

Measure title: **Introduce clean vehicles in a large fleet of urban buses**

City: **Potenza**

Project: **SMILE**

Measure number: **5.5**

A Introduction

Potenza's local administration is developing many measures regarding sustainable mobility, such as: integrated management of the public transport system; the design of a new and more efficient public transport system; and the realisation of new parking areas at the border of the historical centre. Moreover, Potenza is involved, as a main partner and/or as local partner in various projects financed by the European Community to develop sustainable mobility in the city.

A1 Objectives

The measure objectives are:

- **Objective 1-** The introduction of clean vehicles into a large fleet of urban buses; and
- **Objective 2-** Operating clean vehicles in a large urban bus fleet.

The aims of Measure 5.5 were to:

- contribute to the improvement of air quality; and
- attract potential demand that is not satisfied by public transport.

A2 Description

The measure will introduce energy-efficient, cost-effective and clean vehicles for public use in the city's bus fleet. For this aim, four CNG buses have been introduced. In the initial work plan, buses purchased would have been used for the implementation of a Dial-a-Ride system operating on routes linking external districts to the town centre (measure 8.7). However because of the delays presented in the implementation of the measure, the new buses will be used only for ordinary public transport routes.

The introduction of clean vehicles within the public transport fleet concerned two different actions:

1. the purchase of LPG buses; and
2. the purchase of buses using natural gas (methane).

The availability of methane in the town led to the choice of methane buses.

B Measure implementation

B1 Innovative aspects

Innovative Aspects:

- Use of new technology

The innovative aspects of the measure are:

- **Use of new technology, regionally** – The activities described below are expected to have an important demonstration effect, as a significant number of clean vehicles will be running on the streets of Potenza. These buses will be used by individual users. The use of clean vehicles will promote the use of clean fuels to the general public.

B2 Situation before CIVITAS

Presently Potenza's administration intends to develop further actions for promoting sustainable mobility, such as: integrated management of the public transport system, the design of a new and more efficient public transport system; the restructuring of historical sites and the realisation of new parking areas at the border of the historical centre. Attention will also focus on the renewal of the bus fleet. At the moment the bus fleet includes 43 buses. Their average age is 11 years, which is very close to the Italian average stated in bus age data. This figure at the same time is higher than the European age (7 years). Under an energetic and environmental point of view, the bus fleet is still far from European and Italian directives on sustainability. Of the 43 buses, 15 are Euro 0 standards, 17 are Euro 2 standards and only 11 are Euro 3 standards. Whilst the fuels still remain conventional (diesel), no alternative fuels are used.

B3 Actual implementation of the measure

The measure was implemented in the following stages.

Stage 1: Market Research Study (from February 2006 to August 2006) – A market research study helped to identify the best buses under the "clean vehicles" category for the town of Potenza. The results of the market research study led to 2 fuel typologies: LPG or CNG. Both are characterised by low emissions levels and very similar commercial market data. Due high production levels of methane in the whole Basilicata Region and political strategies oriented towards the introduction of deep innovation in the mobility management system, it was decided to buy methane buses.

Stage 2: Funds Procurement (from August 2006 to June 2007) – The public contribution by the City of Potenza to buy ecological buses was given by the regional authority Regione Basilicata and amounted to € 400.000,00. Regione Basilicata, with a formal act issued in August 2006, transferred € 400.000,00 (covering only the 75% of the buses costs) to the city of Potenza, which in turn raised a loan for the remaining € 135.000,00 (this was formalised in a formal act issued in June 2007).

Stage 3: Public Tender for Procurement (from June 2007 to May 2008) – The procedures for procurement could start only after the formalisation of the availability of necessary funds. Therefore different departments in the Municipality of Potenza (General Directorate, Public Tenders, Budget, Mobility) could begin all necessary steps which were needed to prepare the formal public tender.

Stage 4: Buses delivery (from May 2008 in progress) – The winner of the tender was charged, by contract, of delivering the buses in September 2008. This stage suffered from further delays.

The new buses are four IRISBUS – IVECO, Model A50CIIG CNG Minibus .

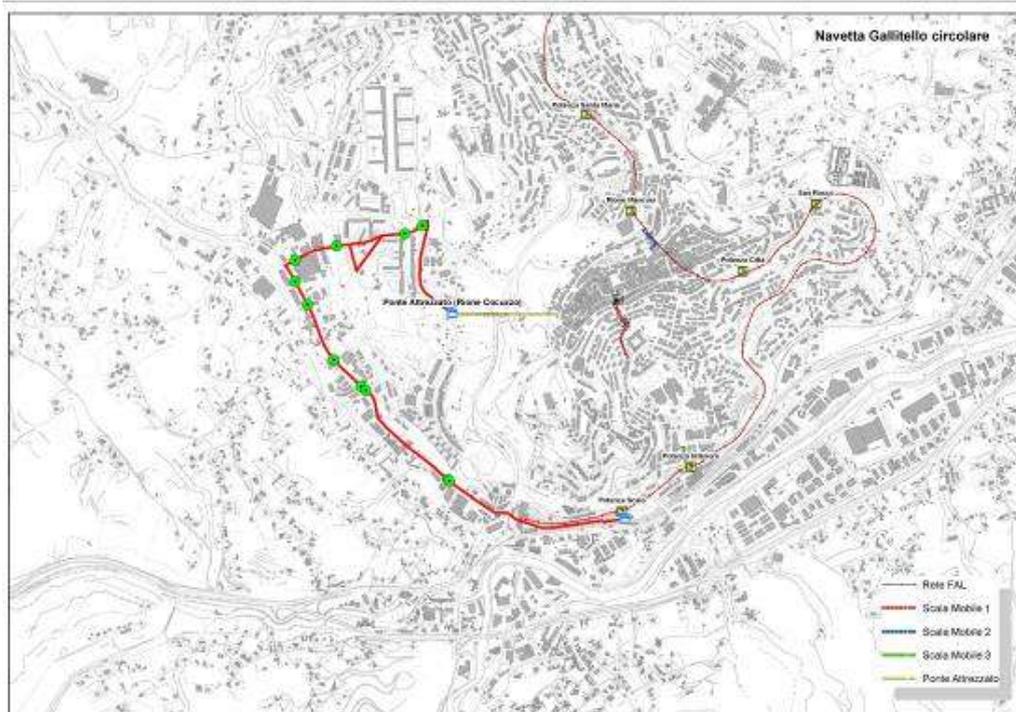


The main technical specifications for the new buses were:

- *Lenght (mm) - 6948;*
- *Height (mm) - 2945/3100;*
- *Internal height (mm) – 2000;*
- *Width (mm) – 1996;*
- *Internal Width – 1750;*
- *Engine 8149.03 – CNG;*
- *Passengers seats - 10–11;*
- *External colour- dark blue; and*
- *one of the four buses was equipped for disabled people.*

The new CNG buses complied with the European Directive 2001/27/CE (gaseous emissions) at level of EEV.

The new buses, being small buses, will be mainly used as fast shuttle services from one of the main entrance points to the town in the Southern part to the "Gallitello" commercial area and the Regional Council offices.



B4 Deviations from the original plan

The deviations from the original plan were:

- **Delay due to changes in project consortium** – The implementation of this measure was delayed due to the purchase of the ecological buses as a result of the reorganisation of the local consortium
- **Deviation due to change in contribution beneficiary** – In the initial plan the regional contribution needed to buy the clean buses (€ 400.000,00) was supposed to be given to the STI Group. CTP was the company that, until November 2005 managed the local public transport fleet. However, at this time a new company, Co.Tr.A.B took the place of STI. Due to contract provision, Co.Tr.A.B couldn't directly procure the buses. Therefore, Regione Basilicata, with a formal act issued in August 2006, transferred 400.000,00 (covering only the 75% of the costs) to the city of Potenza as a contribution to the procurement.
- **Deviation due to a tender amendment** –A first deadline for tender submissions was fixed for December 2007, with a bus delivery planned for March 2008. The buses would begin operating in April 2008. But an amendment was needed, thus extending the tender submission period and as a consequence revisions were asked by some suppliers to the Tender Department (with reference to the anti-trust law on the topic of free competition principles). The amendment resulted in a new deadline for March 2008 and a planned delivery for June 2008.
- **Deviation due to delay in buses delivery** – The supplier delayed the delivery of buses because of concerns with the ticket machines.

B5 Inter-relationships with other measures

The measure is related to 11.6 and the overall activities of mobility management as an instrument aimed at making public transport more appealing within the context of the wider strategic mobility plan. This was launched in Potenza recently.

In the original workplan, the measure related to 8.7 since part of the buses purchased would have been used for the implementation of the Dial-a-Ride system.

C Evaluation – methodology and results

C1 Measurement methodology

C1.1 Impacts and Indicators

Table of Indicators.

NO.	INDICATOR	DESCRIPTION	DATA /UNITS
2	Fuel costs	Fuel cost per yearly	Euros/pkm, quantitative, derived or measurement
3	Vehicle Fuel efficiency	Fuel used per vkm	MJ/vkm
8	CO ₂ emissions	CO ₂ per vkm	G/vkm
9	CO emissions	CO per bus	G/ kWh
10	NOx emissions	NOx per bus	G/ kWh
11	Small particulate matter	PM ₁₀ per bus	G/ kWh
local	HC emissions	HC per bus	G/ kWh

Detailed description of the methodology used in relation to the indicators:

- **Indicator 2 (Fuel costs)** – Fuel costs represented the cost calculated on the basis of the distance covered annually as described in the scenarios in Section C1.2 and C1.3.
- **Indicators 8, 9, 10, 11 (CO₂ emissions, HC emissions, CO emissions, NOx emissions, Small particulate matter)** –HC, CO, NOx and small particulate emissions (PM10) were measured for each bus. The indicators have been quantified on the basis of data presented in the technical cards of the evaluated ecological buses.

C1.2 Establishing a baseline

The starting point of the evaluation is represented by the assumption of having four small buses (FIAT Pollicino) operating and displaying the following characteristics: registered in 2000; Euro 2 standards; fuelled by diesel; and used as shuttle services in the route serving the three most important traffic poles in the town (Gallitello and Regione offices from the area FAL/Southern access, the schools pole arriving to the Ponte Attrezzato and the Hospital) for the distance covered annually of 290 km.

C1.3 Building the business-as-usual scenario

Because the buses were implemented so late in the project, there is a relatively short time period between the baseline and final evaluation. Therefore it is not appropriate to consider a business as usual scenario.

C2 Measure results

The scenario that will be compared to the baseline is represented by the use of newly purchased methane buses on the same route described in the previous scenario. It describes the situation that will occur as soon as the new Public Transit Schedule, where the shuttle service route is foreseen, will be implemented. It should be emphasised that because of the late delivery of the vehicles in relation to the SMILE contract period, this is primarily a desk based impact evaluation.

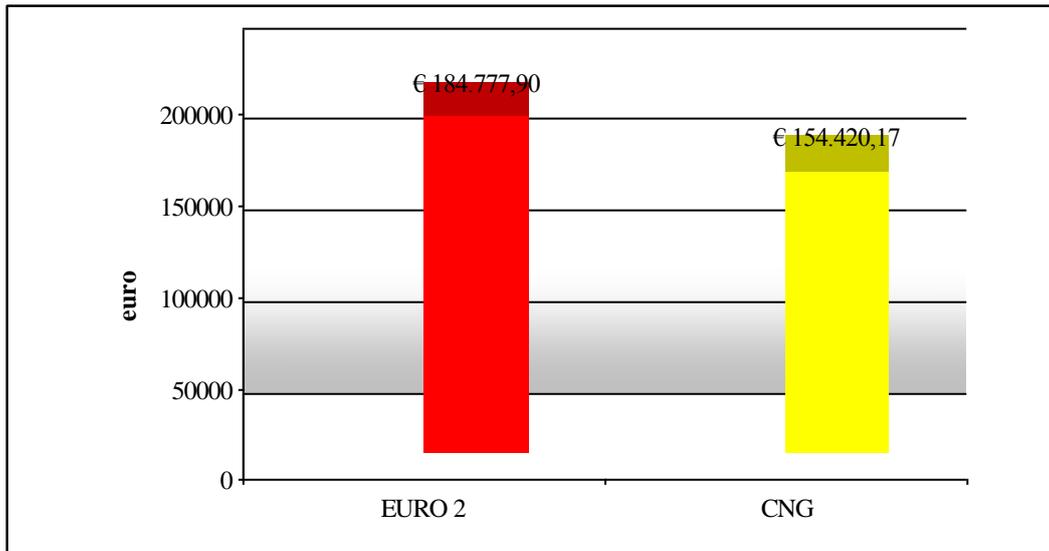
C2.1 Economy

The fuel costs for both scenarios (use of diesel Euro 2 buses and use of methane buses) have been compared. In the following table and bar chart, initial data and measure results are represented. A diesel unit of measurement is referred to as 1 litre of fuel, while a methane unit is referred to as 1 kilogram of fuel.

	Fuel cost (€/lt, €/Kg)	Consumption (lt/100Km, kg/100Km)	Fuel cost per 100 Km	Yearly fuel cost (Km 289176)
EURO 2	€ 1,486 /lt	43 lt/100Km	€ 63,90	€ 184 777,90
CNG	€ 890 /kg	60 kg/100Km	€ 53,40	€ 154 420,17

Economic Saving per bus per year € 30 357,73

Annual Fuel Cost



C2.2 Energy

By using the fuel consumption data above and standard calorific values of the fuels, it leads to the following comparison:

Euro 2 diesel bus: 17.0 MJ/km
 CNG bus: 25.8 MJ/km

This is not an unusual result given the excellent thermal efficiency of the standard diesel engine in comparison with spark ignition engines. The result is also influenced by the extra weight of a CNG bus required to house the gas tanks.

C2.3 Environment

The overall emissions in scenarios described in C1.2 e C1.3 were compared in terms of environmental impact. In the following table the emissions limits indicated in g/Kwh per polluting emission are represented.

	Euro 2	CNG ¹
HC	1,1	0,020
CO	4,5	0,280
NOx	8,0	0,110
PM	0,36	0,009

¹ Taken from buses technical specification form delivered by supplier in the technical offer with the tender

The following section contains estimates of the emissions from a conventional Euro 2 standard bus and a CNG bus. The calculations are based on converting the previously quoted vehicle fuel consumption values and emissions per energy used data into figures for emissions per kilometre travelled.

Estimation of HC emissions:

	CNG	Conversion factor	Distance covered in km
Consumption factor	1,334 km/m ³	1 kcal=0,00116 kWh	289176
Heating value	8250 kcal/m ³		
HC emissions	41 kg/year	Reduction	1464

Estimation of CO emissions:

	CNG	Conversion factor	Distance covered in km
Consumption factor	1,334 km/m ³	1 kcal=0,00116 kWh	289.176
Heating value	8250 Kcal/m ³		
CO emissions	581 kg/year	Reduction	5576

Estimation of NOx emissions:

	CNG	Conversion factor	Distance covered in km
Consumption factor	1,334 km/m ³	1 kcal=0,00116 kWh	289.176
Heating value	8250 kcal/m ³		
NOx emissions	228 kg/year	Reduction	10718

Estimation of PM emissions:

	CNG	Conversion factor	Distance covered in km
Consumption factor	1,334 km/m ³	1 kcal=0,00116 kWh	289.176
Heating value	8250 kcal/m ³		
PM emissions	19 kg/year	Reduction	474

The data for the Euro 2 standard diesel bus, which are based on statutory limit data rather than actual vehicle data, appeared to be rather high when compared with the following calculations based on data from the COPERT IV emissions methodology. This was recommended in the GUARD evaluation guidelines, which lead to the following values.

HC emissions: 212 kg
 CO emissions: 1042 kg
 NOx emissions: 4161 kg
 PM emissions: 82 kg

Compared to the CNG emission values calculated previously, this gives reductions of:

HC emissions: 171 kg = 81% reduction
 CO emissions: 461 kg = 44% reduction
 NOx emissions: 3933 kg = 94.5% reduction
 PM emissions: 63 kg = 77% reduction

Estimation of CO₂ emissions comparison:

Using standard formulae to calculate the CO₂ emissions from the mass of fuel burned led to the following values:

CNG: 1.25kg/km = 360.9 tonnes per year
 Diesel: 1.11kg/km = 320.6 tonnes per year

This indicated an increase of 40.3 tonnes per year or 13% in CO₂ emissions.

C2.4 Transport

n.a.

C2.5 Society

n.a.²

C3 Achievement of quantifiable targets

No.	Target	Rating
1	<i>SAVINGS in Operating costs</i>	**
2	<i>REDUCTION of HC emissions</i>	**
3	<i>REDUCTION of CO emissions</i>	**
4	<i>REDUCTION of NOx emissions</i>	**
5	<i>REDUCTION of Small particulate emissions</i>	**
6	<i>REDUCTION of CO₂ emissions</i>	0

NA = Not Assessed 0 = Not achieved * = Substantially achieved (> 50%)
***** = Achieved in full ** = Exceeded**

C4 Up-scaling of results

Sustainable transport policy was considered in the city of Potenza with the CIVITAS-Smile project.

The introduction of clean vehicles represents the very first step toward reducing emissions of polluting gases. That’s why further national and regional contributions have been made available in order to increase the fleet of ecological buses. A few months after the closure of the project, and on the basis of the results of the new market research study analysing the new bus routes (fixed in the new Public Transport Schedules) and potential demand, more ecological buses will be procured (for an amount of € 1.646.000,00).

In this context, a particularly innovative step for Potenza will be the upscaling of results from data produced by the introduction of 4 buses to a different catchment level determined by a nearly completed renovated public transport fleet. More complex and integrated ecological, economic and social assessment methods, in which stakeholders from the areas of politics, economy and administration are involved, could be applied.

² A follow up customer satisfaction survey will be issued, but because of the delay to the implementation of the buses this will, unfortunately, have to be done after the SMILE project timescale.

C5 Appraisal of evaluation approach

The overall delay in the implementation of the measure seriously compromised the introduction of innovative elements in the evaluation. Therefore, we missed the opportunity of consolidating a traditional analysis and then experimenting with further indicators:

- Contribution to the overall evaluation (i.e. on the impacts expressed in economic savings and polluting emissions within the urban area); and
- Opportunities to populate the data with the variables identified (information updating, frequency of surveys, etc.).

In such a scenario, a further set of indicators could have been applied to encourage progress and follow up the evaluation of synergies amongst different actions.

Under the circumstances, desk-based evaluation is satisfactory and the best that could be achieved. The procedures and indicators belonged to the well consolidated praxis of the evaluation of actions aimed to the reduction of impacts on the urban mobility. They covered all aspects related to an efficient and effective evaluation.

The delays also prevented a full financial analysis based on real operating costs and only fuel costs have been included. This may lead to an underestimation of the full cost of maintaining the CNG vehicles in comparison to the traditional diesel vehicles given it is a less well known and proven technology.

C6 Summary of evaluation results

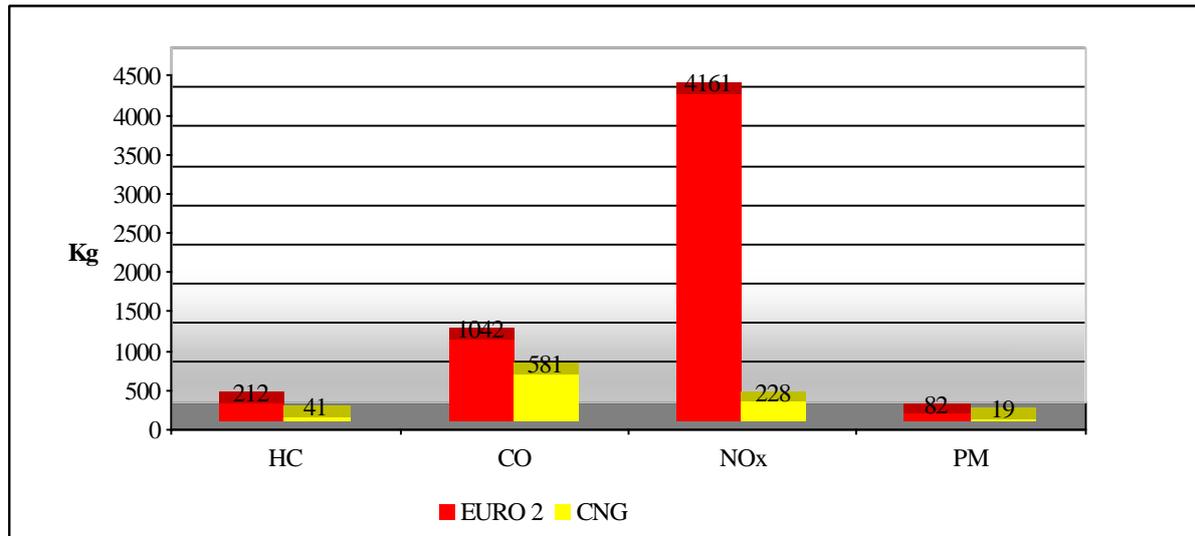
The key results are as follows:

- **Key result 1** – annual reduction of fuel costs (please refer to C2.1 section table and chart) of € 30.357,73.
- **Key result 2** – reduction of polluting emissions as shown in tables and chart below.

In the following table the decrease of polluting emissions thanks to the use of methane buses is summarised.

<i>Kg/year</i>	EURO 2	CNG	Change	% change
HC	212	41	-171	-81
CO	1042	581	-461	-44
NOx	4161	228	-3933	-94.5
PM	82	19	-63	-77
CO₂	320600	360900	+40300	+12.5

In the following bar chart, emissions reductions are summarised:



D Lessons learned

D1 Barriers and drivers

D1.1 Barriers

- **Barrier 1** – the measure had been highly compromised by bureaucratic procedures (especially those related to the necessary steps of public tenders). The time needed to finalise them was quite long.

D1.2 Drivers

- **Driver 1** – national and regional policy are oriented to make more funds available in order to improve environmental conditions (and therefore to renovate the public transport fleet).

D2 Participation of stakeholders

- **Stakeholder 1 – Public opinion** – In a survey related to public transport user satisfaction (conducted in 2007), citizens expressed the necessity of renewing public buses for: finding new solutions to polluting problems related to traffic; decreasing the average age of vehicles; and achieving a better image for public transport.
- **Stakeholder 2 – Political representatives** - Regional and Municipal political representatives have been involved in the necessary steps leading to the purchase of buses. They achieved the necessary conditions needed to increase the present fleet and to improve the conditions of the town.

D3 Recommendations

- **Recommendation 1** – This kind of activity (procurement of public goods or services) takes a long time to complete. Therefore, in order to include it in a time sensitive project, all necessary steps have to be planned accurately. All relevant subjects have to be identified from the very first steps and since the beginning of the project. The city of Potenza has learnt how to accelerate all necessary stages.

- **Recommendation 2** – The evaluation of this measure has been limited by late deliveries in relation to the SMILE contract period. It is recommended that other cities base their decisions on real operational experiences rather than desktop studies if at all possible.
- **Recommendation 3** – The use of CNG rather than diesel changes the balance of pollutants resulting from vehicle use. Local authorities need to consider what their priorities are. The use of biogas, as highlighted in measure 5.3 in Malmö, would more than offset the increase in CO₂ emissions identified in the evaluation of this measure

D4 Future activities relating to the measure

As described in section C4, more buses will be procured in the next months due to the availability of further funds and to the lessons learnt within the SMILE project.