

CLEAN AND ENERGY EFFICIENT VEHICLES

Deliverable 5 of Success Project

**Editors: Dominique BREUIL (EIGSI)
David BLACKLEDGE (TTR)**

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FOREWORD



Jean YATES, Emil CALOTA, Denis LEROY

As senior political representatives of the SUCCESS cities we have been personally involved in the project from its beginnings as a Proposal submitted to the CIVITAS Programme in 2004. We have been honoured to take part in the second phase of CIVITAS and we have been pleased to see how well the plans have been implemented in our cities and how our citizens have benefited.

The rich cooperation that has been the hallmark of SUCCESS, both between the cities and between local partners in each city, has resulted in greater understanding and mutual respect between different organisations and different cultures. This will have long-lasting effects that will benefit all who have been involved in the project.

We have been pleased to cooperate with the European Commission and the wider CIVITAS family, and have contributed to the CIVITAS Political Advisory Committee.

We trust that this document will provide useful lessons for others considering the adoption of measures similar to those that we implemented in the SUCCESS project.

Denis Leroy, *Communauté Urbaine de La Rochelle, Vice Président en charge des transports*

Jean Yates, *Lancashire County Council, County Councillor*

Emil Calota, *Primaria Municipiului Ploiesti, Mayor*

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1 SUCCESS PROJECT

SUCCESS (Smaller Urban Communities in Civitas for Environmentally Sustainable Solutions) is a 4-year project, within the European Research and Demonstration Programme CIVITAS II, with 12 partners including local authorities, transport companies, universities and experts from La Rochelle (FR), Preston (UK) and Ploiesti (RO). The main objective of SUCCESS is to demonstrate that, with an ambitious package of mobility and traffic management measures, significant results can be provided regarding sustainable transport and energy policy in small and medium sized cities. SUCCESS addresses technical, social, environmental and economic aspects of an integrated mobility strategy. As a demonstration project, SUCCESS involves extensive investment in the participating cities, along with a large range of stakeholders and integrated packages of demonstration measures. Several actions have been engaged in each city ranging from controlled access zones to biofuels, from real time information systems to alternative modes for transport, from cycle and walking paths to integrated ticketing. In total, more than 50 different projects have been set up involving a large number of stakeholders leading to a very wide scope of sustainable mobility management and implementation.



The main goals of SUCCESS are:

- To demonstrate that vehicles using clean and alternative fuels can be an efficient choice for urban transport
- To demonstrate that, with an ambitious package of mobility and traffic management measures, significant results can be seen regarding sustainable transport and energy policy
- To demonstrate that accession countries, soon to be new member states, can learn from our previous mistakes and contribute to urban collective transport issues, while implementing at the same time actions promoting alternative transport modes
- To contribute deeply to many different related research and assessment activities such as new, all-inclusive training and communication initiatives supporting the project objectives

La Rochelle, Preston and Ploiesti represent well the medium-sized cities in Europe. Most of medium sized cities are built around an historical city centre. This city centre is quite often rich with several types of shops as well as craftsmen and small industries, with other commercial or tourist areas scattered around in the city. Commercial and industrial zones have grown up in the surrounding areas and are accessible within a short time.

Regarding transport, the main characteristics of such cities are their small surface area, the human size of relationships and their small investment capacity. Buses often provide the main form of public transport.

Medium sized cities generally have a low demographic density, with the population often spread over a large area, sometimes in surrounding small towns which are included in the "life zone". On the one hand this means short travel times, good accessibility and freedom for travelling, but on the other hand it makes collective transport very difficult to organise.

In such cities, relationships between citizens and between citizens and politicians are closer. The proportion of inhabitants involved in the city life is quite often higher than in larger ones: through different associations and clubs, inhabitants come to know each other more easily and have often direct access to politicians involved in these motors of the city life. So the city culture is more widespread and is shared by a many inhabitants.

Smaller cities have in general lower investment capacity; this capacity is not proportional to size and it is sometimes difficult for the local authority to raise financial levers to fund projects.

1.1 The Project Consortium Cities

PROJECT CO-ORDINATOR :

Communauté d'Agglomération de La Rochelle (CdA), FR

PARTNERS :

Ville de La Rochelle (Ville de LR), FR

EIGSI, Ecole d'Ingénieurs de Génie de Systèmes Industriels, FR

Lancashire County Council (LCC), UK

Preston Bus Ltd (PB), UK

Transport and Travel Research Ltd (TTR), UK/FR

Preston City Council (PCC), UK

South Ribble Borough Council (SRBC), UK

Primaria Municipiului Ploiesti (PMP), RO

Regia Autonoma de Transport Public (RATPP), RO

Universitatea Petrol-Gaze Ploiesti (UPGP), RO



LA ROCHELLE - PRESTON - PLOIESTI



1.1.1 La Rochelle

La Rochelle lies on the Atlantic Coast of Western France. The Urban Community of La Rochelle includes 17 surrounding towns and La Rochelle itself. 160,000 inhabitants live in this area of 20,650 hectares and the total population may reach 250,000 people in summer. Based on a strong maritime heritage with several ports (commercial, leisure, fishing), the economic dynamism of the Urban Community of La Rochelle is the main factor of evolution of the city and the foundation of the urban strategies among which policies in favour of the framework of life and urban ecology (sustainable transport and protection of the landscape) stand in first position.

The Urban Community of La Rochelle has been involved for several years in improving urban transport and more specifically in introducing clean vehicles, developing new concepts for sharing vehicles, bicycles, in implementing Park + Ride, and even starting the "car-free day". Clean transport is not the only environmentally friendly improvement introduced in the town. Other actions have already been started to make the city one of the best in the country for environmental issues. Among these are "master planning" for wind turbines in urban areas, an observatory for air quality (ATMO existing since 1976), coastal protection studies (with La Rochelle University) and littoral management, electric boats for collective transport in the harbour. So SUCCESS is clearly part of the global environmental strategy of the local authority for improving quality of life in all of the city's communal areas.

1.1.2 Preston

Preston is England's newest city – city status was granted in 2002. It has a population of 129,000 plus suburban areas in South Ribble (combined population 250,000). Preston is the administrative capital and largest commercial centre of Lancashire in the North-West of England.

Preston is, however, an ancient place, receiving its Charter in 1179 - its historic Preston Guild is celebrated every 20 years with the last celebration in 1992. Preston has a strong economic and retail base. The area is also on the threshold of major regeneration, which will see a transformation of Preston's inner urban areas. This transformation is community-led with the Council and its key partners giving full support. The Council - in partnership with the private sector - is also working on a multi million pound scheme to redevelop Preston's City Centre through better retail, transport, housing, office, leisure and other mixed uses. Preston's student population is acting as a major catalyst too. With over 30,000 students, the University of Central Lancashire in Preston is the sixth largest and one of the fastest growing Universities in the UK.

Preston is already a UK leader in the field of transport Telematics through its involvement in the UK UTMC programme and Lancashire County Council was recently awarded the title of UK Local Transport Authority of the Year 2004. The planned major regeneration of the city centre has created

an opportunity for SUCCESS to support a step-change in the provision of sustainable transport systems within the city.

1.1.3 Ploiesti

Ploiesti City is located in the south of Romania 60 km north of Bucharest, the capital of Romania. Ploiesti is the capital of Prahova County and is located south of the Sub-Carpathian hills and north-west of the confluence point of two main rivers, Prahova and Teleajen. The municipal economy is characterised by a concentration of large and very large businesses. The population of Ploiesti went from 56,460 as indicated by the December 1912 census returns, up to 252,715 in January 1992. At the end of the year 2001, the population had slightly reduced to 248,688.

Ploiesti City (5,844 ha) is intended to become the nucleus of a metropolitan area, which will include some nearby villages adding around 70,000 new inhabitants to the administrative area. The road network has a radial-ring structure and extends from the city to the neighbouring villages. The municipal roads comprise over 800 streets with a total length of 324 km. East and West ring belts mean around 5,300 vehicles transit Ploiesti each day.

Ploiesti is situated at the crossing of the European Corridors IV and IX.

Ploiesti is a railway hub providing connections between Bucharest, Transylvania and Moldavia. The city has several railway stations for passenger and goods transportation.

Ploiesti is also an important national and regional motorway hub. The municipality lies at the confluence point of the North-South and East-West axes, respectively at the crossroads of Transylvania-Bucharest (Danube River or the Black Sea) and Moldavia-Oltenia (the sub-Carpathian connection).

The local transportation company RATP, which is municipality owned, provides connections to all areas within the city. The municipal vehicle fleet comprised 193 buses, 62 trams and 10 trolleybuses carrying about 70 million passengers annually.

2 LA ROCHELLE

2.1 IMPLEMENTATION OF BIOFUEL FILLING STATIONS

2.1.1 Context

At the European level, the Directive 2003/30/EC of 8 May 2003 allows the use of biofuels¹ or other renewable fuels for transport.

At the national level, until 2006, the French law considered as illegal the use of biofuels in the transport field, except for specific agricultural purposes. Since 1st January 2007 –at the mid-term of the SUCCESS project-, a new Law (n°2006-1771) introduced Pure Vegetable Oils in the list of the authorised fuels. The 2007-446 decree of 25th March 2007 indicates that local authorities may use biofuels by signing an agreement with the French government, but also paying the French tax on petroleum products (TIPP) and making a statement for the tax warehouse system (EFPE). This authorisation is valid only for non-passenger vehicles.

On the technical level, it is possible to have diesel engine-vehicles/ diesel combustion run on 100% Pure Plant Oil (PPO) through minor adaptation of the engine. At 30%, no adaptation is necessary with ordinary gasoil, whatever the vehicle.

In 1985, La Rochelle started promoting alternative fuels on its territory by installing a filling station providing Diester to the whole bus fleet.

2.1.2 City Objectives

Through CIVITAS-SUCCESS, the Urban Community of La Rochelle aimed at further improving the environmental performance of its vehicle fleet by introducing biofuels. La Rochelle has bet on biofuels and has taken the risk to comply with the European regulation requirements, despite existing legal barriers in France.

The objectives of the measure are:

- To facilitate and increase the use of alternative fuels in the Urban Community of La Rochelle by installing biofuel filling stations.

Providing that the French legislation becomes more flexible regarding the use of oils as a biofuel, the cooking oils recycled at the treatment plant of La Rochelle (*see Measure 5.5 – Cooking oil recycling pilot project*) will partially or totally replace PPO, according to the needs and quantity collected from the restaurant owners.

¹ meaning “liquid or gaseous fuel for transport produced from biomass”

2.1.3 Achievements

Main features

- Implementation in January 2007 of the 1st fuelling station in the Water Treatment Department at Port Neuf district. No chemical additive is mixed, contrary to Diester.
- Implementation of the second biodiesel pump in Périgny where the waste department of the Urban Community of La Rochelle is located. The works were initiated in November-December 2007 and completed in the 1st semester 2008 at the Waste Management Department. Both fuelling stations are equipped with an automatic blending system.
- Since 2007, Pure Plant Oil (PPO) at 30% is being blended with gasoil (70%), a limit which enables to avoid any adaptation on the vehicle/engine. The experimentation on vehicles started in February 2007. The obtained biofuel is being used by 8 vehicles of the Water Treatment Department, followed by 2 other vehicles from the Waste Management Department. The quantity of PPO used amounted in 2007 to 15,000L.

During 2007, follow-ups were made on several key factors: fuel consumption of the vehicles, quality of motor oil (which is quite representative of the vehicle good health) and off-gases.

2.1.4 Implementation and operation actions

1/ Regulation

From the enforcement of the new legislation in December 2006, numerous administrative and legal actions were undertaken to adapt this measure to the new legal framework. Notably, the Urban Community made a request to the Prefecture and the Regional Customs Office.

2/ Biofuel selection and purchase

In April 2006, the decision makers of the Urban Community decided to choose PPO rather than a methyloethylester. The choice was to favour a process with low energy consumption. Indeed, producing one Litre of PPO is 7 times less energy-consuming than producing one litre of diesel and the use of 30% PPO enables to reduce by 20% the emission of greenhouse gases.

Rapeseed was chosen in the biofuel process as it is a local and requires low water-consuming cultivation. Moreover, it provides plant cover of the soil the major part of the year, thus improving the assimilation of the nitrogen in the soil.

A call for tender for the purchasing of rapeseeds and their pressing into oil was launched during Autumn 2006. The Urban Community selected the company AgriOléa as a supplier due notably to their environmental-friendly methods. A new purchase contract was signed one year later. In between these two call for tenders, the oil price followed the strong increase of the seed price, causing a rise from 0,77 €/Litre in 2006 to 1,08 € in 2007 (all taxes included except the National TIPP).

3/ Partnership and monitoring of the vehicles

Continuous cooperation between several entities inside the local partnership (Mobility & Transport, Water Treatment, Environment and Waste management of the Urban Community; EIGSI) and beyond (ADEME, IFHVP) has helped to overcome some of the barriers.

Indeed, the Urban Community of La Rochelle benefited from the work with other regional and national entities such as the ADEME (French Environment and Energy Management Agency) to receive recommendations for the use of biofuel in vehicles.

In parallel, in October 2006, the Urban Community signed an agreement with the French Institute for Pure Plant Oil (Institute François des Hails Vegetables Purse, IFHVP) for one year. The IFHVP monitors the quality of PPO and supports the Urban Community in the implementation and the follow-up of the experiment on the vehicles.

Before using biofuel, a first analysis of the vehicles was carried out in order to measure its impact on the vehicles.

To contribute to the successful implementation of the measure, specific training - related to the specifications and the use of biofuel – was provided by the IFHVP to the concerned Urban Community staff.

4/ Protocol

In December 2006, the Urban Community of La Rochelle applied for the signature of the protocol related to the use of PPO with the Government to the Prefecture and the Regional Custom Direction.

February 2008, the local authority received from the Prefecture the protocol asked in December 2006. But it turned out that the protocol had to be signed after the local authority obtained a statement for the tax warehouse system (EFPE). The same applies for the producers of Pure Vegetable Oil. After the selected producer refused to start this procedure, the Urban Community had to look for a new producer to carry on the project.

Since February 2008, the statement procedure is ongoing at the Regional Customs and Excise office and in September 2008, the local authority selected a new producer authorised by the Customs Office.

Mean of the measurements	30/01/07		0,0	0,0	1,7	1,3						
		0,97	4	2	9	4	9,75	8,75	18,33	19,01	166	192
	05/06/07		0,0	0,0	1,7	1,2						
		0,69	3	2	0	8	13,38	12,25	18,25	18,90	153	165
	04/09/07		0,0	0,0	1,7	1,2						
		0,59	3	2	3	7	9,71	8,29	18,21	18,93	177	173
	04/12/07		0,0	0,0	1,8	1,4						
		0,90	4	4	8	3	7,13	5,88	18,48	19,13	145	156
Ecart (en %) entre le 30/01/07 et le 04/12/07		-6	25	88	5	7	-27	-33	1	1	-13	-19

A.* = measure at the « high idle speed» engine speed (1300-1500 tr/min)

R.* = measure at the idle engine speed (600-800 tr/min)

These results confirm that the emission of pollutants have decreased, especially the NOx. The carbon part is more important, because a plant is burnt..

- Breakdowns
 - ◆ Vehicle 1: 2 replacements of the filters, tank and injection line cleaning
 - ◆ Vehicle 2: 2 replacements of the filters, tank and injection line cleaning
 - ◆ Vehicle 5: replacements of the filters
 - ◆ Vehicle 7: replacements of the filters.

The lorries breakdowns are only related to a filter clogging due to the development of a bacterium in the tank. As the origin of the development of the bacterium could not be identified, the PPO and fuel tanks have been cured with a bactericide. The diesel is already cured by the supplier.

Eventually, a blender has been installed in the PPO tank. The mixing prevents the bacterial development.

Promotion activities

- Specific livery designed for the vehicles running on biofuels
- Poster displayed in the concerned Departments of the Urban Community
- Press articles and radio interviews



2.1.6 Conclusions

Some of the results from the experimentation can be assessed as positive in terms of greenhouse gas reduction, notably NOx. No major wear had to be noticed on the vehicles.

The main difficulty encountered during the project was linked to the uncertainty around the national legal frame and the necessity to overcome all legal barriers from the beginning of the project. Indeed, in France, very few local authorities have taken the risk to use biofuels, as the national legislation imposes really strict rules. Another difficulty was the location of the second biofuel fuelling station, which has caused a significant change of organisation for the staff using the concerned trucks. For that reason, only two vehicles from the fleet of the Waste Management Department eventually used the biofuel station.

French law allows the use of PPO but the numerous constraints and the high costs prove to be discouraging. Moreover, the success of biofuels participates to the increase of the prices of the food products. This is why this measure is considered in La Rochelle as temporary, until the used cooking oil plant provides biofuels.

2.2 COOKING OIL RECYCLING PILOT PROJECT

2.2.1 Context

Used cooking oils are mainly used in the food-industry sector, in restaurants, institutional and school catering etc. Unlike the great majority of waste produced by the restaurants, used cooking oils cannot be recycled together with household waste, but they must be stocked, collected and recycled according to a specific recycling process.

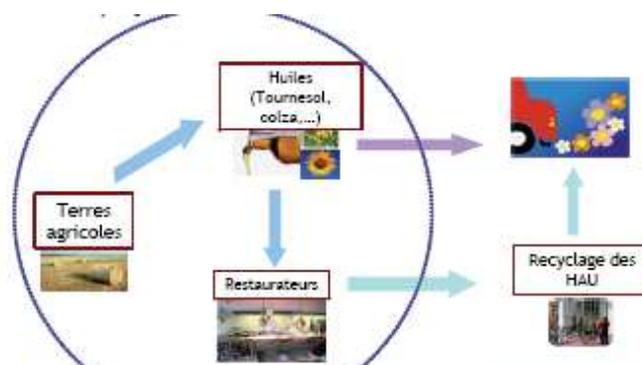
A national decree published in 1978 forbids the rejection of oils with household waste or in the wastewater network. Other decrees mention that the collection of oil must be carried out by a specialised company- a service which became paying after a pollution on dioxin was discovered in the animal feeding sector. The average cost for this service amounts to approx. 0,30€/litre, whereas most of these companies take the cooking oils abroad notably for recycling into biofuel. And finally, storage of oils can be subject to a previous authorisation (Classified Installation for Environment Protection).

Currently in the La Rochelle urban area, only half of the cooking oils is collected by specialised companies, which makes up for 100 000 litres out of a global pool of 175 000 litres. Owing to a high - and discouraging - collection cost, the other half is rejected with household refuse in the wastewater network or in waste reception centres.

2.2.2 City Objectives

- To design and implement a used cooking oil treatment plant using raw material collected from restaurant owners in La Rochelle and surroundings. All types of oil – such as palm oil - cannot be treated and will not be collected. Globally, the Urban Community aimed at collecting 50 000 to 100 000 litres a year.
- Once recycled, the oil will supply some of the vehicles of the Urban Community of La Rochelle.

This experimentation enables to offer a solution to the restaurant owners who haven't signed yet an agreement with a specialised company, while at the same time recycling locally a waste into a 2nd generation biofuel.



2.2.3 Achievements

- Opening and exploitation of the used cooking oil plant since April 2008
- 25 agreements signed between the Urban Community of La Rochelle and restaurant owners for the recycling of their used oils. They can bring for free their oil to 3 sites, among which the cooking oil plant. 10 or 20 litres drums are provided by the Urban Community. Those who don't adhere to this service still have to comply with the legislation and must call upon the services of a specialised company.

At the end of the experiment, storage of oils amounted to about 1000 litres. The plant will be profitable from 50 000 litres recycled per year.

- Negotiations are still ongoing with the French Government to use the recycled oil as biofuel.

2.2.4 Implementation and operation actions

The measure consisted in two main actions:

- The first one concerned the engineering process (studies on the implementation of the plant and on the recycling process, choice of the operator/plant builder, construction and operational launch).
- The second action was dealing with the study of a potential collection itinerary for the used cooking oils (study on the prospective quantity of used cooking oils; choice of the operator; collaboration with the restaurant owners to optimize a collection route; launch of the collection process).

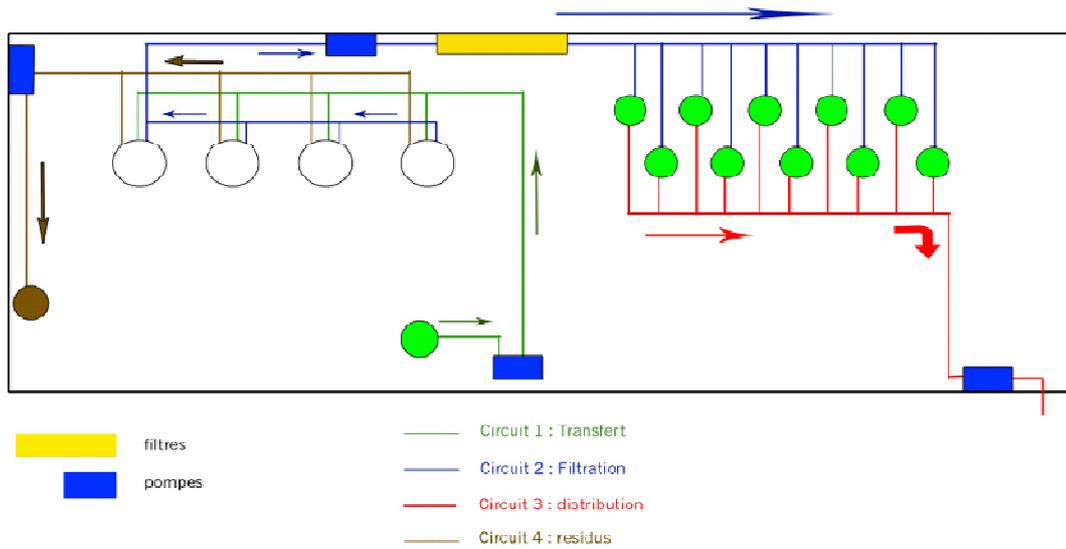
In parallel, meetings and promotional activities took place among the restaurant owners to encourage them to resort to this new service.

1/ Selection of the recycling method

A call for tender was first launched to make an inventory of the existing recycling methods. Priority has been given to the methods avoiding the addition of fossil or potentially dangerous products such as alcohol, in order to save energy during the oil transformation process.

The Urban Community eventually contracted out the company 'Roule Ma Frite' to implement the recycling process. It was agreed to set the recycling plant in La Rochelle at "Port Neuf district".

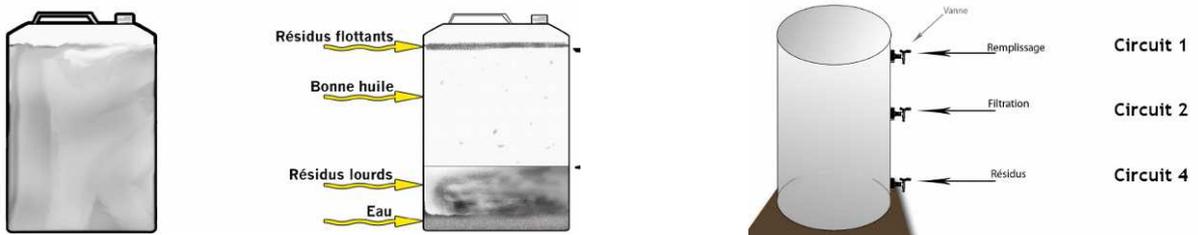
Description of the Recycling process



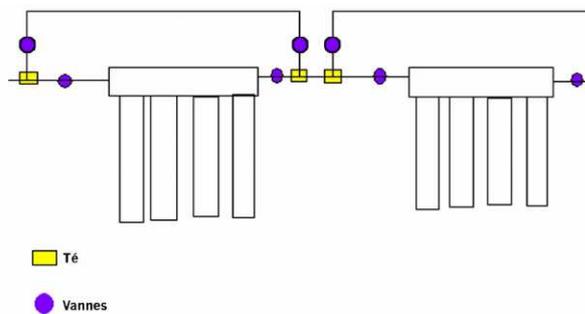
Two phases:

1) (Delivery and) **Decantation**:

- First decantation inside the oil drum: a decantation phase of at least 15 days is required to obtain a good-quality raw material
- transfer of the recyclable part and additional decantation in a decantation tank (another 15 days at least)



2) **Filtration** : once the decantation is completed, the oil is filtered and stored in another tank



3) Distribution of oil and evacuation of waste



2/ Classified Installation for Environment Protection

The activity of waste transfer and recycling is subject to a prior authorisation. The Urban Community had to make a request for registering the site as a Classified Installation for Environment Protection. A temporary request was made by the Prefecture in September 2007. Authorization was granted for a 6-month period, with a possible extension of 6 months.

Additional enquiries were made by the French Government on how to make use of used cooking oils as a biofuel, under its agreement. After studying the case of La Rochelle, the CODERST (*Conseil Départemental de l'Environnement, des Risques Sanitaires et Technologiques*), granted in February 2008 the authorisation for exploiting cooking oils. The plant eventually began its activity in April 2008.

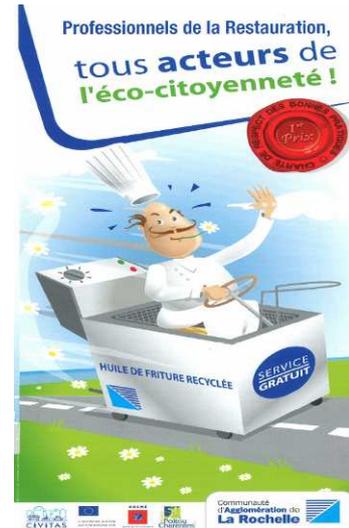
3/ Partnership

The setting up of the collection of cooking oils was designed together with professionals from the food industry sector represented by the Chamber of Trade and the Association for the professionals in hotel business and catering (*Union des Métiers de l'Industrie Hôtelière et de la Restauration, UMIH*).

A survey was carried out among the restaurant owners of the Urban Community territory to establish a qualitative and quantitative overview of the cooking oil pool. From these results, the decision was made not to organise a specific collection route but rather to provide restaurants with a free collection service (at specific locations) on a voluntary basis.

4/ Communication

- The efforts made by the participating restaurant owners are being valued through a specific label and press articles.
- In March 2008, the Urban Community also invited them to participate in an information meeting and to become part of the experiment.



5/ Dispensation request

A custom statement published in August 2007 forbids the use of cooking oil as a fuel as they are « cooked and therefore not similar to Pure Vegetable Oils ». This text does not mention the recycling methods that could be used.

In October 2007, the Regional Customs Office informed the Urban Community that they did not approve the use of cooking oils as biofuel. On behalf of the local authority, a lawyer sent back an answer but this mail has remained unanswered. A new letter was sent in February 2008 to the Prefecture and the *DRIRE* to call for a meeting and ask for advice. Following their recommendations, a dispensation request was made to the Customs Office. Currently, this request is still waiting for an answer by the French Minister for Environment, Energy, Land Planning and Sustainable Development, but also by the French Minister for Budget (due to the question of tax).

2.2.5 CONCLUSION

As long as the French legislation does not allow a more flexible use of biofuels and notably cooking oils, it will not be possible to use the recycled oil as a biofuel for the public vehicle fleet.

Therefore, La Rochelle has made a request to the French Government for a dispensation to conduct a trial in order to demonstrate that the process and the initiative provides a very good alternative to the use of fossil energy, while freeing at the same time the restaurant owners from their waste through local recycling.

2.3 IMPLEMENTATION OF 2 HYBRID BUSES

2.3.1 Context

Increasing global pressures on oil reserves and the issue of air quality are a reality. Regional, national and local government organisations across the world are facing growing public demands for action. Moreover, for the time being, new technologies, or new ways for integrating new technologies, lead to innovative concepts for the hybridisation of power trains with quite good performances concerning pollution and consumption. Buses – as heavy vehicles using fossil energy - are notably concerned.

For the coming years, hybrid vehicles seem to be one of the most likely alternative solutions for reducing the impact of the transport on the environment. Indeed, all stakeholders involved in the transportation field (political, technical, car constructor...) consider that such a technology has to be seen as a serious substitute of the current combustion engines. This technology turns out to be really interesting for public transport vehicles: indeed, the buses exploitation is characterised by a variable demand of energy, which does not allow an optimum performance of the motor. Combining thermal and electric motors presents two interests:

- To use the high performance of an electric motor (less dependent on the conditions of use). It implies that the weight of the electric motor and the batteries should be limited.
- To use the thermal motor with an optimum performance.

2.3.2 City Objectives

The objective of this measure is to introduce several hybrid vehicles into the public transport network.

2.3.3 Achievements

- Two 22 seats hybrid minibuses have been running between the Park-and-Ride “Vieux-Port” and the city centre (Old Port of La Rochelle) since December 2006/January 2007.
- A specific livery was designed for the hybrid buses. The same graphical chart has been extended to other clean collective vehicles operating on La Rochelle network, namely electric buses.

2.3.4 Implementation and operation actions

At the beginning of the project, it had been foreseen to buy hybrid buses. Nevertheless, after months of investigations, a conclusion had to be drawn: no vehicle was available in the market. The decision has then been taken to rent hybrid vehicles and to build a partnership between the Urban Community, the operator and a manufacturer to test the hybrid vehicles.

1. Partnership

- *Investigation on the vehicles available on the market*

An extensive market study on the hybrid technology has been conducted by the Urban Community of La Rochelle and the engineering school EIGSI. Based on these results, specifications have been elaborated for the purchase of hybrid vehicles. In-depth investigations have been carried on to assess the availability of hybrid vehicles. Bus manufacturers at both European and international level have been contacted as well as public transport users and research institutes.

The conclusion at that moment was that only few manufacturers were able to produce hybrid vehicles, and only one had the possibility to commercialise them. A call for tender has been launched but no tender were received.

La Rochelle Urban Community has then established contact with this manufacturer (Gruau, based in Laval, France) in order to purchase hybrid vehicles. However the transaction has been made impossible because the hybrid midi bus commercialised had encountered serious technical problems. Indeed, Gruau had commercialized approximately 10 hybrid minibuses in France, but after a promising start, the hybrid version went through significant technical difficulties. All the cities which acquired hybrid midi buses had left them to come back to 100% diesel vehicles, mainly for reliability issues. Time was required by the manufacturer to identify the problems and improve the reliability of the hybrid version of the midi bus. Significant tests (notably in terms of duration) were needed by Gruau before considering a new marketing operation.

Given this situation, the Urban Community decided to rent the vehicles instead of buying them.

- *Partnership*

The basic idea was to build a “win-win” partnership with Gruau which has been interested in testing the adapted vehicles and get useful results for their promotion. The rental contract has been passed for two years, with the engagement on strict conditions of running.

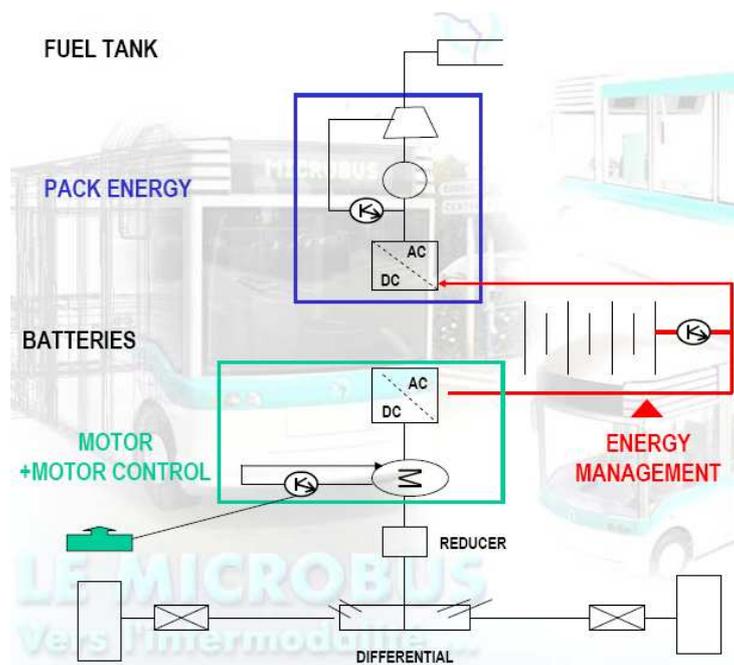
2. Description of the hybrid vehicles



The hybrid microbuses combine a thermal and an electric motorization. The thermal motor is a Euro 3, 3 cylinders.

- How does it work?

The hybrid vehicles have a permanent electric assist. It is possible to run in 100% electric but it has been decided to run only in diesel assisted by the Pack Energy. This Pack is used when a high energy demand is made by the driver (high acceleration next to a stop, high slope, etc...), and its function is to help this energy demand by limiting the use of the diesel motor.



Presentation of the different modes:

- Electric mode

The energy comes from the batteries. To preserve the autonomy, the speed is limited to 60km/h, with a 25 km autonomy.

- Hybrid mode

The flux of energy is different according to the condition of use. In case of strong solicitation, the tractive energy comes from the batteries and the thermal motor via the generator. At the starting up,

the batteries are solicited. When the speed is constant on a flat road, the energy provided by the thermal motor are distributed between the batteries (which are recharged) and the wheels.

- Pack Energy mode

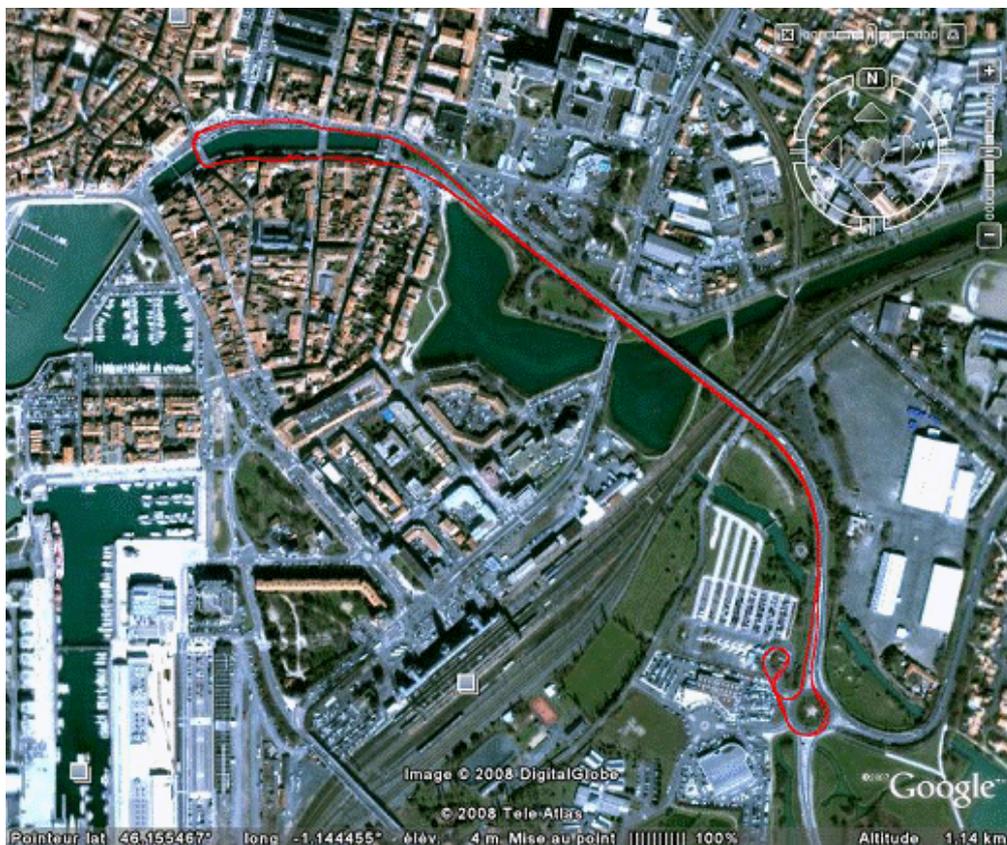
During the braking phase, part of the mechanical energy produced by the wheels is recovered. This energy, with the energy produced by the thermal motor, recharges the batteries.

- Plug in mode

During the night, the batteries are connected to be recharged.

3. Route of the hybrid microbuses

A common decision between the Urban Community, the operator of the Hybrid buses (Océcars) and Gruau has been taken to operate both vehicles between the Park-and-Ride and the city centre of La Rochelle (2,8 km).



In order to be as efficient as possible, the hybrid vehicles have been running at P+R peak hours, in order to have the maximum of people using them every day and used to travel with the electric shuttles.

4. Experimentation

Within CIVITAS SUCCESS, the vehicles have been tested on a 2-year period in real exploitation conditions (traffic, climatic conditions, passengers, reliability). This experimentation allows assessing the impact of the hybrid technology on polluting emissions and energy consumption.

- *Experimentation during the exploitation*

The experimentation has been carried out in hybrid mode. The following data have been collected:

- Note down of the milometer in the morning, before departure
- Note down of the electric milometer in the morning before departure (if connected to the mains)
- Note down of the milometer during the tank fill
- Note down of the litres of gasoline added during the tank fill
- Note down of the milometer every night at the end of the service

This data is used to calculate:

- The monthly average consumption of electricity
- The monthly average consumption of gasoline
- The number of kilometres per month

- *Reliability of the system*

After a few weeks, problems appeared, first on some equipment of the vehicles, and then on the motors (thermal and electric): - a huge portion of electrical traction and thermal motor malfunctions, as well as braking, rolling and bearing problems. Our assumptions are that these phenomena might deal with the weight of the storage batteries aboard the buses. Motorisation problems proved to be far more complicated for the operator company to manage. Interventions from the constructor has been recurrently necessary, running has been stabilised, after more than one year of difficulties.

The following table shows the cumulative hours of maintenance broken out by main category and vehicle type:

	<i>ELECTRIC</i>	<i>HYBRID</i>	<i>DELTA</i>
Mandatory roadworthiness test	35	6	-29
Miscellaneous	2	6	4
Miscellaneous: battery	2	0	-2
Miscellaneous: bodywork	2	12	10
Miscellaneous: electricity/lighting	4	6	2
Electrical: battery	8	23	14
Electrical: traction	52	51	-2
Mechanical: steering	0	13	12

Mechanical: misc.		1	15	14
Mechanical: breaking		31	25	-6
Mechanical: rolling/bearing		18	10	-8
Tyres		1	3	2
Thermal		0	45	45
Thermal: electrical		1	1	0
Programmed maintenance		0	10	10
Total		157	224	68

The conclusions made about these problems were focused on the type of motorisation, certainly non-adapted for the dimension and the weight of the vehicle. In any case, this kind of hybrid technology has not been reconsidered.

- *Horiba 200 test*

A Horiba 200 test had been conducted during two weeks in September 2008, on the usual route.



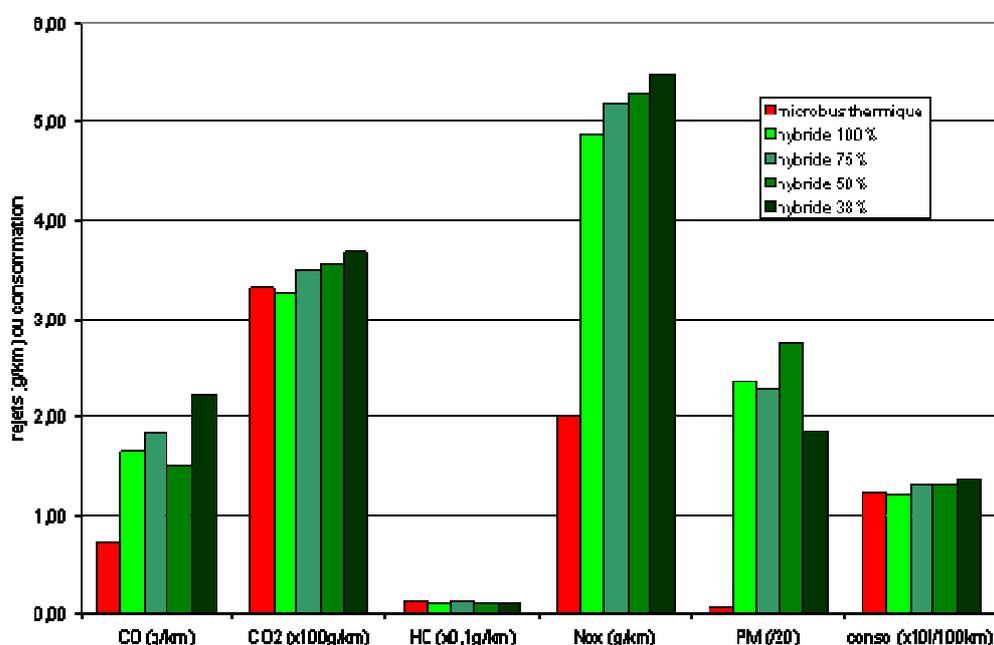
*System of measure of the particles
in the hybrid vehicle.*

The Gruau hybrid microbus has been compared with a thermal microbus (a brand EURO IV vehicle equipped with Particle Filter has been provided by Gruau – which was not requested by the local authority and skewed significantly the results of the test):

- Gruau series hybrid microbus, diesel motor 40 CV norm Euro III and electric with different levels of charge of the batteries, PTAC 3T600
- Gruau microbus, motor diesel 130CV with particle filter Euro IV PTAC 3T100

The results of the test are presented in the graphic below. It has to be noticed that the results cannot be fully exploited as the two vehicles have a different motorisation.

Comparaison des rejets entre le microbus hybride et le microbus thermique



5. Promotion

A specific livery has been designed for the hybrid buses. A lot of articles have been published in the local and regional media.



6. Perception by the users

The first weeks of running have been well received by the population, mainly because the comfort and the quality of the shuttle service had been improved by using the hybrid buses. Users more noticed that the speed of the vehicles was more efficient compared to electric vehicles – actually circulating on the route between 19 km/h (when climbing a slight slope on Jean-Moulin bridge) and 35 km/h. Thanks to the implementation of hybrid vehicles, the “cruising speed” of the shuttle service between the Old Port and the Park-and-Ride was much improved (between 30km/h and 50km/h).

The improvement of the speed - and of the comfort of the hybrid vehicles in general - much explains the satisfaction of the vehicles among the users².

2.3.5 Conclusions

Rolling out hybrid minibuses in a real-world situation over a long period generated a considerable body of information and it was possible to make useful comparisons by using hybrids alongside electric buses. Nevertheless, the lack of available commercial offerings when the CIVITAS-SUCCESS project was initiated, limited observations of the prototypes actually tested and these observations should not be applied to the technology in general nor to its future development.

In spite of highly satisfactory societal indicators concerning the acceptance of hybrid buses and the perception of the service, based on an analysis of the experiment conducted in La Rochelle, the hybrid

² The public transport survey of November 2008 highlights the following :

Of the 87 people who said that they had used the hybrid shuttle bus, 61% stated that they were very satisfied and 34% “quite satisfied” with the service.

Of these 87 people, 40 were “Park-and-Riders” and the satisfaction rating among this user category rises to 98% (60% very satisfied and 38% quite satisfied). Shuttle bus users have a very favourable overall impression of the quality of the service. It should be noted that “Park-and-Riders”, who are in principle the most frequent shuttle service users as the Park-and-Ride station is both the arrival and drop-off point, have an even more favourable opinion than other users.

minibuses do not appear to have achieved the expected results in terms of protection of the environment, energy efficiency or economic efficiency.

The hybrid minibuses suffered from the teething problems of a nascent technology and apparently remained at the prototype stage in the experiment carried out. This may appear surprising at a time when major constructors are harnessing this technology to develop both individual cars and buses.

The experience has taught La Rochelle Urban Community and its partners that it is probably not enough to juggle with a thermal engine tailored to an automobile, and an electric engine in the same chassis. Hybrid technology has a future provided that it has an integrated design from the outset. The principle is to have thermal traction under steady-state operating conditions making it possible to optimise power and the reduction of pollutant emission levels.

This is by no means the same thing as harnessing a thermal engine directly to a transmission system, which needs to be able to generate a high rate of torque over a wide operating speed range. With the new technology, torque and traction power will be based exclusively on electrical motorisation.

3 PLOIESTI

3.1 CONVERSION OF BUSES TO LPG

3.1.1 Context

“Clean and Energy Efficient Vehicles” are a central part of the CIVITAS and SUCCESS demonstrations. The objectives of the clean vehicle demonstrations in SUCCESS are to:

- Reduce emissions of, and human exposure to, air and noise pollution.
- Ensure to the transport systems’ users good health and well-being.
- Ensure that transport system contributes towards a successful economy by creating access to jobs and creating an attractive environment.

In Romania, one car from 100 uses LPG instead of gasoline the cost of the trip being significantly reduced. The LPG equipment is 300 euros, and there is an important saving in the cost of the fuel (300 euros/10,000 km). Thus, the investment is profitable. It is worthy noticing that LPG is an alternative for those who use cars frequently. That is why most of the taxi companies converted their cars to LPG use. In 2004, 100.000 tones of LPG were used in Romania; the quantity is continually increasing (10-15%/year).

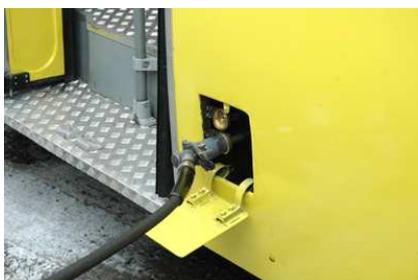
Even if the LPG market is more and more increased in Romania, there is no diesel vehicles converted to LPG yet. Therefore, conversion of RATPP diesel buses to LPG use is a premiere in Romania.

3.1.2 City Objectives

The main objective of this measure was to develop the use of clean vehicles in all possible situations within the urban context and to evaluate the advantages as well as determining what could be the best ways for this development in medium sized cities.

3.1.3 Achievements

25 LPG buses will be set up in Ploiesti during the project..



There is an important concern regarding the old polluting buses built during the command economy. In this respect, RATP Ploiesti started to convert diesel buses to LPG.

The old, polluting buses still represent an important part of RATPP fleet. Besides buying the new buses, we tried to improve our activity converting the buses to LPG. The action started in 2002; five buses were converted and they have been working ever since. The buses were well-received by the citizens in Ploiesti and that is why we decided to continue this activity.

More, RATPP signed a partnership with the main LPG distribution company in order to have the fuelling station inside the public transport company. Thus, there is a LPG fuelling station placed nearby having two LPG tanks: one for cars and the other for buses. Not only RATPP buses but also private cars can be fuelled at the filling station. The LPG fuelling station is operated by five RATPP

employees and works 24 hours/day, 7 days/week. The infrastructure (fuelling pumps, skids etc.) belongs to our partner (Shell Gas Romania). There are some important advantages for RATPP, namely: our LPG buses can be fuelled very quickly (the LPG fuelling station being placed next to the tram depot, i.e. 200 m away from the bus depot); the buses can be fuelled anytime as the filling station works non-stop; the last, but not the least important, RATPP pays 1,40 RON per litre instead of 1,65 RON (the LPG price on the market). The difference is used for paying the employees and to maintain the filling station in proper conditions. Taking into account the above mentioned aspects, RATPP decided that the best option was to continue the activity to convert diesel buses to LPG use.

3.1.4 Implementation and operation actions

Prerequisites for success

LPG vehicles can be designed as such by original equipment manufacturers, or converted from other fuel systems. A typical aftermarket conversion includes installing a new fuel tank, fuel pressure regulator, electric or vacuum-operated switches, and electronics.

Many manufacturers offer LPG as an option-installed at the factory or converted at the time of purchase. In Europe, Volvo offers fully factory-assembled bi-fuel cars with equipment specifically designed and tested for Volvo. Vauxhall Motors in the United Kingdom offers three models with a bi-fuel option. In the United States, a Ford bi-fuel pickup truck is available. Mitsubishi offers LPG passenger cars in Japan, where they are used primarily as taxis (95% of taxis in Japan use LPG).

More common than dedicated LPG vehicles are bi-fuel vehicles, storing gasoline and LPG in two separate tanks. Fuel is pressurized to about 300 pounds per square inch in the tank-about twice the pressure as in an inflated truck tire. LPG's lower pressurization requirement is sometimes cited as an advantage over other alternative fuel designs.

Filling an LPG vehicle is similar to filling a gasoline vehicle, except that a tighter connection is made between the hose and vehicle tank to prevent the pressurized fuel from escaping. In most countries where LPG is a vehicle fuel, it is sold alongside gasoline and diesel at traditional fuelling stations. LPG is also available at dedicated LPG fuelling stations.

According to the WLPGA, successful automotive LPG market depends on achieving critical mass in the LPG market. Critical mass is defined in several ways. The number of vehicles must be large enough to show fuel providers that LPG is a viable business. The fuel must be widely available and convenient to consumers. The market must be large enough to ensure an adequate supply of equipment and mechanics trained to convert and maintain LPG vehicles. And the market must be sustainable so that OEMs are willing to develop LPG vehicles.

In many countries with large automotive LPG markets, government policies have been key to creating a market. France, for example, is one of Europe's fastest growing LPG markets. That country allows LPG vehicles to operate during periods of high air pollution when driving restrictions are imposed on other vehicles. South Korea is the world's largest automotive LPG consumer. According to the Korea Gas Safety Corporation, more than 10 percent of all registered vehicles in Korea are LPG-fuelled. LPG's recent rapid market growth in South Korea resulted from a large excise tax advantage over gasoline and diesel (which the government recently decided to reduce).

Organisation of the measure

We established the team that will work on this measure. Then, we established the tasks and the risks of the measure.

The tasks of the measure are:

- Global study regarding the best solution for using alternative fuels in the public transport bus fleet. Contacts with Romanian suppliers.
- Buying new equipment for conversion.
- Introduction into exploitation.
- Evaluation of the new clean vehicles into exploitation.

The risks of the measure are:

- Lack of money. Insufficient funds on behalf of RATPP.
- Delays on behalf of the suppliers.

Technical issues

Taking into account the technical conditions of the buses that will be converted to LPG we decided to start their overhauling with our own funds. It would have been a mistake if we had converted the buses to LPG without any modifications. The team that works on this measure decided to convert IKARUS buses to LPG because they are the oldest and the most polluting in the fleet. An old IKARUS bus has been working in Ploiesti for about 10 years, but it was made in 1987. That's why we decided to re-construct them. The re-construction meant to dismount the bus completely and then to replace all the body, the seats, stairs, doors and windows. Seven workers have worked for 2 months at the first bus which was overhauled. The overhauling lasted so much because we didn't know for sure how many raw materials or spare parts were necessary and we had to buy them gradually. Because of this the works were delayed several times. Then, the works continued with a higher productivity only one month being necessary for each bus. For overhauling, the total amount of money used for materials is 5000 euro for each bus and the manpower represents about 4000 Euro. Therefore, we can say that the entire activity represents an important financial effort on behalf of RATP, respectively 9000 euro for each bus.

Before



After



Technical presentation of the LPG equipment

SC InterGas Romania SRL Bucharest was the company in charge with the conversion of RATPP diesel buses in LPG. The technical data were offered by the supplier. The fuelling system for LPG buses consists of:

- electro-valves InterGas fuelled by pressurized LPG from the gas cylinders, having the role to pass the gas between the gas cylinders and the reduction gear.
- pressure reduction gear InterGas which decreases the pressure of the LPG making possible its distribution to the engine
- step-by-step engine placed between the reduction gear and mixer having the role to measure the LPG supplied to the engine
- mixer which measure the air quantity intended for the engine and mix it with the LPG delivered by the reduction gear
- controlling computing station which receives signals from the engine, process them through a microprocessor and then sends the commands to the step-by-step engine
- lambda drill which is placed at the engine outlet, sends a signal to the controlling computing station depending on the composition of the exhausted air
- electric wire which is already designed specifically for the vehicle that will be converted.

This advanced supplying system has many advantages in comparison with standard supplying systems as follows: InterGas electro-valves are built so that they can take the pressured LPG from the tank and, in the same time, to protect the reduction gear against the pressure from the tank and thus the reduction gear is protected after the engine has been stopped. In fact, the controlling computing

station receives a signal from the sensor placed on the engine, when the engine is running, and if there is no signal it can close the electro-valves.

Legal issues

Our legal counsellors tried to find the best solution in order to have the contract signed in the due time and form according to Romanian legislation. The single Romanian supplier for equipment to convert diesel buses to LPG is INTERGAS ROMANIA. We asked for confirmation from Romanian Register for Road Vehicles, our national authority in the area and we received it in August 2005. Then, we started to negotiate the contract. After several meetings between our representatives and the representatives of INTERGAS, the contract was signed at the end of December 2005. Then we started to install the LPG equipment on the first bus that had been overhauled. According to Romanian legislation we had to homologate the buses at the Romanian Register for Road Vehicles before starting to use them.

Stages, problems/delays



According to the contract concluded between RATP Ploiesti and INTERGAS ROMANIA there were 3 (three) main delivery periods of the LPG equipment as follows:

- 6 units until 1st of March 2006;
- 9 units until 31st of July 2006;
- 10 units until the end of 2006.

The first thing to be done was to transform the diesel engine RABA-MAN D 2156 HM6U into a version that would permit LPG use. Several actions were needed:

- to eliminate the diesel fuelling system (injection pump, filters, injectors, pistons)
- to modify the head of the cylinders so that to replace the induction plugs
- to remake the plug thread adapting it to the type of the plug
- to change the shape of the combustion chamber (the chamber being left into the piston); the piston has a chamber type HERON and the compression ratio was reduced to 9,33:1.

A carburettor for LPG was installed in the admission chamber by InterGas in Scandiano Reggio Emilia – Italy. These carburettors were designed for low pressures with a good homogeneity of the mixture and a constant lambda of about 1.05.

Two pressure reduction gears, having two reduction stages with separated minimal fuel supply, were installed. The engine number one is designed for LPG. Its purpose is to shut the LPG electro-valve when the vehicle engine is stopped. The other's purpose is to keep the maximum number of revolutions, i.e. 2300 rev/min. When the ignition key is on, the power is on, and then the electro-valves are fuelled from the reduction gear. If the engine number one is not running, the electronic control cuts the power after ten seconds. This is a safety device used in case of emergencies.

We decided to convert to LPG not only short buses, but also articulated ones. The representatives of the supplier worked together with RATPP staff in order to install LPG equipments on the diesel buses.



After the homologation, the LPG buses went on routes immediately. We chose routes that cross the centre of the city in order to have less pollution and a higher impact upon the citizens.

Problems / delays:

The contract was fulfilled according to the schedule, but there was a little delay in the beginning because the modification of the diesel engine was made in Italy. This meant a longer period of inactivity but it was recovered in the next months. No other significant delay within the contract.

Promotion campaigns

Another important activity concerning the implementation of the measure is represented by the awareness campaign. People must know what the benefits of the LPG use are, the stages of the implementation as well as the cost of the conversion. That is why we started to inform the citizens using advertisements in the local media, articles and interviews in the newspapers, radio and TV. On the other hand the buses themselves have advertisements that inform the passengers about the conversion to LPG as part of the CIVITAS – SUCCESS project.



The conversion of diesel buses to LPG was also presented to the representatives of several European cities, Poznan and Katowice (Poland), Miskolc and Szeged (Hungary), Nicosia (Cyprus), Daugavpils (Latvia), Stara Zagora and Plovdiv (Bulgaria), Iași (Romania) and Strasbourg (France) during the URBACT study visit in Ploiesti that took place in February 2006.

3.1.5 Conclusions

The conversion of buses to LPG in Ploiesti can be considered as a successful measure of the CIVITAS – SUCCESS project.

There are still many problems to be solved in the next months. Firstly, we need to find solutions to decrease the LPG consumption which is 1.8 higher than diesel. Tests are being done by Romanian specialists. When we decided to convert diesel buses to LPG, the cost of diesel was double than LPG and the economic perspectives were very promising. Now, the cost of LPG is only 60% lower and the economic benefit is lower, too.

On the other hand, Romanian legislation does not recognize LPG as being at least Euro III. That is why RATPP buses are still considered polluting ones, i.e. non-euro, and consequently the taxes are higher. We are going to make lobby at the Romanian Government in order to obtain a modification regarding LPG use. The Romanian Register for Road Transport has been already notified.

Our experience in converting the buses to LPG will be shared with other Romanian cities that expressed this intention. For instance, the City Hall in Suceava (the Romanian city which is partner in CIVITAS – SMILE) asked for details about LPG conversion in order to implement it in the public transport fleet.

4 GENERAL CONCLUSIONS ON THE WP.

4.1.1 Conclusions and lessons learnt

The main barrier to the use of the biofuels in France is not technical but legal. Indeed, the use of PPO is authorised only for local authorities and can't be used for vehicles carrying passengers. Moreover, French law is not adapted to 2nd generation biofuels: the used cooking oils are a legal vacuum.

The environmental balance of the use of PPO is positive: reduction of the greenhouse gases and NOx emissions and of the energy consumption during the fuel production process. No problems have been detected on the vehicles. Nevertheless, given the current debate on first generation biofuels and their impact on the food production, La Rochelle wants to focus on the production of used cooking oils when the legal context allows it.

4.1.2 Future developments

As the main barrier is legal, further developments and experimentations are linked with an evolution of the French legislation. Then, communication campaign toward the professionals of food services can be extended and the production incremented. New vehicles will use 2nd generation biofuels and further developments of the partnership could be considered.

5 REFERENCES

STARBUS - promoting sustainable energetic pathways for buses' fleets - www.starbus-project.eu

SUGRE – Sustainable Green Fleets - www.sugre.info

COMPRO Project –Common procurement of collective and public service transport clean vehicles
www.compro-eu.org



Project Coordinator

Jean Marie GRELLIER, Directeur du service Transport et Mobilité,

e-mail: Jean-marie.grellier@agglo-larochelle.fr

La Rochelle Site Manager

Matthieu GRAINDORGE, responsable projets européens, service Transport et Mobilité

e-mail: matthieu.graindorge@agglo-larochelle.fr

Preston Coordinator

Stuart WRIGLEY, Director Strategic Planning & Transport,

e-mail: Stuart.Wrigley@env.lancscc.gov.uk

Preston Site Manager

Christopher Hadfield,

e-mail : Christopher.Hadfield@lancashire.gov.uk

Ploiesti Coordinator

Cozia-Roxana GEORGESCU, Head of European Integration Department,

e-mail: pci@ploiesti.ro

Ploiesti Site Manager

Milena PERPELA, European Integration Department,

e-mail: al21@ploiesti.ro

Project Advisor

David BLACKLEDGE, Corporate Director

e-mail: david.blackledge@ttr-ltd.com

Project manager

Marie LAUNAY, Directrice TTR France,

e-mail: marie.launay@ttr-ltd.com

Technical Coordinator

Dominique BREUIL, Directeur de la Recherche,

e-mail: dominique.breuil@eigsi.fr



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