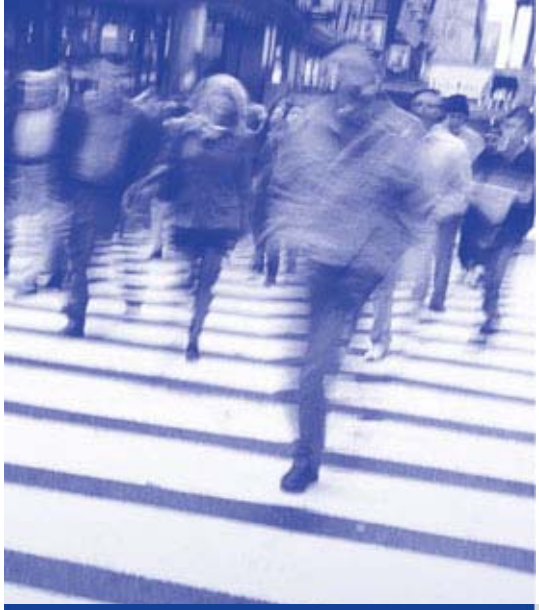

CiViTAS
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Measure Evaluation Results

BOL 1.1 Mini Fleet of Clean Vehicles for PT

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Executive Summary

The measure 'Mini fleet of clean vehicles for PT' aimed at analyzing pre-requirements to develop an energy efficient public transport (PT) fleet in Bologna and to implement the selected solutions in the frame of a pilot project. The objectives included: determining a financial sustainable strategy for the renewal of buses towards energy efficient vehicles; and testing technological solutions in practice with the long-term vision to deploy the solution to the entire PT fleet. To do this, the measure was implemented in the following stages:

Stage 1: Feasibility study (October 2008 – June 2009) The public transport operator TPER conducted a feasibility study to analyze different technological alternatives for "clean" buses based on the entire energetic chain of bus engines: from fuel production to the bus wheel. Based on the results, the hybrid engine proved the best technological solution to introduce low pollutant buses to Bologna. Indeed, hybrid technology is currently the only technological alternative to reduce energy consumption in the medium term.

Stage 2: Industrial partner search /call for tender for the vehicles purchase (Jan – May 2011) Based on the results of the feasibility study the technical specifications for the call for tender were drafted to select a subcontractor for the supply of two hybrid vehicles.

Stage 3: Contract award and supply of the buses (May 2011- December 2011) Two buses from Van Hool were bought as a result of the tender. These buses are equipped with innovative super capacitors that replace conventional electric batteries. Compared to traditional hybrid vehicles, they offer a considerable reduction in fuel consumption and lower exhausted gas emissions. Maintenance costs are reduced, as they do not need periodical substitution of the conventional batteries. The hybrid buses procured have a capacity of 24 seated passengers and 56 standing. It also has a reserved area for one wheelchair and a buggy, and a manually folding access platform for disabled passengers (located at the central door).

Stage 4: Bus operation (April 2012) The two hybrid buses operate in Bologna urban area. The vehicles demonstrated reliability during the service, a good performance in fuel consumption (about 2.5 km/l with the air conditioning system working) and the noiseless engine was appreciated from drivers and passengers alike.

Because of its long-term impact on TPER bus fleet, this measure was selected as a priority measure. The methodology used for evaluation is based on the comparison between new hybrid buses (with supercapacitors) and traditional hybrid buses (with batteries) already in service on the TPER lines taking into account economical, energetically, environmental and transport aspects between the new hybrid vehicles. In order to have the same operation conditions, the tests and data collection took place on a specific line in the historical centre.

Key results of the evaluation showed a decrease in operating costs as well as a decrease in energy consumption. Indeed, the new hybrid vehicle is equipped with supercapacitors that do not need to be changed while traditional hybrid vehicles have batteries requires substitution every 3 years with a cost of about 30.000,00 euro each. Furthermore, data collected in real service condition demonstrated a considerable saving in fuel consumption of the new hybrid vehicles compared with the traditional ones.

The **barrier**s which accompanied this measure can be expected when new technological solutions are implemented, including high investment costs, the general distrust in new technology and the new skills needed to be acquired in maintaining such vehicles. Nonetheless, the local authorities had great interest in the development of sustainable

mobility policies and they supported the strategic choices of TPER to buy low emission vehicles. This was an important **driver** to overcome these obstacles.

This measure **can be replicated** in other cities. The feasibility study showed that hybrid vehicles are appropriate both for companies that have already invested in alternative buses (trolley buses, natural gas buses) and reached the saturation point of infrastructure and for companies that have no possibilities to invest in infrastructure. The introduction of two vehicles in the TPER fleet further demonstrated their potential with respect to energy savings and customer satisfaction.

From Bologna´s experience, **two main recommendations** came out. Firstly, companies who undertake the renewal of a bus fleet should be aware that the challenges not only relate to technological changes but also to cultural changes in the organization of the company. It is therefore highly recommended to implement the measure in a comprehensive way by organizing personnel trainings, adapting the process of maintenance, adapting and implementing appropriate infrastructures for the new fleet including new logistics for the fuel supply. A lack of internal cultural change within management could generate high costs of operation and lead to a low service level of new buses. This highlights the necessity of implementing new technologies within a medium/long-term strategy. The second recommendation concerns the choice of an appropriate technology which should be sustainable on the city scale in a long-term perspective. In Bologna, a range of tests were conducted in order to determine which technology is the most appropriate to the specific context taking into account the needs of the public transport operators. It is crucial to develop a bus fleet with innovative vehicles with low environmental impact while keeping in mind that the technology chosen allows for the daily use of buses as a service forming part of the entire PT network.

Presently, TPER will continue to monitor the two hybrid vehicles to obtain feedback concerning operations during the winter season (i.e. consumption levels with the air conditioning system off). Nonetheless, hybrid vehicles will enter in TPER investment plan in the medium term.

A Introduction

A1 Objectives

High level objectives:

- Increase use of clean energy vehicles.
- Reduce pollution emission due to public transport.

Strategic objectives:

- Increase the use of clean vehicles in public transport fleets

Specific measure objectives:

- **Objective 1:** analyse new sustainable technologies for energy efficient vehicles, compare costs and benefits in regard to the existent ones and to find the better choice for Bologna's specific situation;
- **Objective 2:** deploy a mini-fleet of clean vehicles and analyse results of a long period running test

A2 Description

The measure aimed at creating conditions for a greater use of clean technologies in public fleet buses.

The measure developed a feasibility study in order to analyse different clean technological possibilities. The study permitted the identification of the the best technological solution to introduce low pollutant buses considering the scenario of Bologna.

The study concluded that the best "well to wheel" solutions are buses with hybrid engines. Following the results of previous steps, a mini-fleet of 2 hybrid buses was ordered and tested in real service conditions.

The hybrid bus is a simple solution that can be adopted to develop and environmental friendly bus fleet.

A relevant training activity was realized within the measure for technicians that will take care of the vehicle maintenance in the depots.

B Measure Implementation

B1 Innovative Aspects

Use of new technology at national level - Wide and scientific analysis based on economical, technical and environmental factors and a real test in urban environment with a mini-fleet of buses.

B2 Research and Technology Development

ATC realized the analysis for the development of a bus fleet with characteristics of environmental sustainability and reasonable costs. The study takes into account the state of the art and the market trend of buses, considering development and technological innovations concerning environmental sustainability.

The methodologies used to evaluate the different solutions were:

- life cycle assessment (LCA);
- life cycle cost (LCC);
- well to wheel (WTW).

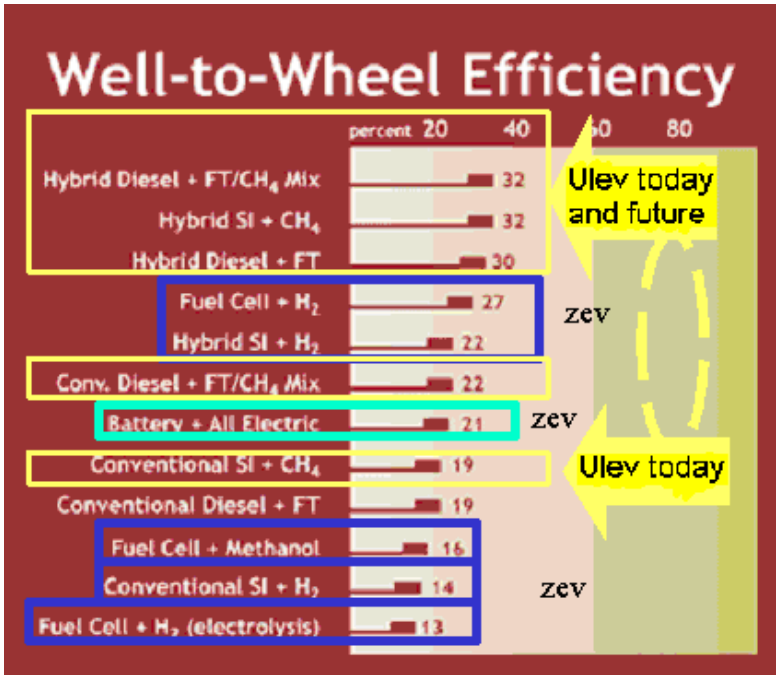
The "**well to wheel**" (**WTW**) approach was particularly interesting: this method evaluates the whole energetic chain of bus engines starting from the fuel production arriving to the bus wheel.

It consists of two parts:

- "Well to tank" that means evaluation of energetic consumption to extract and transport the fuel to the bus tank;
- "Tank to wheel" from the vehicle tank to the vehicle wheels.

The study concludes that the best "well to wheel" solutions are buses with hybrid engines.

Fig. 1 – Well to wheel efficiency of different bus engines



Hybrid vehicles reduce petroleum consumption under certain circumstances, compared to otherwise similar conventional vehicles, primarily by using three mechanisms:

1. Reducing wasted energy during idle/low output, generally by turning the internal combustion engine off
2. Recapturing waste energy (i.e. regenerative braking)
3. Reducing the size and power of the internal combustion engine, and hence inefficiencies from under-utilization, by using the added power from the electric motor to compensate for the loss in peak power output from the smaller internal combustion engine.

Any combination of these three primary hybrid advantages may be used in different vehicles to realize different fuel usage, power, emissions, weight and cost profiles. The internal combustion engine in a hybrid vehicle can be smaller, lighter, and more efficient than the one in a conventional one, because the combustion engine can be sized for slightly above average power demand rather than peak power demand.

The power curve of electric motors is better suited to variable speeds and can provide substantially greater torque at low speeds compared with internal combustion engines.

Substantial use of the electric motor at idling and low speeds implies reduced noise emissions.

B3 Situation before CIVITAS

The local context shows a strong interest of public institutions in alternative fuel/engine investments: Bologna infact is already experienced in using alternative/sustainable fuels for public buses, thanks also to regional co-funding initiatives:

1. LPT - CNG Choice

The choice for methane for the urban public transport fleet (ATC company) is giving many environmental benefits, as a result of the regional and the municipal Administration policies and EU suggestions.

“Bus methanization" plan:

- Increase of LPT methane vehicles: 0 natural gas buses in 2000, 31 in 2002, 62 in 2004, 105 in 2005 and 113 in 2006, 141 in 2007-2008 (almost 30% of the urban fleet);
- Two quick filling stations, located in bus depots, first of such kind in Italy supplying more than 160 gas tons per month. Quick filling stations are capable of supplying a bus with 200 CNG standard mc in about 5 minutes;

2. LPT - "antiparticulate filter" (FAP)

At the moment, 391 diesel buses have been equipped with FAP (almost 80% of the urban fleet)

3. LPT - TROLLEY LINES

Three of the main public bus lines are currently trolley lines (53 trolley buses) and in the next years 2 more electric lines will be created in order to increase the trolley bus fleet.

B4 Actual Implementation of the Measure

The measure was implemented in the following stages:

Stage 1: Feasibility study *(Oct 08 – June 09)*

The feasibility study analysed different clean technological possibilities.

The study aimed to identify the best technological solution to introduce low pollutant buses in Bologna scenario.

The study concludes that the best "well to wheel" solutions are buses with hybrid engines.

The study shows how hybrid vehicles are the best solution both for companies that already invested in alternative buses (trolley buses, natural gas buses) and reached the saturation point of infrastructures and for companies that have no possibilities to invest in infrastructures because hybrid technology is the only possibility to reduce energy consumption in the medium term.

Stage 2: Industrial partner search /call for tender for the vehicles purchase (Jan-May 2011)

We contacted bus manufacturers in order to start a cooperation activity to develop the first bus prototype. We found several difficulties as manufacturers were not ready to spend time and resources without the assurance of a future supply of a small fleet. So we were obliged to initiate a call for tender.

The results of the feasibility study have been the input for the realization of the technical specification for a call for tender for the supply of hybrid vehicles with innovative characteristics.

The call for tender concerned the supply of 2 hybrid buses.

Stage 3: Contract award and supply of the buses (May 2011- Dec 2011)

The contract was awarded on May 2011 and buses were completed on December 2011.

The selected buses are equipped with innovative super capacitors that replace conventional electric batteries. Compared to traditional hybrid vehicles, they offer lower exhausted gas emissions through reduction in fuel consumption . Maintenance costs are also reduced, as they do not need the deployment of battery charging stations at the bus depots, nor the periodical substitution of the conventional costly batteries, known to wear out quickly.

Super capacitors can stand a significantly higher number of charge-discharge cycles and last longer than conventional batteries, making both the super capacitor and vehicle more environmentally friendly. Additionally, as super capacitors are not as limited by low battery charge levels, these new buses make for a more reliable, constant and long serving bus service.

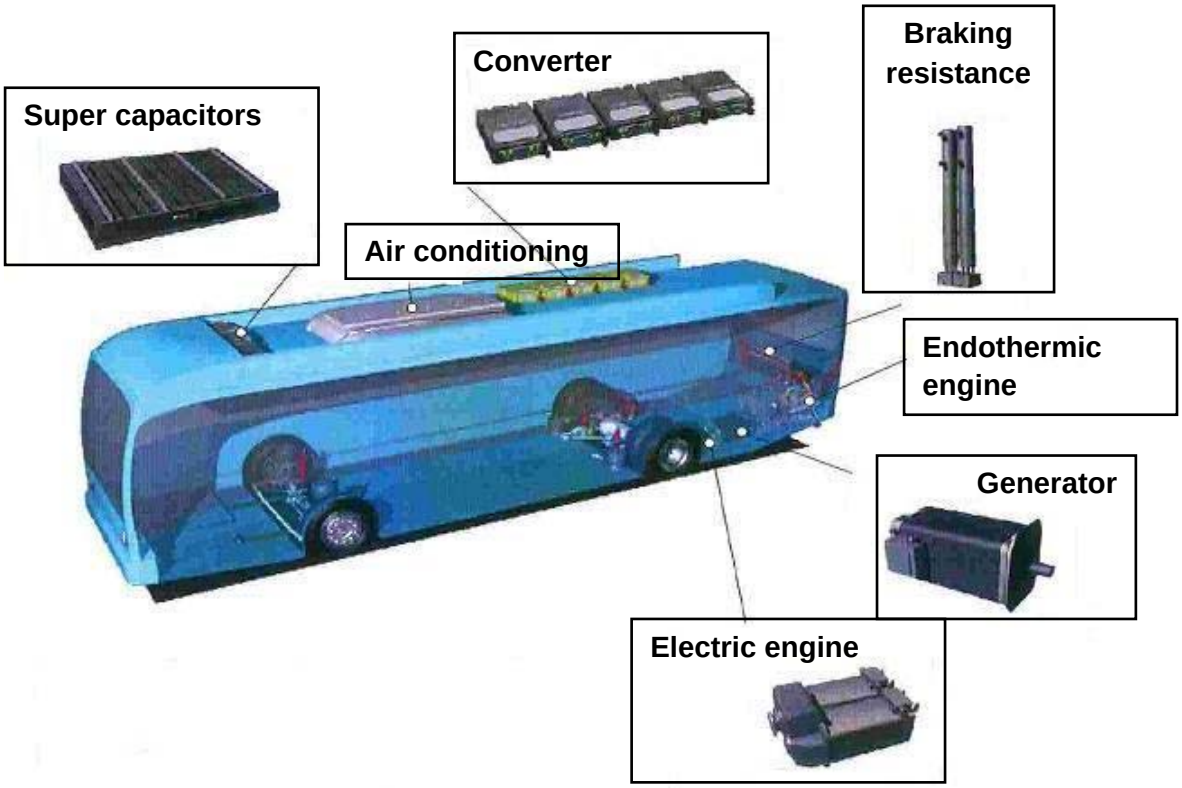
The two Van Hool vehicles are equipped with an electric generator powered by an endothermic diesel engine. The generated energy is stored by the super capacitors and released by the electric drive engine during the acceleration phases, to support the endothermic diesel engine, thus reducing fuel consumption and improving the performance.

During the braking and decelerating phases the energy produced by the generator is driven to the super capacitors to be stored. In other words, the super capacitors work like a type of super condenser, which can very rapidly store and give back energy in great quantities.

The hybrid buses procured by TPER can take 24 seated passengers and 56 standing. It also has a reserved area for one wheelchair and a buggy, and a manually folding access platform for disabled passengers (located at the central door).

Fig. 2 –hybrid bus VAN HOOL A330 Hyb

Fig. 3 – layout of components on the bus



Stage 4: Bus operation

From April 2012 the 2 hybrid buses are operating in Bologna urban area: from Monday to Friday they cover varied urban lines to test the performances on different routes.

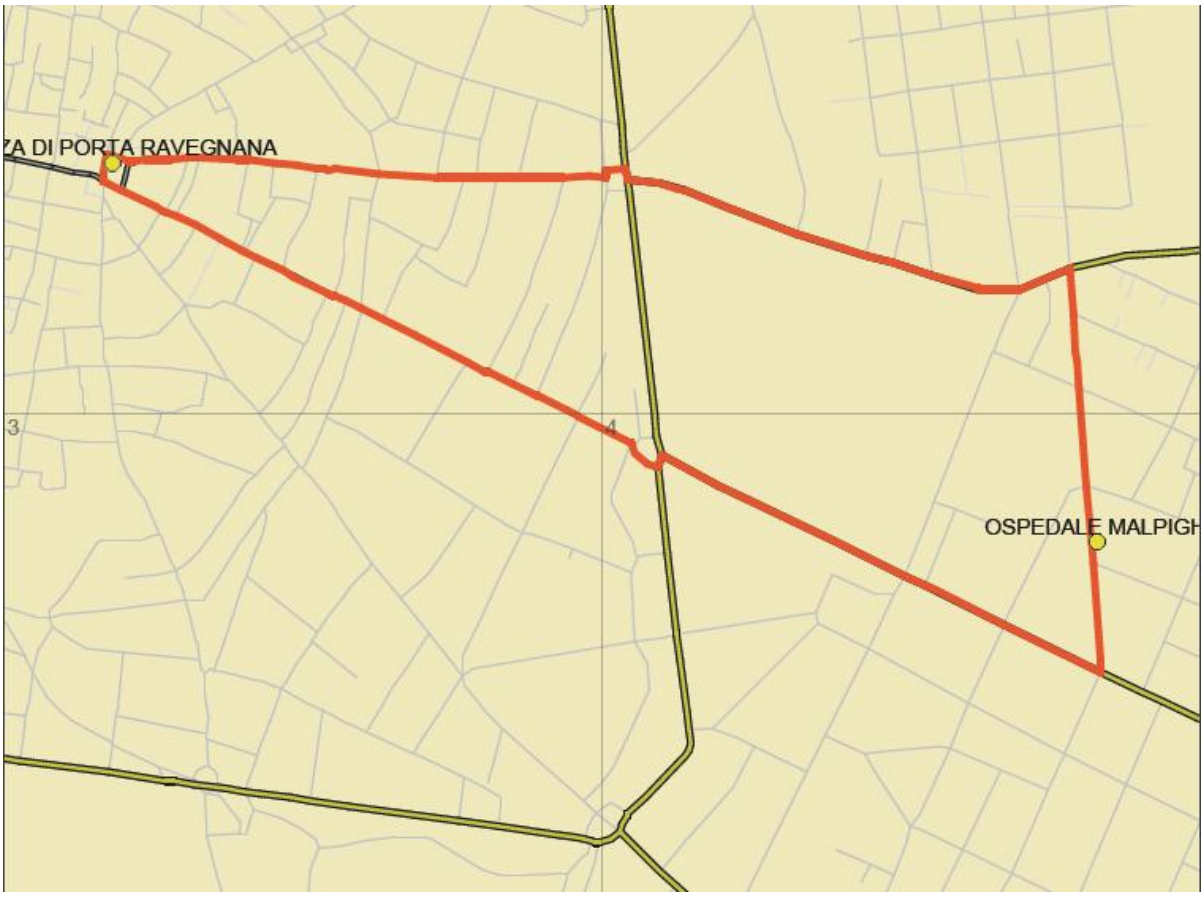
On Saturdays and Sundays the vehicles operate on the new shuttle line “T” recently created to connect the city centre to the parking area Sant’Orsola during the “T-days” (main line data: route length 4,126 km, travelling time 22 minutes)..

During T-days the circulation on the main three streets of the city centre is allowed only to pedestrians and bicycles.

The service data collected and the feedback from drivers are very positive:

- the vehicles demonstrated reliability during the service
- fuel consumption are good: about 2,5 km/l with the air conditioning system working (both for drivers and passengers compartments)
- the vehicles have a noiseless engine appreciated from drivers and passengers

Fig. 4 - Shuttle Line "T" route



B5 Inter-Relationships with Other Measures

Not applicable

C Impact Evaluation Findings

C1 Measurement Methodology

C1.1 Impacts and Indicators

Table C1.1: Indicators

Evaluation area	Evaluation category	Impact		Indicator	Source of data	Month
Economy	Costs	Capital Costs	1	Purchase costs	Company	Apr/Sept 2012
		Maintenance cost	2	Repairing costs	Company	Apr/Sept 2012
Energy	Energy Consumption	Vehicle fuel efficiency	3	Fuel used per vkm, per vehicle type	Refuelling data	Apr/Sept 2012
Environment	Pollution	Emissions	4	CO2 emissions	Estimation	Apr/Sept 2012
			5	CO emissions	Estimation	Apr/Sept 2012
			6	NOx emissions	Estimation	Apr/Sept 2012
			7	Particulate emissions	Estimation	Apr/Sept 2012
Transport	Transport system	Operative data	8	Fuel distance (Operating range)	Vehicle data	Apr/Sept 2012
			9	Reliability	Reports on engine failures during service	Apr/Sept 2012

The methodology used for the evaluation is based on the comparison between new hybrid buses and other vehicles alredy in service on the TPER lines. We compared the economical, energy, environmental and transport aspects between the new hybrid vehicles (with supercapacitors) and traditional hybrid buses (with batteries).

In order to have a better comparison between the two vehicles we didn't use them on the whole urban area but we tested them on a specific line in the historical centre in order to have the same operation conditions.

It's important to highlight that consumption data were collected from April 2012-September 2012 a period characterized by an intensive use of the air conditioning system that has relevant influence on consumptions.

- **Indicator 1 - Capital cost:** we indicated the cost for the purchase of the two hybrid vehicles
- **Indicator 2 - Maintenance cost:** we indicated the annaul maintenance costs of the vehicle after the expiry of the warranty that is 4 years.
- **Indicator 3 - Vehicle fuel efficiency:** data were collected in real operation conditions
- **Indicators from 4 to 7 - Emissions:** the pollutant emissions were extimated on the base of real consumptions and engine data declared by the constructor.
- **Indicators from 8-9 - Operative data:** data were based on the feedback from real operation.

C1.2 Establishing a Baseline

Baseline data are represented by operative data related to traditional hybrid vehicles running in similar conditions. In this way the comparison is homogeneous: in paticular for the comparison we took data of Breda Menarini M240 hybrid 12 metres already operating in TPER fleet.

C1.3 Building the Business-As-Usual Scenario

TPER in the past years implemented infrastructures to support sustainable vehicles (trolley buses, natural gas buses). The measure allowed to understand that hybrid vehicles are the best solution for future purchases once existing infrastructure has reached the saturation point.

Without the realization of this measure we wouldn't have a sustainable strategy for the enlargement of the bus fleet without further infrastructural investments.

C2 Measure Results

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

C2.1 Economy

Indicator 1-3 "Economical evaluation area":

The investment cost for the purchase of 2 innovative buses is 700.000, euro

Table C2.1.1: Investment costs, maintenance costs in Euro for 2 hybrid vehicles

	2011	2012	…	2016
Total capital costs (in euro)		700.000,00		
Yearly maintenance costs (estimation since the buses are under warranty)				42.000,00

Traditional hybrid buses have a purchase and an annual maintenance costs very similar to the innovative ones. The difference in that traditional hybrid vehicles have the batteries that need to be substituted every 3 years with a cost of about 30.000,00 euro.

C2.2 Energy

Consumption:

Data concerning fuel consumption of the innovative Hybrid Buses were collected in real service conditions. From these data the average consumption is **2,52 Km/l,** equivalent to: 39,68 litres/100 km.

The average daily consumption is about 80 litres for a daily service of 200 km. Data refer to the summer season with an intensive use of the air conditioning system.

C2.3 Environment

The bus constructor declares that the engine that activates the generator observes the emission limits of the 2005/55/CE "EEV" Directive. "EEV" means: Enhanced Environmentally-friendly Vehicle.

Emission data are indicated in Table C2.3.1.

Table C2.3.1: Emission data declared from the bus constructor

LIVELLO EMISSIONI INQUINANTI motore termico (*) (*)in conformita con prova ESC	
Dispositivo per abbattimento emissioni (sì / no)	Si
Tipo dispositivo abbattimento emissioni (CRT, SCRT etc)	CRT – SMF (filtro di metallo sinterizzato)
Costruttore dispositivo abbattimento emissioni	HJS – DES
Modello dispositivo abbattimento emissioni	CRT 61 CSMF
NOx (in g / kWh)	1,6695
CO (in g / kWh)	0,022
Particolato (in g / kWh) (solo DIESEL)	0,055
HC (in g / kWh)	0,0105
Fumosità (solo DIESEL)	0,048 (prova ELR)

NOX= Nitric oxid;

CO = carbon monoxide;

PT = particulate;

HC = total hydrocarbon

CO2= carbon dioxide.

Emission data declared are in conformity with ESC (European Steady State Cycle) a testing procedure with 13 different testing cycles.

Emission extimation:

Starting from the consumption in litres of diesel fuel and with the value of Kwh/litre that the diesel engine can supply, we obtain the level of emissions.

We estimated the calorific value of the diesel fuel in **41** MJ/kg, with a density of the diesel fuel of 0,85 kg/dm3, we obtained: 35 MJ/litre.

1 KWh = 3,6 MJ, at the end we obtained 10 KWh/litre.

The estimated emission are:

NOX= (1,669 X 4) = 6,67 gr / Km;

CO = (0,022 X 4) = 0,09 gr / Km;

HC = (0,0105 X4) = 0,04 gr / Km;

PT = (0,055 X 4) = 0,22 gr / Km.

The table C2.3.2 compares energy and environmental data of the innovative hybrid bus Van Hool and a traditional hybrid bus operating on the TPER fleet in the same service conditions.

Table C2.3.2: Emission comparisons (new hybrid bus Van Hool/Traditional hybrid vehicle)

Description	**Unit**	**Innovative hybrid vehicle Van Hool (with supercapacitor)**	**Traditional hybrid vehicle (with batteries)**
Specific consumption	l/km	0,40	0,54
Emissions CO2 (estimation)	gr./km	1.052	1.431
Emissions CO (estimation)	gr./km	0,09	1,19
Emissions NOX (estimation)	gr./km	6,67	9,01
Emissions HC (estimation)	gr./km	0,04	0,06
Emissions PT (estimation)	gr./km	0,22	0,3

As concerned CO2 emissions, we estimated 212 kg of CO2 per day, calculating 2.650 gr of CO2 for each litre of Diesel fuel (this calculation uses standard coefficients for CO2 estimation).

C2.4 Transport

Indicator 8-9: Main relevant data concern the new hybrid bus reliability: in the first 6 months of intensive operation (buses in service every day for about 15 hours) no failures occurred.

Table C2.4.1: operative data (new hybrid bus Van Hool/Traditional hybrid vehicle)

Description	Unit	Innovative hybrid vehicle Van Hool (with supercapacitor)	Traditional hybrid vehicle (with batteries)
Batteries life cycle	Years	No batteries	3
Availability (days per month)	%	99,38	75
Fuel distance	km	About 600 km	About 600 km

C2.5 Society

Not applicable

C3 Achievement of Quantifiable Targets and Objectives

No.	Target	Rating
1	analyse new sustainable technologies for energy efficient vehicles, compare costs and benefits in regard to the existent ones and to find the better choice for Bologna's specific situation.	**
2	deploy a mini-fleet of clean vehicles and analyse results of a long period running test	**

NA = Not Assessed O = Not Achieved * = Substantially achieved (at least 50%)
**** = Achieved in full *** = Exceeded**

The study conducted within the measure identified the hybrid buses as the best solution for Bologna's situation. This solution can be easily adopted also by companies that do not have the possibility to invest in infrastructures that are required for trolleybuses, electric vehicles and natural gas buses.

Two innovative hybrid vehicles equipped with supercapacitors were obtained and are operating since April 2012 with very positive results in terms of reliability and performances.

C4 Up-Scaling of Results

The hybrid bus is a simple solution that can be adopted to develop an environmental friendly bus fleet: hybrid technology guarantees low emission levels and the introduction of this vehicles does not imply infrastructural investment.

We think that the purchase investment plan of TPER for the next year will foresee the introduction of further hybrid vehicles.

We also think that this solution can be easily adopted from other transport companies that want to improve the environmental sustainability of their fleets.

C5 Appraisal of Evaluation Approach

The evaluation methodological approach could be improved with the measurement of the emission levels in real operation conditions (for the current evaluation we only extimated them).

This would imply an agreement with research institutes that have the necessary instruments (very expensive) to measure emissions. The instruments would be installed on board and data would be collected during the real operation of the bus.

C6 Summary of Evaluation Results

Key results of the evaluation can be summarized as follows:

- **Decrease in operating costs** – The new hybrid vehicle is equipped with supercapacitors that do not need to be changed while traditional hybrid vehicles have batteries that needs to be substituted every 3 years with a cost of about 30.000,00 euro.
- **Decrease in consumption** – Data collected of the new hybrid vehicles in real service conditions demonstrated a saving in fuel consumption of about 26% compared with the traditional ones.

C7 Future Activities Relating to the Measure

As it concerns the short term, TPER will continue to monitor the two hybrid vehicles in order to have feedbacks concerning operation during the winter season (for example it will be interesting to measure consumption levels with the air conditioning system off).

Hybrid vehicles will enter in TPER investment plan in the medium term.

D Process Evaluation Findings

D0 Focused Measure

- *Please fill in the number of the reason from the checklist in the clarification section according to importance.*
- *If it is not clear what the reason(s) is (are), please check this with your Local Evaluation Manager and / or your Project Evaluation Manager.*

	0	No focussed measure
4	1	Most important reason
2	2	Second most important reason
3	3	Third most important reason

D1 Deviations from the Original Plan

We could not have prototyping activities because we couldn't find any bus manufacturers ready to supply a bus for testing before the tender procedure. For this reason the testing phase and the measurements were done after the tender awarding.

D2 Barriers and Drivers

D2.1 Barriers

Overall barriers

- **High investment costs** – hybrid buses have a higher costs than diesel vehicles
- **Innovative technology distrust** – Distrust on the technology of supercapacitors that is vey innovative and do not have any feedback on reliability.
- **Lack of knowledge in maintenance** – there is not knowledge concerning maintenance procedures of the innovative components installed on this type of hybrid buses

D2.2 Drivers

Preparation phase

- **Political commitment –** Local authorities have great interest in the development of sustainable mobility policies and they addressed the strategic choices of TPER to low emission vehicles.

Operation phase

- **Visibility** – The two hybrid vehicles always operates during weekends on a shuttle line in the city centre. This was a successful opportunity that gave high visibility to these

innovative buses. Otherwise they will be mingled with the urban fleet without any particular relevance.

D2.3 Activities

Overall activities

- **EU contribution** – the participation in an european project allowed TPER to justify the choice of innovative hybrid vehicles both for the feedback in terms of company visibility and the financial contribution.
- **Investment risk evaluation** – The market analysis and the technical study demonstrated that the supercapacitor technology is reliable and for this reason the risk of the company in investing on this technology have been evaluated as low
- **Training plan** – A relevant training activity was planned for technicians that will take care of maintenance in the depots. The high level of skill and knowledge of technical personnel inside TPER will avoid to involve external firms for the maintenance process with a consequent reduction in costs.

D3 Participation

D3.1 Measure Partners

- **Measure partner 1 –** TPER spa
- **Measure partner 2** – Regione Emilia Romagna (for the dissemination activities)

D3.2 Stakeholders

- **Stakeholder 1** – Municipality of Bologna
- **Stakeholder 2** – Regione Emilia Romagna
- **Stakeholder 3** – Province of Bologna

  The Municipality, Regione Emilia Romagna and the Province are the shareholders of TPER (the transport company) so they influenced the strategic choices of innovative projects
- **Stakeholder 4** – SRM (Mobility Agency supervisor of the public transport in Bologna. TPER and SRM sign each year a service agreement)

D4 Recommendations

D4.1 Recommendations: Measure Replication

Recommendation 1 : The use of hybrid technologies on public transport buses does not imply investments in infrastructures. For this reason it's a quite simple and economic "clean vehicle solution" and recommended for companies that do not have the economical resources for investments in plants.

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

Recommendation 1: A company that wants to develop a “sustainable” bus fleet has to consider that sustainability has not only technological implications but has also cultural impact on the company organization.

Before the purchase on the market of low environmental impact buses, the company has to improve its internal processes as concerns:

- personnel training
- adaptation of maintenance process
- adaptation/realization of infrastructure
- logistics for the supply of innovative fuels

This cultural impact explains why the introduction of new sustainable vehicles is possible only in the medium-long period. Without a “cultural” approach the company will face to high costs of operation and low service level of new buses.

Recommendation 2: The innovative technology chosen has demonstrated its validity and its correspondence to the needs of a transport company.

For a transport company it’s important to improve the bus fleet with innovative buses with low environmental impact; at the same time it’s fundamental that the innovative technology chosen is a “mature” technology that allows one to have buses in real service in the city every day and not only prototypes parked in a depot.