# THE FIRST HYTHANE® REFUELING STATION IN FRANCE: A SUCCESSFUL DEMONSTRATION

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## 1. MOTIVATION FOR AN HYTHANE® PROJECT IN FRANCE

Hydrogen energy is recognised as an attractive solution to reduce greenhouse gases (GHG) emissions and urban pollution, to which road transport is a great contributor. But there are still today numerous barriers before introducing hydrogen in the current vehicle fuel pool. The blend of natural gas (NG) and hydrogen, referred to under the name Hythane®, represents a relevant and pragmatic solution to introduce hydrogen in the public transportation system (buses, captive fleets), by taking advantage of the synergies with the NGV (Natural Gas Vehicle) technology and infrastructure. Hythane® brings solutions to current concerns on reduction of local and urban pollution (NOx, CO) and CO2 emissions.

This paper presents the results of the project lead by the Research & Innovation Division of GDF SUEZ in France, which demonstrated the use of Hythane® (blend of 80 %vol. NG + 20 %vol. H2) and:

- confirmed the relevance of Hythane® as pragmatic solution of environmental friendly fuel,
- quantified the immediate benefits with reduction of energy consumption, urban pollution and greenhouse gases.

## 2. ADMINISTRATIVE AUTHORISATION

The main challenge of the project deals with the administrative authorizations required to exploit this new type of refueling station and to run this new type of buses with public on board. The existing regulation did deal with NG or H2 but not with their mixing gas.

Based on the necessary regulatory files including the detailed safety studies on the designed refueling station and the adapted buses, all the necessary authorization were granted for the demonstration, and a daily operation of the Hythane® station and buses transporting passengers on board started in July 2009.

## 3. THE REFUELLING STATION IN DUNKERQUE

The project was set in the Dunkerque city in the North of France that has a strong environmental policy and wishes to lead the path of innovation towards hydrogen.

In the project, the hydrogen was produced locally at the refueling station and mixed to the compressed natural gas upstream the nozzle. The production of H2 took advantage of the great potential of wind power as renewable energy resources, by means of a small electrolyser supplied with “green” electricity (from wind power) (figure 1). Therefore a reduction of CO2 emissions compared to NGV is induced considering the whole energy chain analysis.

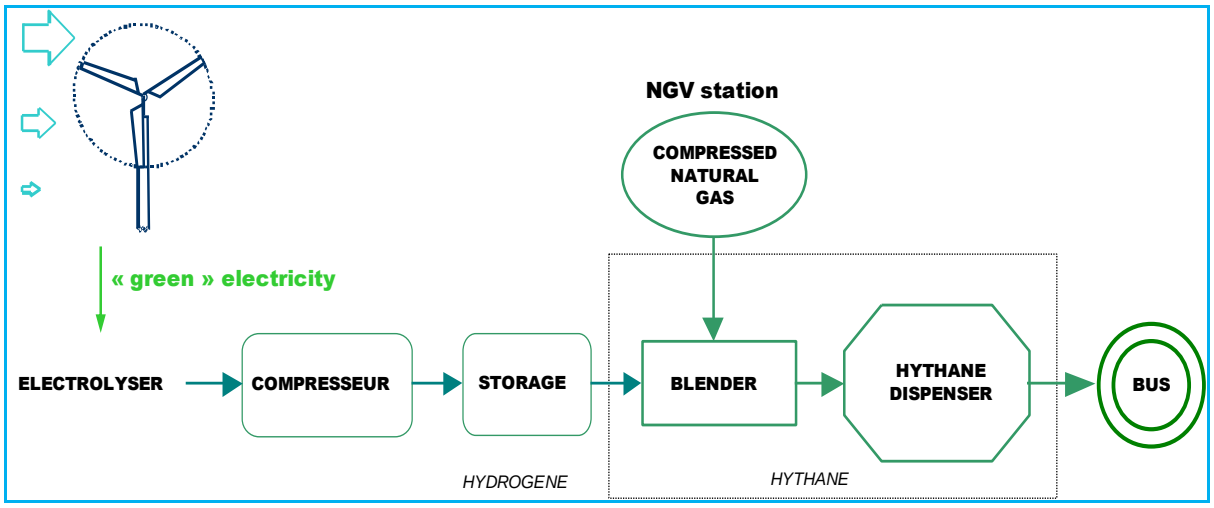


Figure 1 – Scheme of the refuelling station from renewable energy to buses.

Hydrogen was produced by an electrolyser with a capacity of 10 $Nm^3/h$, from Hydrogenics NV. The H2 produced has an high purity. The whole efficiency is around 65 % including the consumptions of the auxiliaries (pumps, electricity process, heat exchanger). The hydrogen is then compressed to 300 bar and stored (figure 2) before to be mixed with NG at the dispenser for filling the bus tanks with Hythane® fuel (figure 3).


Figure 2 - The two containers of the Hythane® station.


Figure 3 – The Hythane® bus at refuelling.

## 4. FEED-BACK AND PERFORMANCE OF THE REFUELLING STATION

The filling took less than a quarter of an hour. The refueling station was in operation for two years and delivered 58 400 $m^3$ of Hythane® fuel. No incident occurred during this demonstration.

## 5. THE HYTHANE® BUSES: NGV BUSES RETROFITTED TO HYTHANE® FUEL

The two NGV buses were equipped with the new stoechiometric engine CURSOR 8 from IVECO. The adaptation of these buses included a mapping modification of the stoechiometric engine. Bench tests were carried on in order to find the best engine performance trade-off in term of emissions, efficiency and reliability, for several H2 contents in the blends. The optimised tuning was applied to the engine on the buses.

The emissions released by the bus (green house gases and local pollutants) were measured by means of a standardized drive applied to the bus. Both NGV and Hythane® fuels were used for an accurate and relevant comparison of their emissions.

## 6. FEED-BACK AND PERFORMANCE OF THE HYTHANE® BUSES

The two buses were operated for one year and each of them run around 40 000 km. The drivers were fully satisfied of this new fuel which makes the driving more comfortable. No incident occurred during this demonstration.

## 7. ASSESSMENT OF THE HYTHANE® FUEL

The environmental advantages were confirmed by experimental measurements and the Life Cycle Analysis:

| Compared to: | NGV | Diesel |
|---|---|---|
| Reduction of CO2 emissions | - 8 % | - 14 % |
| Reduction of NOx emissions | - 10 % | - 95 % |
| Therefore:<br>Reduction of the external costs | - 9 % | - 47 % |

Moreover, the Hythane® induced a reduction of the energy consumption of the buses on their daily service with passengers : - 7 % versus GNV.

The safety assessment was excellent as no incident occurred nor in the refuelling station neither on the buses.

A cost analysis was carried on the refuelling station and the buses. These results obtained from a quite small scale demonstration, were not representative of an actual normal operation of bus fleet involving 20 buses or much more.

The over-cost of Hythane® fuel compared to NGV depends on few parameters: the number of Hythane® buses and the H2 volume, the NGV cost, the financial supports. Assuming a mature solution, this over-cost may be ranged between 0% to 20% of the NGV cost.

## 8. CONCLUSION

That demonstration and its assessment confirmed that:

- the Hythane® is a pragmatic solution bringing advantages at short term on specific markets, like public transports,
- it is now a relevant candidate for enhancement of clean urban transports,
- it takes profits of the NGV know-how and infrastructures,
- it is a support to introduce some renewable energy among fuels, like wind power or biomethane,
- the Hythane® paves the way for introducing the hydrogen energy within the energy mix, without heavily investment in vehicles and infrastructures.