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Fact Sheet: NG/biomethane used as vehicle fuel

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Methane

- **Natural Gas**
    - H-gas with high energy content
    - L-gas with low energy content
- **Biomethane**
    - Upgraded landfill gas
    - Upgraded biogas from AD fermentation of organic waste, grass, algae, sea-weeds, and crops from set-aside land
    - Upgraded biogas from AD fermentation of crops
    - Thermochemically produced biomethane based on gasification of forest industry waste

Biomethane feedstock and production technologies

The use of crops for production of biofuels has been questioned (the food vs. fuel debate). This discussion will continue. The classification of the land used to grow the crops has an influence. When comparing the energy efficiency of different biofuels the relevant comparison basis is the fuel energy content per hectare of land used, not the yield per tonne of feedstock used.

- Landfill gas typically has a methane content of around 45 %, balance CO2 and sometimes also nitrogen (5-15 %).
- Raw biogas typically has a methane content of around 65 % (varies between 50 and 75 %, depending upon feedstock), balance CO2
- Synthetic biomethane from gasification will be almost pure methane

Different upgrading technologies will result in marginally different methane contents. Most will leave 2-3 % CO_2 in the produced biomethane, and also leave any nitrogen in the landfill gas in the produced biomethane. Some processes may produce almost 100 % pure biomethane, e.g. cryogenic upgrading and various chemical processes.

The typical composition of biomethane is 97-98 % methane, and 2-3 % CO_2. This is a quality which is chemically identical to Russian natural gas, the most common H-gas quality in Europe.

Biomethane delivered directly to CNG refuelling stations or into the natural gas grid, is odorized and typically holds 97-97 % methane. If the NG grid at the point of injection delivers a gas quality with a higher energy content (due to minor contents of ethane, propane, butane, or pentane), propane is usually added when injecting biomethane to provide a gas mix with the same energy content per cubic metre.

LNG (Liquefied Natural Gas) technologies

Biomethane or natural gas distributed via LNG tank trailers to LNG or L-CNG stations is not odorized. L-CNG stations will handle the odorization of gas to be refuelled in the form of CNG.

As an alternative to odorization a potential gas leak in a vehicle transporting or using LNG is instead detected via gas sensors, or simply by observing abnormal ice formation on the surface of the LNG fuelling system.

The operational costs (electric power and maintenance) for CNG delivered from an L-CNG station will be at least 2/3 lower than the costs at a conventional CNG station (for conventional CNG stations the electric power demand depends on pressure in the grid – the higher the inlet pressure, the lower the compression energy demands).

Comparison of energy contents and CO_2 emissions from different fuels

Tailpipe CO_2 emissions based on energy consumed

Different fuels have different chemical properties:

Fuel	hydrogen in %	LHV MJ/kg	LHV kWh/kg	CO2 in g per kWh	Theoretical CO2 reduction in %
Methane (NG/biomethane)	25,0	50,0	13,89	198,0	29,2
Propane (LPG)	18,2	45,6	12,67	236,8	15,3
Butane (LPG)	17,2	45,3	12,58	241,2	13,7
Diesel	13,5	42,7	11,86	267,5	4,3
Gasoline	13,5	42,4	11,77	279,5	0,0

The second last column of the above table shows the tailpipe CO2 emission resulting from the burning of one kWh (LHV – lower heating value) of each respective fuel.

The last column shows the theoretical reduction of CO2 emissions, compared to gasoline, in vehicles with identical properties and with identical engine efficiency.

Please note that the energy contents and the tailpipe CO2 emissions from diesel or gasoline will change when instead using a blended fuel containing biofuel components. Lower heating value contents and chemical composition must be stated for each fuel in order to calculate the theoretical CO2 emissions per kWh LHV in each fuel.

Benefits connected with the use of NG/biomethane

Tailpipe CO2 emissions

In real life engine efficiencies on different test cycles will be different (compression ignition engines e.g. still with a higher efficiency than positive ignition engines), and vehicles using CNG cylinders will normally have a slight weight penalty compared to similar gasoline powered vehicles. The optimization with regard to cetane and octane ratings will also play a role.

State-of-the-art NGVs achieve a 25 % CO2 benefit compared to a similar gasoline powered vehicle.

In a dual fuel vehicle with a compression ignition engine running on methane, but supported via pilot injection of diesel, the reduction of CO2 emissions compared to a standard diesel vehicle will depend upon the diesel substitution ratio (an 80 % substitution ratio would e.g. mean around 20 % reduction of the CO2 emissions).

Dedicated state-of-the-art positive ignition gas engines may presently reach around 10 % CO2 reduction in comparison to a similar diesel engine.

Technological developments and changes of exhaust emission treatment systems to meet future emission demands, means that the relations quoted may shift over time. Positive ignition NG engines are likely to profit from these developments.

Other emissions

- Uniquely low emissions of toxic or carcinogenic substances
- Almost zero particulate emissions
- No emissions of reactive hydrocarbons contributing to the formation of ground level ozone
- Reduced NOx emissions compared to compression ignition diesel engines
- Reduced noise and vibrations in comparison to compression ignition engines

Other advantages

- Much lower fuelling costs than for conventional fuels
- Offers the potential for future large scale use of renewable biomethane without any restrictions on blending ratios
- Can immediately offer large volume substitution of oil based fuels, thus reducing oil dependence

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