridden by trolleybuses, electric buses, bimodal (methane-petrol) buses, Euro IV buses per each year



C3 Achievement of quantifiable targets

No.	Target	Rating
1	Increasing of Euro IV buses (and/or EEV buses if available) (*)	**
2	% increasing of Zero Emission Vehicles (ZEV) as trolleybuses	**
3	% increasing of methane vehicles (*)	
4	% decreasing of pollution	***
NA = Not Assessed * = Not achieved ** = Achieved in full *** = Exceeded		

(*) Clarifications respect to the Evaluation Report:

- the increment of Euro IV buses (and/or EEV) will be expressed in absolute value (number of Euro IV/EEV) not in percentage (before Civitas Caravel there were no Euro IV buses)
- the increasing of methane buses is applicable only in the case that the critical issues concerning the methane (described in the above points) will be resolved

C4 Up-scaling of results

The up scaling is defined in terms of levels of pollution produced by the average operated buses if all buses in operation will be EEV. Table 2 shows these levels

Table 2 Levels of pollution by the average operated buses – all buses are EEV

	Emission indicators		
	CO emissions (unit: g/Km)	NOX emissions (unit: g/Km)	Particulate emissions (unit: g/km)
Up scaling (all AMT buses are EEV)	3,04	6,20	0,04

Respect the business as usual scenario (year 2005), the up-scaling will permit to cut pollution (g/Km):

- minus **51,35%** in **Co emissions**;
- minus **60,25%** in **Nox emissions**;
- minus **92,63%** in **Particulate emissions (PM10)**.

C5 Appraisal of evaluation approach

- The data concerning the fuel mix elaborated in collaboration with ARE.
- The data concerning the levels of pollutions produced by AMT buses elaborated thanks to the contribute of ARPAL

6 Summary of evaluation results

To be completed

At the end of The Caravel Project the quantifiable targets achieved are the following:

- **32 Euro IV buses** (14 large size buses + 9 medium size buses + 7 small size buses) acquired and **in operation**. In 2005 there were **no Euro IV buses**. Assigned the **international tender to acquired 57 (+ 5 as optional) new EEV**
- **17 new Euro IV trolleybuses 18 metre long** have been **acquired and in operation since 2008**. In 2005 there were **20 trolleybuses (not in operation and not Euro IV)**. In February 2007 the renewal and extended trolleybus line entered in operation with those 20 trolleybuses. During 2008 entered in operation also the new 17 trolleybuses.

The Table 3 shows the fleet actually implemented

Table 3. Fleet actually implemented

Type	Engine	Number	Status
Large (18 m) buses	Euro IV	14	In operation
Medium (9,5 m) buses	Euro IV	9	
Small (7 m) buses	Euro IV	7	
Large (18 m) trolleybuses	ZEV	17	Tendering procedure to be closed within 2008, first vehicles expected to be delivered and running in first half of 2009
Large (18 m) buses	EEV	30 (+5 as option)	
Medium (12 m) buses	EEV	25	
Small (7 m) buses	EEV	2	
TOTAL		104 (+5 as option)	

- **50 filters reducing pollution** (further the existing 7 ones installed on 5 Euro 0 buses and 2 Euro 2 buses) acquired and progressively installed on the remaining Euro 0 buses.
- thanks to the **Navebus** (the new AMT PT service travelling by sea) about **14% is the shift estimated from private cars to this PT service**.

D Lessons learned

D1 Barriers and drivers

D1.1 Barriers

- **Lack of public funds** since the end of 2007. About 50% of the new 47 Euro IV vehicles (14 large size; 9 medium size, 7 small buses + 17 Euro IV bi-powered trolley buses) acquired since the above date **have been full financed by AMT own funds**. There are no solutions to overcome the lack of public funds for fleet renewal. The only solution is to substitute public funds with own funds if any.
- Some **technical problems** arose by the suppliers with Euro IV buses and new trolleybuses. Working together with the supplier is the normal way to overcome technical problems.
- **Burocracy problems** about approval certificates concerning the new trolleybuses Euro IV . No solutions for these problems.

D1.2 Drivers

- **Ministry of the Environment** with public funds for co-financing 42 of 57 (+5 as option) EEV buses
- **AMT as developer of the Transition Strategy Plan towards Clean fleet (and new PT service)**. Moreover **AMT** financed **with own funds** part of the new clean fleet
- **Municipality of Genoa** that approved the **AMT Investment Plan towards clean fleet as shareholder of AMT and subject responsible of PT in the town.**

D2 Participation of stakeholders

- **Media** for the positive press articles about the new AMT clean vehicles and PT services (such as **Navebus**)

D3 Recommendations

For a rational choice of vehicles to be purchased, especially if the choice concerns methane buses, it is fundamental to take into account the following items:

- investment costs
- maintenance cost
- logistic issues
- infrastructure projects.

All these items are detailed in the previous paragraph B4 Deviations from the original plan (in the sub-paragraph titled Reasons of modification - in short)

D4 Future activities relating to the measure

On going the implementation of Strategy Plan towards clean fleet and PT services ecologically friendly.

In addition to the implementation of this Strategy Plan no other implementations are foreseen due to lack of funds.