Technical opportunities for the utilisation of biogas in Eastern Europe

WP2 - Task 2.6 report of the BiG>East project

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Authors:

Dipl.-Ing. Tobias Finsterwalder[1]
Dipl.-Ing. Dominik Rutz M.Sc.[2]

[1]Finsterwalder Umwelttechnik GmbH & Co. KG
(FITEC)
Mailinger Weg 5
83233 Bernau
Germany

[2]WIP Renewable Energies, Germany

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1 INTRODUCTION

This report reviews possibilities for the utilisation of biogas in Eastern Europe and was elaborated in the framework of the BiG>East project, supported in the Intelligent Energy for Europe programme of the European Commission.

The present report is based upon the data collected in the framework of the BiG>East reports on “Technical review of the utilisation of waste material for biogas production in Eastern Europe” (Task 2.2) and “Estimation of the potential feedstock availability in Eastern Europe” (Task 2.3).

The elaboration of this report was guided by Finsterwalder Umwelttechnik (FITEC) who presupposes that all the well known bio-waste streams like, food-waste, expired foods, source separated organic wastes (households) or sewage sludge can be treated in biogas plants and it is only a question of money and time to determine the best technology. Considering this, the present report is not a description of different technologies for the utilisation of biogas, but it is an analysis of opportunities for biogas utilisation in Bulgaria, Croatia, Greece, Latvia, Romania, and Slovenia (BiG>East target countries). Understanding structures and markets helps determining whether a biogas plant fits into a country or what is necessary to make it fit. The technologies for the utilisation of biogas are described in the BiG>East Handbook which is available on the BiG>East website www.big-east.eu.

2 OPPORTUNITIES OF BIOGAS PRODUCTION

The opportunities for biogas production in the BiG>East target countries are very high, especially in the waste treatment sector. Implementation will enable efficient and environmentally sustainable waste disposal, while at the same time generating a significant amount of energy in a manner that aids the region’s responsibility to reduce and offset its carbon footprint. Generally, the countries involved have good infrastructure and framework for waste collection as well as lots of potential in growing energy cops ore animal slurry.

However the waste is not separated, and largely ends up in landfill sites. EU standards for collection and handling have been largely adopted and there are some (usually small or pilot) programs for separating and recycling. With this basic framework and mentality in place it only requires another step to see the waste streams properly dealt with and used to great benefit, rather than causing environmental, space and economic problems. Most countries are seeing a rise in the amount of waste produced, yet naturally a decline in the availability of space for traditional disposal methods.

There are adequate waste streams to support a variety of biogas technologies and the population density is such that economies of scale can be achieved. The biogas facilities can be distributed to map onto existing waste, industrial and agricultural facilities, thereby introducing very little additional transport costs. The countries in this region also have large agricultural sectors which provide both waste streams, and markets for biogas process by-products such as compost and liquid fertiliser.

Therefore with infrastructure and logistics largely in place, and with available waste streams and a healthy agricultural sector, the conditions are very favourable. Options for setting up facilities are numerous as they can be centralised or distributed as required. All the countries involved have ample and well established landfill sites, waste management sites and agricultural farms suitable for co-location of biogas plants. Distributed systems offer more benefits as they can be tailored to specific sites and waste requirements while transport costs are minimised or eliminated. In Germany experience has shown that power generation can be fed into the municipal energy grid successfully even with very small capacity plants. Alternatively, where feed-ins tariffs are low or non-existent - and therefore do not support connection to the grid – a focus can be placed on small systems which are designed to supply the energy requirements of the plant itself and surrounding waste management infrastructure or other neighbouring industry.

3 TECHNOLOGIES FOR BIOGAS PRODUCTION

Biogas systems using energy crops as feedstock are robust simple and reliable technology. Waste treating biogas systems are more complicated because of contaminants removal, but the working principle is the same. The organic material is broken down in large tanks in an anaerobic process resulting in the formation of methane gas which is then used as a fuel to drive an electric generator. Greenhouse gas benefits are derived from the capturing of methane gas which would otherwise be liberated in a landfill process and further, the conversion of methane to CO_2 in the combustion process. This is an important issue as CO_2 is a much less potent greenhouse gas than methane. Although CO_2 is released during energy production the carbon is largely offset by the carbon sequestered in the growing process of the organics in the waste and the agricultural products. The spent slurry material at the end of the biogas process known as digestate can be separated into solid material which forms rich and productive compost, and a liquid rich in nutrients suitable for direct application to farm land as a liquid fertiliser.

Adequate waste streams for biogas plants can include food waste from households, restaurants or supermarkets, garden waste, bio waste, cow and farm animal slurry, straw, sewerage, food processing waste and other industrial organic waste as well as non waste crop inputs such as maize and grass silage. Essentially all organic and biodegradable waste material can be used for biogas production. Woody materials are not digested and are better utilised by chipping and composting. Woody products passing through the biogas process will come out as solids and can then be composted. Some biogas plant technologies have very large tolerance for contaminants in the organic waste and therefore the process is suited to household rubbish. In fact the process can actually be used as a waste sorting mechanism. Using various presses and pumping and skimming techniques plastics, tins, glass etc can be removed. Some waste streams unsuitable for recycling, anaerobic digestion or composting such as construction materials and some mixed and shredded plastics can be incinerated and energy derived from the heat.

The secondary system required is landfill gas harvesting (and burning for energy production) from existing and future landfill sites. Anyhow, land filling is being phased out in Europe due to European legislation. The same greenhouse benefits outlined above can be derived due to methane capture and energy production resulting from non fossil-fuel materials.

4 OPPORTUNITIES FOR BIOGAS UTILISATION

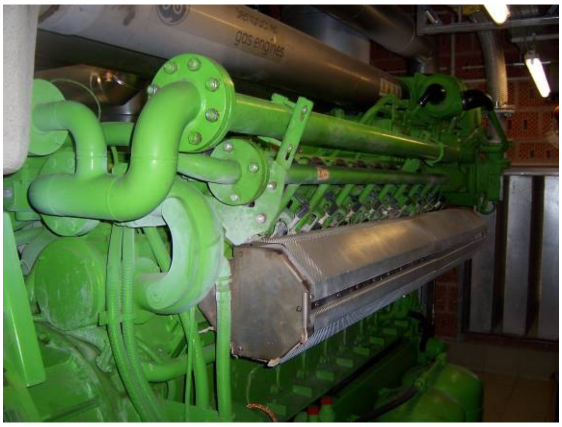
As it was shown in the previous chapters, the conditions for biogas production in Bulgaria, Croatia, Greece, Latvia, Romania, and Slovenia are very favourable. However, the question is which technologies are most promising for the utilisation of the produced biogas?

In general, biogas is an energy carrier which can be used for several energy applications. This includes electricity generation, heat production, combined heat and power production (CHP), and transport applications. These technologies are described in the BiG>East Handbook which is available on the BiG>East website www.big-east.eu.

Biogas upgrading to natural gas quality (biomethane) and feed-in into the natural gas grid is described in the BiG>East report “Biogas purification and assessment of the natural gas grid in Southern and Eastern Europe”, also available at the BiG>East website. Anyhow, this technology is rather new and needs more development. Implementing the biogas upgrading technology can be only recommend in very special cases and in countries with existing experience in biogas production like in Germany where 22 biogas upgrading plants are currently being installed.

For the utilisation of biogas in the target countries, it should be feasible, that all systems and components can be constructed or installed by using domestic labour and engineering services. The technology should also be simple rather than sophisticated, since simple technologies are more robust, easier to maintain and better suitable for the local infrastructure in cases where it is at an early stage of development.

The most suitable system which should be implemented in the BiG>East target countries is a combined heat and power plant operating with combustion engines. The combined heat and power production technology is a well known, robust technology for the utilisation of electricity and heat. CHP generation from biogas is considered a very efficient utilisation of biogas for energy production. Before CHP conversion, biogas is drained and dried. An engine based CHP power plant has an efficiency of up to 90% and produces 35% electricity and 65% heat. The pictures below show typical combustion engines (Gas-Otto-Engines) used for biogas CHP plants.



An important issue for the energy and economic efficiency of a biogas CHP plant is the utilisation of the produced heat. Usually, a part of the heat is used for heating the digesters (process heating) and approximately 2/3 of all produced energy can be used for external needs.

Many biogas plants in countries with good feed-in tariffs for electricity and no incentives for heat utilisation, like in Germany, were established exclusively for electricity purposes, without heat utilisation. Due to the lost income from heat sale of these plants (and some other reasons like increased energy crop prices), many biogas plant operators in Germany had serious economic problems in 2007 and 2008. New biogas plants to be set up in the target countries should therefore always include heat utilisation in the overall plant design.

Biogas heat can be used by industry processes, agricultural activities or for space heating. The most suitable heat user is the industry, as the demand is constant throughout the whole year. Heat quality (temperature) is an important issue for industrial applications. The use of heat from biogas for building and household heating (mini-grid or district heating) is another option, although this application has a low season during summer and a high season during winter. Biogas heat can also be used for drying crops, wood chips or for separation of digestate. Finally, heat can also be used in 'power-heat-cooling-coupling'-systems. This process is known from refrigerators and is used e.g. for cooling food storage or for air conditioning. The input energy is heat, which is converted into cooling through a sorption process, whereby a differentiation is made between adsorption and absorption cooling process. The advantage of cooling by the sorption is the low wear, due to few mechanical parts, and the low energy consumption, compared to compression cooling plants. The use of power-heat-cooling-coupling in biogas plants is currently being tested through several pilot projects.

5 CONCLUSION AND RECOMMENDATIONS

The overall goal in the BiG>East target countries should be to utilize biogas from biogas plants with waste as feedstock. Anyhow, the total amount of waste should be reduced and as much as possible waste should be recycled. In parallel with the implementation of biogas waste treatment and energy production facilities the collection, sorting and recycling systems must be brought up to a high standard.

When the waste streams are correctly sorted and processed there is no need for landfill and the goal must be to completely stop disposing of waste this way. With the right incentives, programs and engineering, the outputs from waste should be (1) recycled/reused material, (2) energy, (3) compost and fertiliser, or (4) products for incineration (in small cases where the first two methods are unachievable).

Biogas systems offer all target countries a primary means of waste disposal, extracting the organic and biodegradable fractions from the waste. The non-biodegradable components extracted can be filtered into recycling facilities. The systems can be adapted in size and design to meet all the listed applications whether they are municipal, industrial or agricultural wastes.

In the interim period while landfills are being phased out, the secondary means of waste utilisation should be the tapping of methane gas liberated from those landfills to be used for heating and electricity generation.

Farm based biogas plants for manure treatment and other agricultural wastes have good opportunities in all target countries. The systems are simple and reliable in use. Typically the plants use energy crops to increase the electrical output.

In conclusion, waste materials for biogas biogas production in the BiG>East target countries should be prioritised. The utilisation of energy crops like e.g. maize as feedstock for biogas production in the BiG>East target countries, either in pure energy crop biogas plants or in co-digestion plants, should be supported with secondary priority. The following table shows opportunities for biogas production in the BiG>East target countries.

	Large farm based biogas plants	Small farm based or community biogas plants	Municipal biogas plants for municipal and industrial waste	Landfill gas extraction biogas plant	Biogas plants connected to industry sites	Biogas plants attached to sewerage treatment works
Slovenia	√	√	√	√	√	√
Greece	√	√	√	√	√	√
Latvia	√	√	√	√	√	√
Croatia	√	√	√	√	√	√
Bulgaria	Limited	√	√	√	√	√
Romania	√	√	√	√	√	√

Regarding the utilisation of biogas, there is no need to implement sophisticated biogas technologies as maybe biogas cleaning systems or fuel cells in the BiG>East target countries. From the economic point of view biogas installations with robust and reliable CHP systems are adequate for all target countries.

However, the selection of a suitable biogas utilisation technology is a case to case decision based on the individual economic conditions. The utilisation of the produced biogas largely depends on factors such as feed in tariffs, tipping fees, and harvesting costs in the target countries.