

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

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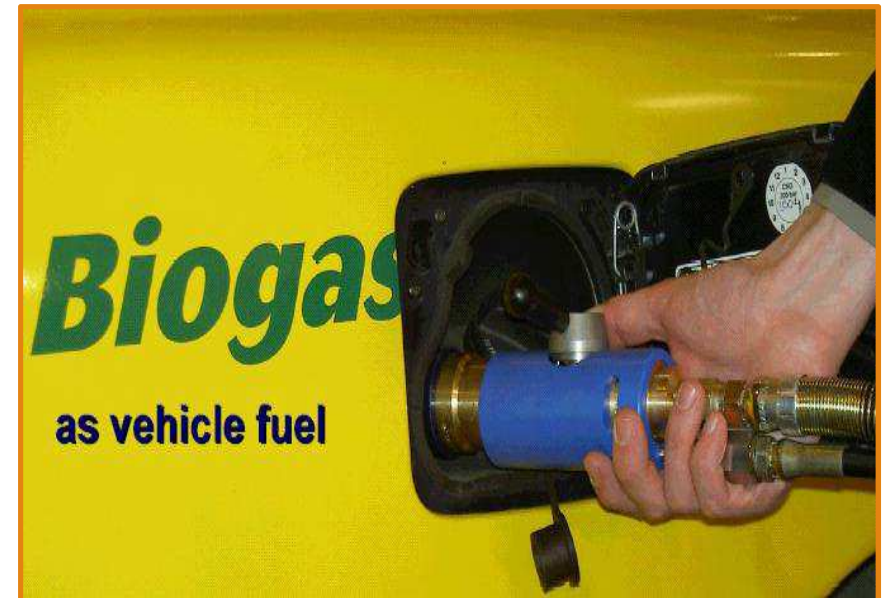


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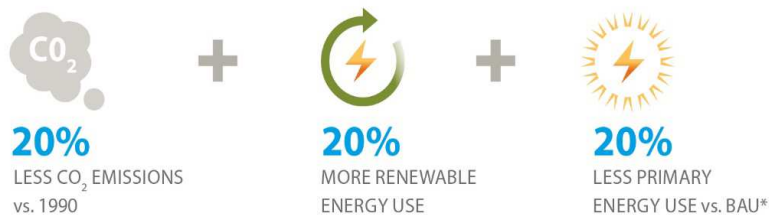
- Natural Gas and LNG as vehicle fuels;
- LNG infrastructure and supply;
- Biomethane advantages and opportunities;
- A case study.



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



By the year
2020

*Business As Usual

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;
- It can decrease the dependency from importations and usage of other conventional fuels.

LNG infrastructure

Critical aspects

| | |
|---|--|
| Optimum ratio between NG vehicles and refuelling stations | No more than 1000 NG vehicles per refuelling station |
| Refuelling station distance | NG stations equal to 10-20% of conventional stations |
| Waiting time for refuelling | Technological improvement and L-CNG stations |



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

| Fuel | CNG | LNG | Diesel | Gasoline | LPG |
|------------------------------|-------------------------|----------------|----------------|----------------|----------------|
| Base price | 0.5483 €/m ³ | 0.4488 €/liter | 0.6611 €/liter | 0.6347 €/liter | 0.619 €/liter |
| Tax (excise) | 0.0033 €/m ³ | 0.0021 €/liter | 0.6198 €/liter | 0.7308 €/liter | 0.1473 €/liter |
| VAT (Value Added Tax) * =22% | 0.1214 €/m ³ | 0.0992 €/liter | 0.2818 €/liter | 0.3004 €/liter | 0.1340 €/liter |
| Retail Price | 0.6730 €/m ³ | 0.5500 €/liter | 1.5627 €/liter | 1.6659 €/liter | 0.7432 €/liter |
| Normalized price | 0.0192 €/MJ | 0.0262 €/MJ | 0.0437 €/MJ | 0.0515 €/MJ | 0.0293 €/MJ |

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;
- CO₂ emissions during combustion = CO₂ 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 $\text{€} \times 10^{-1}$ Gcal of biomethane

10 Gcal = 11,63 MWh

| Feedstock | Number of CIC | | | |
|---------------------------|--------------------|--|--------------------|--|
| | New plant | | Existing plant | |
| | Sold in o.r.s. *** | Own r.s. ** | Sale in o.r.s. *** | Own r.s. ** |
| By – products* < 70% | 1 | $1 \cdot 1,5 (1^\circ \div 10^\circ \text{ year})$ | $1 \cdot 0,7$ | $1 \cdot 0,7 \cdot 1,5 (1^\circ \div 10^\circ \text{ year})$ |
| By – products* \geq 70% | 1,7 | $1,7 \cdot 1,5 (1^\circ \div 10^\circ \text{ year})$ | $1,7 \cdot 0,7$ | $1,7 \cdot 0,7 \cdot 1,5 (1^\circ \div 10^\circ \text{ year})$ |
| By – products* = 100% | 2 | $2 \cdot 1,5 (1^\circ \div 10^\circ \text{ year})$ | $2 \cdot 0,7$ | $2 \cdot 0,7 \cdot 1,5 (1^\circ \div 10^\circ \text{ year})$ |

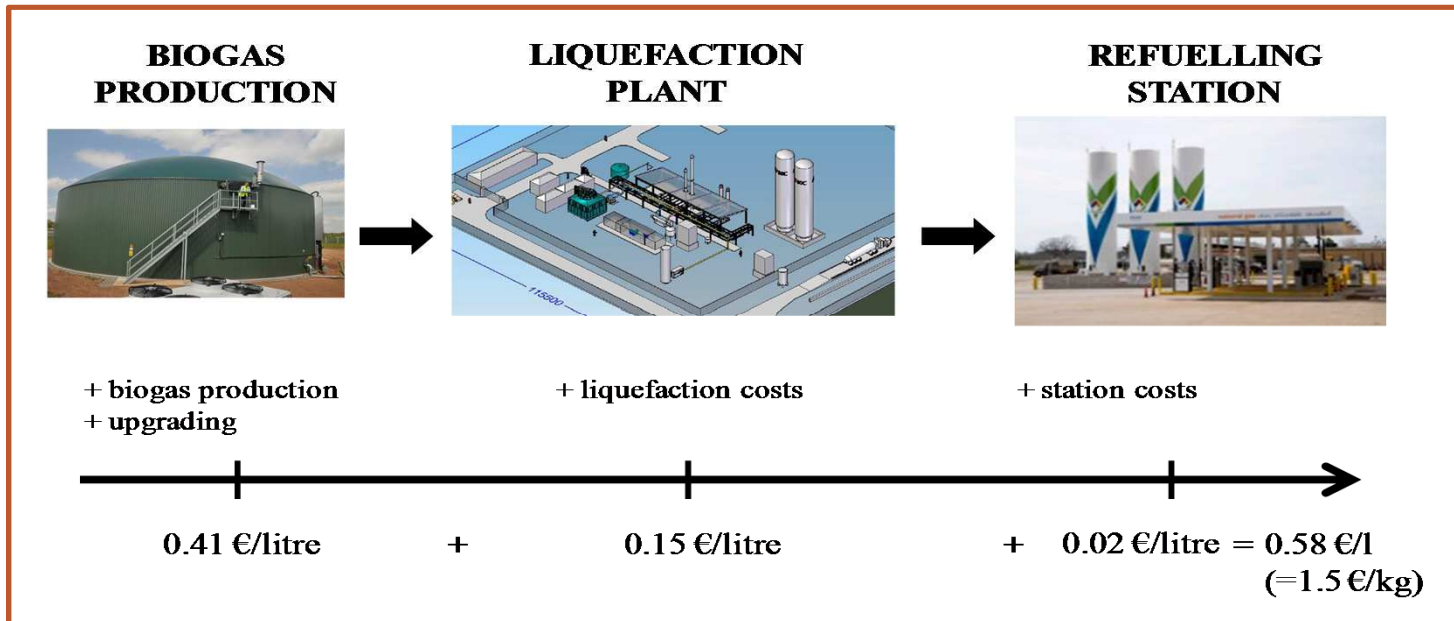
* Table 1° - D.M. July 6th, 2012

** Refuelling Station

*** Others Refuelling Station

Up to now, the CIC value is unknown, supposed to be in a range between $300 \div 800 \text{ €}/\text{CIC}$

A case study



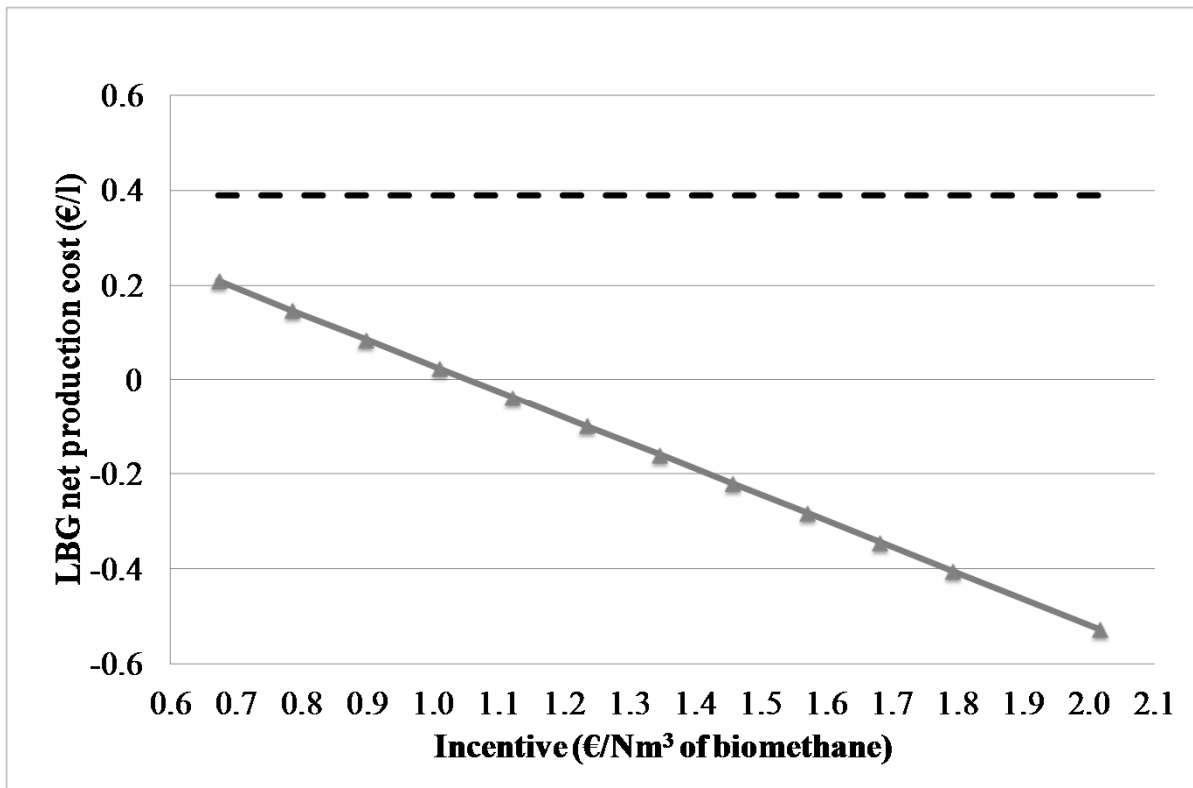
One owner for all the chain

A compression station is not required

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

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

A case study



The minimum incentive has been found to be $0,35 \text{ €} \cdot \text{Nm}^{-3}$ 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.

