The feasibility of liquid methane as alternative fuel: the role of biomethane
Contents

- Natural Gas and LNG as vehicle fuels;
- LNG infrastructure and supply;
- Biomethane advantages and opportunities;
- A case study.
LNG as vehicle fuel

GHG emissions due to transport sector ~ 20% of total emissions

- ~ 93% of this are represented by road transport
- In this sector emissions have risen by ~ 26% in the period 1990-2006
- In this period passengers vehicles increased by 34%, 62% for heavy goods vehicles

2020 climate and energy package
LNG as vehicle fuel

Advantages of Natural Gas:

- Environmental benefits with a reduction of CO₂ from combustion;
- Readily available at a competitive price using well known technologies;
- In can decrease the dependency from importations and usage of other conventional fuels.
LNG infrastructure

Critical aspects

<table>
<thead>
<tr>
<th>Critical aspect</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Optimum ratio between NG vehicles and refuelling stations</td>
<td>No more than 1000 NG vehicles per refuelling station</td>
</tr>
<tr>
<td>Refuelling station distance</td>
<td>NG stations equal to 10-20% of conventional stations</td>
</tr>
<tr>
<td>Waiting time for refuelling</td>
<td>Technological improvement and L-CNG stations</td>
</tr>
</tbody>
</table>

European projects

- GasHighWay
- Blue Corridor Project
NG supply in Italy

Natural gas vehicle situation in Italy

- 880000 natural gas vehicles (~ 80% of Europe’s entire car fleet on gas);
- 1060 NG refuelling stations (1010 are open to the public);
- 8 L-CNG filling stations (the last one as part of the Blue Corridor Project – April 2014);
- 3 import terminals for LNG;
- Lacks truck-loading facilities.

Market penetration of LNG is very low

How to supply LNG refuelling stations at a competitive price?
NG supply in Italy

To be attractive, LNG selling price should be 40-60% less than traditional fuels

0.4488 €/l = 1.06 €/kg

<table>
<thead>
<tr>
<th>Fuel</th>
<th>CNG (€/m³)</th>
<th>LNG (€/liter)</th>
<th>Diesel (€/liter)</th>
<th>Gasoline (€/liter)</th>
<th>LPG (€/liter)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base price</td>
<td>0.5483</td>
<td>0.4488</td>
<td>0.6611</td>
<td>0.6347</td>
<td>0.4619</td>
</tr>
<tr>
<td>Tax (excise)</td>
<td>0.0033</td>
<td>0.0021</td>
<td>0.6198</td>
<td>0.7308</td>
<td>0.1473</td>
</tr>
<tr>
<td>VAT (Value Added Tax) * =22%</td>
<td>0.1214</td>
<td>0.0992</td>
<td>0.2818</td>
<td>0.3004</td>
<td>0.1340</td>
</tr>
<tr>
<td>Retail Price</td>
<td>0.6730</td>
<td>0.5500</td>
<td>1.5627</td>
<td>1.6659</td>
<td>0.7432</td>
</tr>
<tr>
<td>Normalized price</td>
<td>0.0192</td>
<td>0.0262</td>
<td>0.0437</td>
<td>0.0515</td>
<td>0.0293</td>
</tr>
</tbody>
</table>

LNG refuelling stations can be supplied in 2 different ways:

- Purchasing at regasification terminal;
- Liquefaction on site.
NG supply in Italy

Regasification terminal

- LNG terminal price (0,164 €/l)
- Transportation costs (0,0994 €/l)
- LNG refuelling station costs (0,0373 €/l)
= final price 0,3007 €/l

Liquefaction on site

- NG pipeline price (0,24 €/l)
- Liquefaction costs (0,1772 €/l)
- LNG refuelling station costs (0,0448 €/l)
= final price 0,462 €/l

With Italian incentive scheme, biomethane could overcome the problem of supply
Biomethane advantages

Obtained from biogas purification (upgrading)

- Alternative fuel with higher energy density;
- CO\textsubscript{2} emissions during combustion = CO\textsubscript{2} capture during biomass growth;
- Less dependence on natural gas importations;
- It could be involved in Smart Grids;
- It could be injected into the national gas grid.

It represent an opportunity to fulfil the UE 20-20-20 targets
## Incentives scheme (automotive)

D.M. December 5th, 2013

1 CIC (Certificati di Immissione in Consumo) measured in € x 10^{-1} Gcal of biomethane

10 Gcal = 11,63 MWh

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Number of CIC</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>New plant</td>
</tr>
<tr>
<td></td>
<td>Sold in o.r.s.***</td>
</tr>
<tr>
<td>By – products* &lt; 70%</td>
<td>1</td>
</tr>
<tr>
<td>By – products* ≥ 70%</td>
<td>1,7</td>
</tr>
<tr>
<td>By – products* = 100%</td>
<td>2</td>
</tr>
</tbody>
</table>

* Table 1° - D.M. July 6th, 2012
** Refuelling Station
*** Others Refuelling Station

Up to now, the CIC value is unknown, supposed to be in a range between 300 ÷ 800 €/CIC
A case study

- Biogas size: \(500 \text{Nm}^3 \cdot \text{h}^{-1} \approx 250 \text{Nm}^3 \cdot \text{h}^{-1}\);
- Upgrading system: PSW;
- LBG price: 1 € · kg\(^{-1}\) (no tax).

The incentive obtained for this scenario is 3 times the base incentive value.

One owner for all the chain

A compression station is not required
A case study

The minimum incentive has been found to be 0,35 € · Nm$^{-3}$ of biomethane.

A sensitivity analysis shows that the expected incentives are so high to cover the LBG production also in different scenario.
Conclusions

Biomethane for Bio-LNG

- Environmental benefits;
- Incentive policy makes biomethane attractive;
- Overcoming the supply issue.