



H2POWER

**H2POWER – LIFE ENV 09 IT 000216
Political Guidance - final version
English language summary**

Action 1

European Commission has been pushing for years towards safe, clean and reliable energy sources, with no or little emissions; the 2008 “20-20-20 strategy” established ambitious targets capable of ensuring local development for new initiatives searching for new technologies for fighting climate change.

In particular road transport is still strongly chained to petrol and is asking for research on alternative fuels, possibly coming from renewable sources. In this project a mix of methane and hydrogen has been experimented as fuel, relying on the clean and efficient combustion, compared with gasoline, diesel, pure methane or LPG.

EC has been interested in hydrogen experimentation for long, as proofed by the “Fuel Cells and Hydrogen Joint Undertaking” (2007) and the more than 200 financed projects on the field.

Energy policy of the Municipality of Perugia for urban mobility.

Methane has been the main recipe of municipal strategy for emission reduction in Perugia since 2002. In this year PT fleet has started to be converted to be CNG fueled, progressively substituting more than 60% of diesel buses.

After financial crisis a pure substitution program was no more affordable, and, thanks to the Civitas Plus program (Renaissance project), a new conversion kit for Euro 2 diesel buses to a “dual fuel” (diesel and methane) bus has been developed, tested and implemented in over 20 buses. Retrofitting instead of substituting grants a 1 to 10 cost reduction, with an environmental efficiency almost equal.

After retrofitting, the 95% of urban fleet is composed by clean buses, either pure CNG or dual fuel, with a longer life expectancy, a reduction of running costs and better functionalities.

Actually PT fleet is composed by:

- 76 CNG buses
- 20 dual fuel diesel methane
- 26 diesel buses, used only as replacements.

After a “Dual fuel” conversion:

- Particulate emissions are reduced from 40% to 80%;
- CO₂ emissions are reduced up to 14%;
- CO emissions are reduced up to 90%;
- Noise is reduced by 40%;
- Fuel costs diminished by 31%.

Life Plus initiative, through the H2Power project can significantly improve further the fleet: hydrogen and methane mix can lower pollutant emissions of CNG engines.

Project description

H2Power has been developed by a public-private partnership composed by:
Municipality of Perugia, a city with a long pioneer role in alternative mobility;
Egenera, private company with expertise in innovative technologies for energy and environment;
Umbria Mobilità, the PT company in Perugia and in the whole region of Umbria;
TAMAT, an ONG active on the environmental sustainability
I&TC, private company with a tradition in sustainable communication.

H2Power has a total cost of about 1,4 M€, and a fund from EC of €. 634.000 and is focused in experimenting a fuel composed by a mix of methane and hydrogen coming from renewable sources. Hydrogen combustion is with zero emission and its availability as fuel is illimitate. The project aims to experiment the innovative fuel in a dedicated minibus, previously methane fuelled.

Vehicle and fuel are the demonstrator with which project wants to proof advantages and potential, that can replicated in other cities, with similar orographic characteristics (Perugia is a classical top-of-the-hill city with steep road network).

General targets of H2Power were:

- To enhance the environmental performance of the urban mobility system lowering CO2 emissions;
- To create the know-how to build a green PT fleet;

- To raise the awareness of the stakeholders (politicians, PT companies, citizens) to enlarge the impact of project activities and collect potential effects to ease transferability in other European cities;
- To attract the interest of experts in the field to grant the full exploitation of project results.

Specific targets were:

- To demonstrate the use of a mix of methane and hydrogen as fuel in small PT vehicles;
- To set up a vehicle with a kit for the use with a mix of hydrogen and methane;

Main activities were:

- To identify the highest percentage of hydrogen in the mixed fuel;
- To analyze the electronic optimisation of combustion by operating on the Engine Control Unit
- To adapt technically and structurally the vehicle for the use with the new fuel;
- To monitor electrical systems, propulsion and exhaust with a dedicated equipment, controlled by an ad-hoc designed microchip;
- To compare cost, efficiency and refuel time of hydrogen;

Main results

Experiments taken inside Industrial Engineering Department of Perugia University showed:

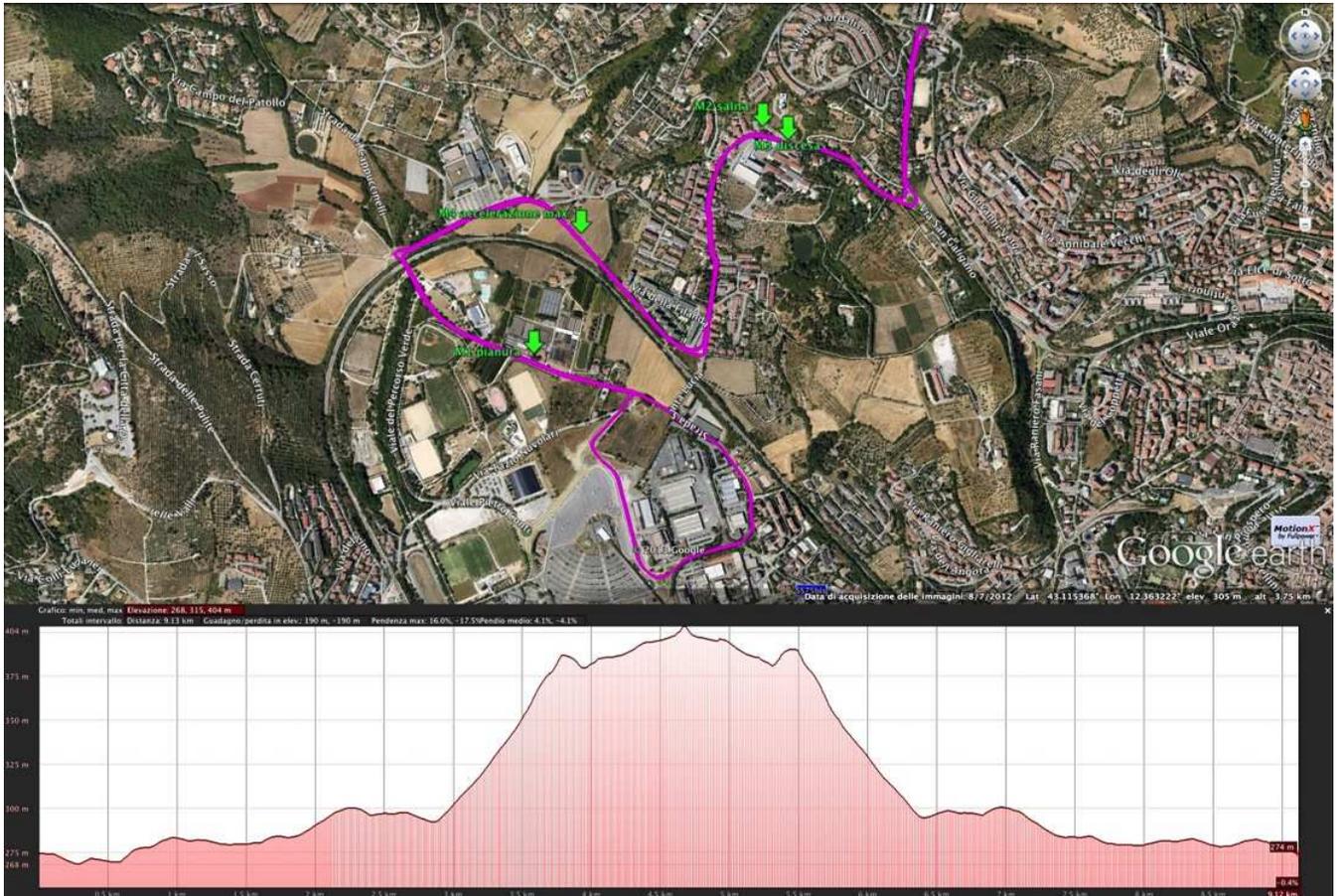
- Less CO₂ emission
- Reduction in fuel consumption
- Better CH₄ combustion, with less uncombusted elements
- Energy increment per weight of fuel
- Energy reduction per volume, because of minor density of hydrogen.

Experiments were taken on a four cylinders 2800 cc Iveco CNG engine: a number of different hydrogen concentrations were tried, with a maximum value of 35% in volume. The original Engine Control Unit (ECU) was replaced with an ad-hoc designed one, to ensure the addition of four new injectors.

Methane was injected with the original injectors, while the new four ones were used by the 35% Hydrogen-methane mix, so that a dynamic map could be achieved: hydrogen was useful at lower regimes, while pure methane was used when maximum power was requested. The ECU managed

the intermediate regimes, granting the optimal balance between low emissions and power production.

Experiments taken on the bench were replicated in reality on the demo vehicle running on a real urban path of 10 Km and mixed conditions of traffic and road altimetry; passengers were simulated with weight on the bus (450 Kgs).



The following table summarizes main results achieved in reducing emissions:

Test phase	Pollutant/greenhouse gas	Methane % vol	Hydro-Methane % vol	Reduction
Flat	CO	0,30	0,03	90,0%
	CO2	9,70	5,08	47,6%
Rise	CO	0,64	0,11	82,8%
	CO2	10,49	7,70	26,6%
Slope	CO	0,21	0,02	91,0%
	CO2	5,00	2,73	45,4%
Max.acceleration	CO	0,29	0,04	87,6%
	CO2	10,20	8,23	19,3%

A further positive judgment has been given by drivers of demo vehicle: with the new mixed fuel the feeling remains of high drivability, confirming the choice of designing a dynamic variable mix system.

Strategic conclusions

Project results confirm the potential of urban mobility strategy: the good results obtained with methane can be further enhanced by hydrogen: each gas can be seen as a single step in the stairway towards a clean easy and safe public transport. Hydrogen is now at the beginning of its development: actual results, fairly good, will be enhanced with technology progression.

Results finally give a numeric dimension to the strategic forecasts long elaborated: H2Power granted finally the scientifically proofed analytical support to politicians.

Next step can be seen in the industrialization process of retrofitting a real fleet and monitor how hydro-methane minibus can react to everyday work, establishing a MTBF on the field.

Perugia can be again pioneer in the urban mobility vision.

Participated communication

The necessity of granting a clear vision of the project activity development also by non-technical people has been approached as a main pillar of the project.

It's clear that H2Power uses technical issues (ECUs, stoichiometric combustion, emissions, etc.) to stimulate concept of sustainability. EC itself promotes sustainable communication, meant as accessibility of results by stakeholders and not only.

According to this strategy, dissemination progressed not only through technical workshops, seminars and cross-project information, but also with on-site participation of high-school groups, each one focused on different parameters, according to the study target. Each component of the visit group has become a voice in the choir of the project dissemination.

Every effort in participation is a further step to reach the revolutionary world where mobility is clean and efficient: hydrogen can have a huge role in this world, if we realize that it can be produced by just demineralized water and some photovoltaic panels.

H2Power vs Italian legislative framework

H2Power results showed clearly the enormous hydrogen potential as “technical” instrument to enhance engine efficiency, either energy-related or environment related.

Speaking from an engineering point of view, the project has progressed more or less smoothly along the track that technical forecasts designed from the first idea.

Speaking from the juridical and administrative point of view the progress has been much more foggy: homologation of demo vehicle according Italian law has been a real issue, even after the first willingness of Ministry offices.

The main problem, although not the only one, has been addressed in the scarce flexibility of rules towards a fuel which is not methane and is not hydrogen: there are no specific regulation and judgment (for a potential homologation) is left to high Ministry offices, with no time forecast.

Given the experimental nature of H2Power this has not affected results, as the demo vehicle could run on the road network with a temporary license plate and increased insurance coverage. If a real fleet had to be created, this problem could have been a project killer.

As a matter of fact H2Power demonstrated, at a hardware level, that there are no major differences between a CNG engine and a hydro-methane one: what is regularly homologated for methane can be safely used (unless further evidences not shown by H2Power experiments) for a 35% hydrogen-methane mix.

H2Power experience suggests that Italian legislative framework is still lacking of flexibility to implement such projects even at a little-medium scale. H2Power partnership recommends a revision in this direction and is willing to share with Authorities the whole project data.

H2Power and European framework

Actual European framework about the use of hydro-methane mix as fuel is not much different from Italian one, given the huge concentration of CNG fueled European vehicles in Italy.

Technical innovation of H2Power has relevance at continental level: there are no other European experiences of 35% hydrogen-methane mix in PT lightweight vehicles.

The project has some further European relevancies in the wider field of environmentally sustainable vehicles production: as said hydrogen efficiency is much more relevant on the environmental parameters than on the energetic ones, given the enormous savings in CO and CO₂ emission (even compared with CNG, which is much better than gasoline or diesel).

CO₂ reduction is strongly related to vehicle production, given the regulation that limits the average CO₂ emission of a fleet.

In particular recently vans regulation fixed the threshold of CO₂ average production per kilometer at 175 g for 2017 and 147 for 2020: it is clear that H2Power demo vehicle is, as a matter of fact, a passenger transportation version of a commercial van (including engine).

Car and van producers could start engineering hydro-methane versions of their vans to lower the fleet average CO₂ production, avoiding to incur in penalties and counter-balancing the necessary investments: hydro-methane vehicles could be the top of environmental respectful production (except electric vans, which are totally chained to short distance runs).

H2Power partnership is totally willing to exchange experiences with any car or van producer, to maximize the exploitation of project data and the realization of hydrogen potential, still at a too minimal level.