

Logistic pathways of purified compressed biomethane (CBG) and future opportunities using liquefied natural gas (LNG)

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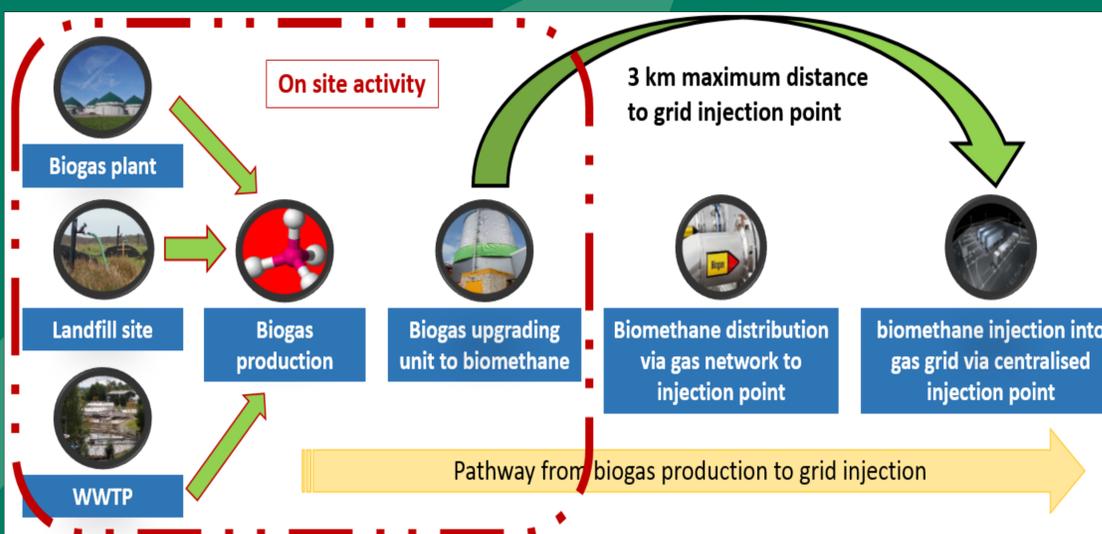
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Biomethane which originates from a diluted form called “biogas” comes mainly from anaerobic digestion or landfill sites. This gas has to be cleaned, purified and dried. The final end-product which is called biomethane has an equivalent calorific value as of natural gas. The same product contains mainly methane but can surprisingly enough have various names depending on origin and state of gas (gaseous or liquid). In the list below some examples of names have been collected to outline the complexity when using methane; the same product which can originate from various sources:

- | | |
|---------------------------|---|
| CNG | Compressed Natural Gas (coming from fossil fuel sources) |
| CBG | Compressed Biomethane Gas (coming from renewables) |
| LNG | Liquefied Natural Gas (coming from fossil fuel sources) |
| LBG | Liquefied Biomethane Gas (coming from renewables) |
| E-Gas/power to gas | Electricity produced Gas (coming from mainly renewable energy sources) |

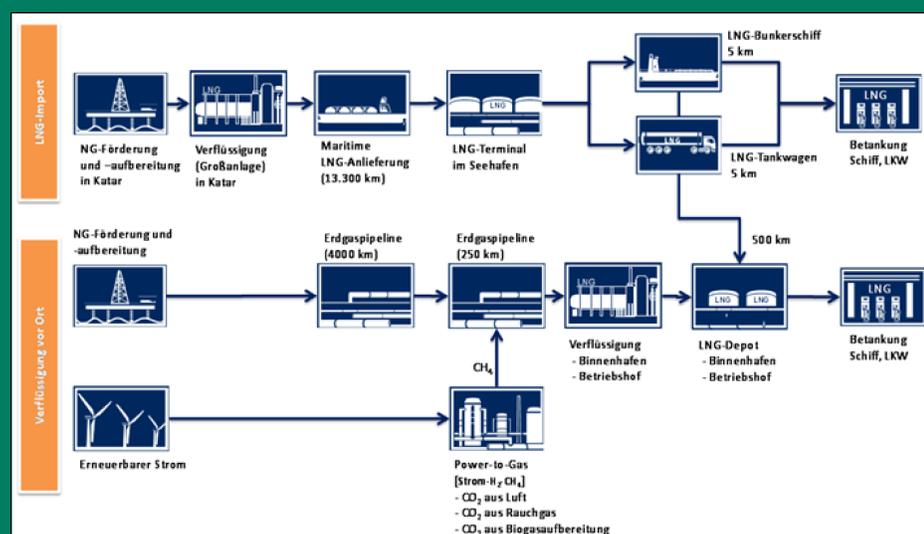
Methane or the environmentally friendly counter-product biomethane can be used in its original state under atmospheric pressure conditions, compressed form normally between 200-250 bar or as in liquid form chilled down to -162 degrees.

CBG pathway



(Source: Own schematic flow of a biogas pathway, October 2015)

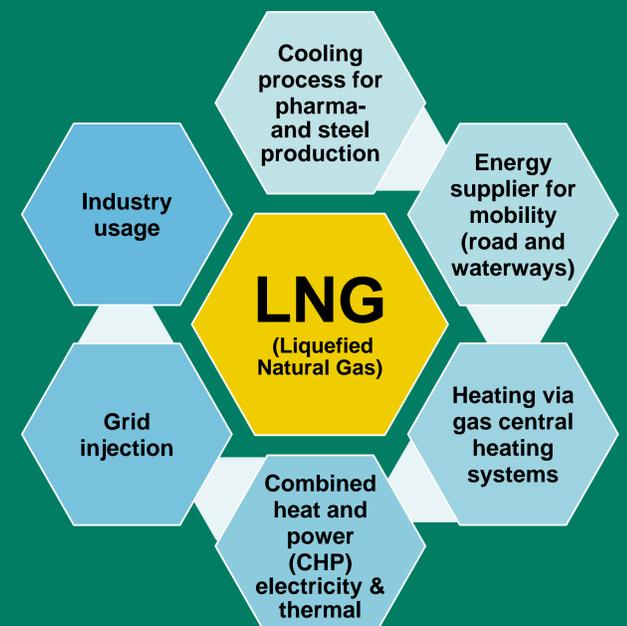
LNG pathway



(Source: Gewinnung, Transport und Lagerung von Flüssiggas (BMVI, 2011))

After intensive research on various fuel types it can be concluded that methane in terms of weight has a much higher energy density than diesel fuel, but compared with a defined storage volume methane is not even closely competitive. For that reason, methane as a fuel replacement in the haulage industry can only be practical and financially viable in a compressed or liquefied form.

In order to compress or liquefy methane, it requires a lot of electricity which can be used from wind turbines or photovoltaic electricity production when electricity demand is low and electricity can be used as a cheap sustainable source of energy.



(Source: Own LNG customer flow chart, June 2015)