The best utilisation routes for biogas

1. Introduction

Southeast Asian countries are possessing the largest biogas potential in the world. As nowadays the biogas can be easily treated to use as transport- or vehicle fuel it offers also a great advantage. Combined with the need for reduction of Green House Gas (GHG) emissions this offers a compelling economic and sustainable alternative.

In the biogas field there is nowadays a wide range of technologies available. They include several ways of biogas capture, as well as several techniques to utilize the biogas, ranging from electricity production all the way to creating increased value, by transforming it into bio-methane, bio-CNG or even bio-LNG. As it becomes more common to capture and use the biogas, there is an increasing need to look at the best utilization route available. Since power generation from biogas is only 42% efficient at best as co-produced heat can often not be used, this article focuses on the utilization routes: bio-methane, bio-CNG and bio-LNG.

2. *Biogas:* an untapped treasure

Biogas is a renewable source of energy and is produced by digesting biodegradable organic matter in the absence of oxygen/air. Sources providing the organic substrate for biogas production can be wastewater, crop residues, dairy livestock manure, municipal solid waste etc. Typical raw biogas consists of about 55–65% methane (CH_4), 30–45% carbon dioxide (CO_2), traces of hydrogen sulphide (H_2S), fractions of water vapors and other contaminant gases.

Biogas can be utilized in several ways. However, prior to any use it is essential that the raw biogas is pre-treated in order to remove the excess water vapors and to separate compounds such as H_2S, NH_3 etc. This is important since H_2S for example is highly toxic for living organisms but also harmful for mechanical equipment due to its corrosive nature. This problem can be tackled with an effective pre-treatment technology ranging from easy to operate activated carbon filters all the way to highly sophisticated chemical and/or biological desulphurization scrubbers.

After pre-treatment, biogas can be directly used for heat and power production in CHP units. This option used to be dominant. However, the produced heat from a CHP installation does often not match with heat requirements on site, resulting in a rather inefficient energy conversion.Therefore, nowadays industries, public sector companies as well as individuals are looking to utilize biogas as a fuel substitute, given that biogas, after treatment, is essentially similar to natural gas. However, for biogas to be utilized effectively, purification is required to remove contaminants which reduce its calorific value. The removal of (mainly) carbon dioxide “upgrades” the biogas into natural gas quality and generates biomethane, a renewable

fuel offering exciting possibilities. Biomethane can be used a natural gas replacement for industrial uses, injected into the local gas grid, compressed and used as vehicle fuel (bio-CNG) or finally polished and liquefied to produce bio-LNG.

To make use of the higher energy potential and improved profitability it is important to have an optimized process in terms of low energy and material consumption, with high efficiency and low methane losses. There are a number of technologies available today for biogas upgrading, with varying capacity and complexity. Most common upgrading systems are pressurized water scrubbing (PWS), catalytic absorption/amine wash (CA), pressure swing absorption (PSA), highly selective membrane separation (MS) and cryogenic liquefaction (CL). Each process has its own advantages and disadvantages, depending on the biogas origin, composition and geographical orientation of the plant. For more information regarding the performance of upgrading technologies please see *www.bioenergyconsult.com/biogas-to-biomethane/*

3. Utilization Routes

a. Grid injection

Due to the presence of a highly developed gas infrastructure, one of the main utilization routes of biomethane in Europe is that of gas grid injection. Distribution of biomethane through the natural gas grid has the advantages that large quantities of gas can be relatively cheaply transported to end customers without being limited by local demand. Grid access is subject to strict legislation. Depending on the type of network and the network operator the required gas quality (and methods of quality monitoring) can vary greatly. It requires the right equipment, flexibility and above all engineering quality to be able to meet all the various specifications in different countries.

Biogas upgrading plant (based on Pressurized water scrubbing technology): processing 550 Nm^3 of biogas per hour for distribution into the Dutch national gas grid.

Biogas upgrading plant (based on Membrane separation): processing 1400 Nm^3 of biogas per hour for distribution into the English national gas grid *(on courtesy of DMT)*..

b. bio - CNG

When no wide spread gas infrastructure is available within a reasonable distance (as is often the case in South East Asia), the production of bio - CNG is a suitable solution with an average R.O.I of 3 years. Converting the biogas into bio-methane of CNG quality through upgrading, would facilitate the transportation and commercialisation of over 95% of the energetic content of the biogas. Within the CNG utilization route, the raw biogas will be typically pre-treated (to remove H_2O, H_2S and other contaminants), upgraded to a methane content of >95%, compressed to 250 bar with a CNG compressor and stored in racks with gas bottles. On a side note it is mentioned that in Thailand the market standard for CNG is 85% methane purity. The buffered gas (bottles) will be suitable for transportation by truck or ship. In addition CNG fuelling station can be put in place.

Biogas upgrading plant – Carborex MS (based on Membrane separation): processing 400 Nm^3 of biogas per hour to CNG *(on courtesy of DMT).*

For facilitating the storage and distribution of high pressure CNG, a wide range of commercial system are available. They range from simple gas rack based skids, to tube trailers to highly sophisticated standalone dispenser units. Typical storage volumes range from a couple of hundred to multiple thousand kilograms of LNG.

CNG storage and distribution system supplied by Galileo

Titan tube trailer for CNG storage and distribution

Alternatively to transporting the CNG by virtual pipeline (transporting by truck), the gas can be used for local applications such as burning in boiler systems or for (co-)fuelling of vehicles at e.g. palm oil plantations.
Through retrofitting a truck it can be converted to a co-fuelling vehicle, which runs on both bio-CNG as well as conventional fuels. An additional advantage of retrofitting is that the engines run on a lower RPM, and therefore, will have less wear and tear. The cost of retrofitting an engine will depend on its Horse Power/cylinder size. Indicative prices for Asia are shown below.

- 150 HP – 4 cylinder: will cost ± 7.000 - 8.000 $ (excl. cylinder tank)
- 300 HP – 6 cylinder: will cost ± 11.000 – 12.000 $ (excl. cylinder tank - all in around 15.000 $)
- Common Rail system is more expensive to retro-fit

c. Bio- LNG

Nowadays LNG is continuously gaining momentum worldwide as the fuel of choice for trucks and ships, by combining clean combustion, easier transportation, flexibility and higher security both in terms of reserves capacity and stability of price. Bio-LNG is the most cost effective fuel or technology available today for CO_2 emissions reduction (up to 70% less compared to diesel). Given that LNG reduces the volume of biomethane with 600x, liquefaction is an excellent way to store fuel when the price or demand is low. It is also the best and, sometimes, the only way of methane transportation.

4. Conclusions

Over the past years the technique for biogas upgrading has evolved in such way that it has become easy to fully utilize the biogas potential available.
The bio-CNG allows for significant diesel savings when used in industrial boilers or as fuel for retrofitted trucks. With an average ROI of +/- 4 years, this technology is now available for those who want to use the biogas potential to the full.

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