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OPPORTUNITIES AND BARRIERS FOR DEVELOPMENT OF BIOGAS TECHNOLOGIES IN ROMANIA

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Abstract

The development of technologies for waste treatment, simultaneously with minimizing greenhouse gas emissions, has become a matter of great concern at global level. Biogas systems can help in the fight against global warming by avoiding to escape methane from organic waste, into the atmosphere. Biogas technology is of great benefit to the end-users and the environment by energy, compost and nutrient recovery. Romania is a country with a huge biomass potential. Implementing of biogas technology could be a proper solution for waste treatment and producing of electricity from renewable energy sources, as stipulated in EU and national legislation. This paper presents an overview on the progress of biogas technologies in Romania since 1980s and the main obstacles that have slow down the development of this technology in the context of the major political and economical changes registered in Romanian industry after 1990. There are mentioned the main benefits which biogas plants could bring to the environment and also some common problems with biogas plants which have been noticed in the developed countries in this field.

Keywords: organic waste, anaerobic digestion, biogas plants

1. Introduction

In the last decades pollution of the air and water from municipal, industrial and agricultural operations has grown continuously. The emission of CO_2 and other greenhouse gases (GHG) has become an important concern at global level. Governments and industries are therefore increasingly on the lookout for technologies that will allow for more efficient and cost-effective waste treatment while minimizing GHG.

Biogas is a combustible gas produced by the anaerobic digestion of organic material, e.g. animal manure, human excreta, kitchen remains, straws and leaves through the action of micro-organisms. Biogas is primarily composed of methane (CH_4) and carbon dioxide (CO_2), with smaller amounts of carbon monoxide (CO), hydrogen sulfide (H_2S), ammonia (NH_3), nitrogen (N_2) and oxygen (O_2).

Biogas plants can successfully treat the organic fraction of wastes such as food and alcohol industry waste, crop waste, farm waste, municipal waste, sewage sludge etc. When used in a fully engineered system, biogas technology not only provides pollution prevention, but also allows for energy, compost and nutrient recovery.

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Thus, biogas plants can convert a disposal problem into a profit centre.

2. Policy background

Renewable energy sources are those that produce electricity or thermal energy without depleting natural resources. Greenhouse gas emissions are blamed for the accelerated climate change throughout the world. Thus, renewable energy use and greenhouse gas emission reduction are globally recommended.

The European Commission has taken some important decisions to promote renewable energy in general and biomass in particular. The Directive 2001/77/EC on the promotion of electricity produced from renewable energy sources in the internal electricity market represents the first step of European Union in complying with the Kyoto targets of reducing the greenhouse gases. By the year 2010 the average electricity production from renewable sources should be increased from 12% to 21%. Further more, fossil fuel consumption for transport should also be increasingly substituted by biomass to reach 8% by 2020 (ANRE, 2006).

Romania was one of the first European Union candidate countries transposing the Directive 2001/77/EC stipulations into its own legislation. Romania has adopted many of the needed laws concerning fuel policy and it is working towards complete harmonization. All the directives valid on the European Community have been put into law in Romania (Ofiteru et al., 2008). The national legal framework concerning electricity from renewable energy sources focuses mainly on Electricity Law no. 13/2007 and GD no. 443/2003 regarding the promotion of electricity produced from renewable energy sources, modified by GD no. 958/2005.

According to Romanian Energy Preservation Agency (ARCE), Romania has to encourage the companies and also the citizens for making more investments in energy renewable sources based technologies. The Romanian objective target for 2010 concerning E-RES is that 30% of internal consumption (national production + imports/exports) to be covered by electricity produced from renewable energy sources. This type of non-pollutant energy source is practically endless, in long and medium terms, and is significantly cheaper than conventional sources, especially in condition of a continuous increase of oil price.

Although 40 % of Romania is agricultural area and ca 30% forest, only 10% of the biomass is used for energy production. Currently biomass is used only for heating purposes, direct burning for cooking and hot water preparation consuming the largest share. The Romanian government is planning to implement a new program for increasing the use of renewable energy that also includes biomass and biogas energy (Ionel et al., 2006).

Although in Romania, an indirect stimulating mechanism for utilization of renewable energy sources is regulated, the schemes for direct subvention of prices for which the producers of electricity from renewable sources are selling their product are lacking.

3. Stat-of-the-art in biogas technology development in Romania

Research activities for biogas generation using anaerobic digestion have been performed in Romania since 50' by some laboratory testing regarding active methanogenic bacteria which can produce biogas from different organic substrates.

The researches and experiments performed after 1980 were focused on biogas production both from dejections generated in farms and sewage sludge resulted within wastewater treatment plants. In 80s years, biogas plants operating near wastewater treatment facilities had been generated over 85.000 m^3 a day. It was also been built some biogas plants for treating organic waste in food industry companies, farms, distilleries and several farm-scale plants that facilitated small communities (Ofiteru et al., 2008).

Types of biogas plants used or still in use in Romania are the followings:

- *small facilities*, capacity up to 14 m^3, simple design, biogas production 3 m^3 per day;
- *medium capacities*, capacity 30-50 m^3, simple design;
- *larger capacities*, over 500 m^3 .

Unfortunately, started from 1990, the interest for biogas production by anaerobic digestion, using animal wastes resulted in farms and food industry residual materials, has decreased significantly, due to socio-economical and political reasons on the one hand and, on the other hand, the lack of detailed information concerning process selection and performance. Nowadays, it can be outlined the following aspects concerning biogas production:

- No major investment done in this sector after 1990;
- No maintenance work done on the existing facilities;
- Very few research projects carried out after 1990 on this field. Very few reports on the still functioning capacities;

Considering the economical development that Romania has registered in the last years and also the huge biomass potential, there are good opportunities to develop biogas technologies in Romania.

There are many sources of biodegradable waste in the country suitable for extracting biogas, such as wastes of livestock breeding and poultry farming, food wastes, industrial organic wastes and residues of crops. Municipal organic waste and sewage could also be an important source for biomass processing by anaerobic treatment (Bejan and Rusu, 2007).

Recently it can be noticed an increased tendency for livestock in the animal farms and consequently and increasingly farm slurry for disposal. In 2007, livestock consisted of about 3 mln. of cattles, 8,8 mln. of sheeps, 6,9 mln. of swines and 86 mln. of poultry. The quantity of methane that might have been produced only from animal waste in Romania in the year 2007 was estimated to be $7.05x10^6$ m^3 CH_4/ day (MAPAM, 2007).

In spite of that statistic, the present status shows that biogas technologies are not yet widely adopted in the country.

There are few incentives of foreign companies with tradition in biogas plants to enter the Romanian market and also some laboratory research studies to improve the biochemical processes in anaerobic digesters in order to reach a high biogas yield and to make the biogas plants efficiently from economical point of view economically at current energy prices (Băran, 2008).

4. Reasons to implement a biogas technology

Biogas is a carbon neutral way of energy supply. The substrates from plants and animals only emit the carbon dioxide they have accumulated during their life cycle and which they would have emitted also without the energetic utilization. On the whole, electricity produced from biogas produces much less carbon dioxide then conventional energy supply. 1 kW of electricity produced by biogas plants prevents 7.000 kg CO_2 per year. Biogas burns with a hot blue flame and can be used for cooking, lighting and to run refrigerators.

Biogas can be used for all applications designed for natural gas. It can be used as a fuel in power generators, engines, boilers and burners.

While producing electricity, heat energy can also be recovered by using a co-generator which usually contains an internal combustion engine or power turbine and heat exchanger to capture the heat generated while electricity is produced. Thus, co-generators have higher efficiency in energy production when compared to other electricity generators (Butchaiah, 2006).

The sludge resulted after digestion is rich in basic nutrients such as nitrogen, phosphorus potassium and can be used as high quality fertilizer, so there is no waste in biogas technologies, as shown in Fig. 1 (Bhat et al., 2001).

Apart from getting biogas and fertilizer, decomposition and fermentation of organic material in biogas digesters improves sanitation because the gas and the slurry/sludge obtained does not usually smell, and moreover breeding site for flies and mosquitoes, which transmit disease are eliminated. Most of the pathogens are also killed during the fermentation process (www.thepigsite.com/.../2205/anaerobic-digesters).

There are many benefits resulting from the use of biogas technology, as following:

- *Waste treatment benefits*
  - Natural waste treatment process
  - Requires less land than aerobic composting
  - Reduces disposed waste volume and mass

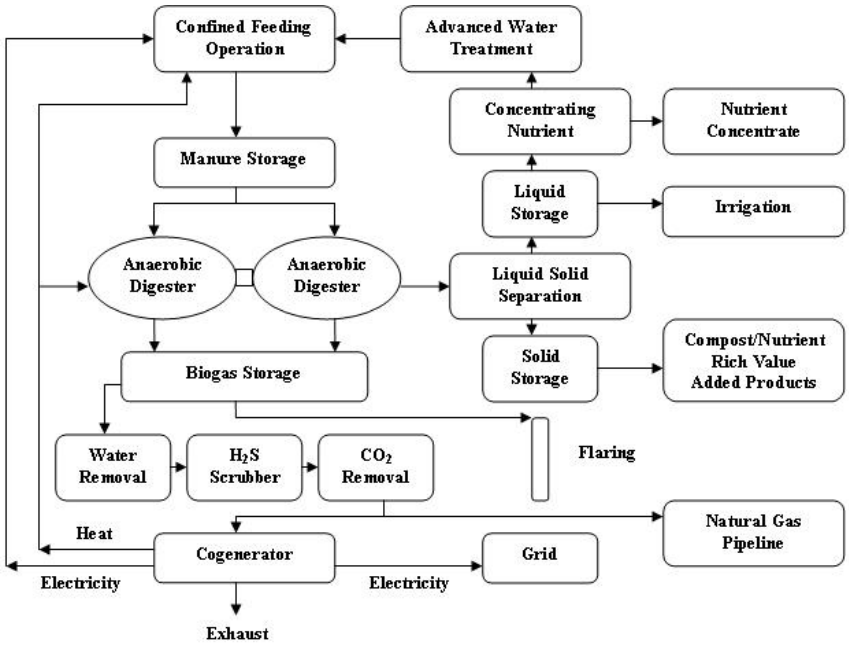

Fig. 1. Flow sheet of a biogas plant with co-generation

- *Energy benefits*
  - Net energy producing process
  - Generates high quality renewable fuel
- *Environmental benefits*
  - Significantly reduces greenhouse gas
  - Eliminates noxious odors
  - Produces a sanitized compost and nutrient-rich liquid fertilizer
- *Health-related benefits*
  - Improved sanitation (reduction of pathogens, worm eggs and flies)
- *Economic benefits*
  - Considering the whole life-cycle, it is more emissions cost-effective than other treatment options
  - Jobs are created (related to the design, operation, and manufacture of energy recovery systems).

In spite of these strong environmental and economic benefits, the production and use of biogas is not yet a common application in Romania due to the main market barriers: lack of knowledge and experience of farmers, biogas plant operators and engineering companies, lack of awareness of decision makers, and insufficient access to funding sources (www.big-east.eu).

5. Potential barriers in development of biogas plants

History shows that biogas plants have not always been introduced with success. Many years, the focus of the government policies was on biogas quantity not quality. This resulted in badly functioning digesters, many of them being not in operation today.

The situation is similar also in Romania. Many biogas plants that were treating farm waste and sludge from municipal wastewater treatment facilities are not operational now due to difficulty of financing and poor maintenance.

To develop and implement biogas technology at large scale it would be useful for Romania to benefit from the experience of the developed countries in this field and to avoid the obstacles these countries faced during their growth.

Biogas systems require a financial investment which is an important obstacle in biogas plants development in Romania and also a management responsibility. The main financial obligations associated with building an anaerobic digester include capital (equipment and construction and associated site work), project development (technical, legal, and planning consultants; financing; utilities connection; and licensing), operation and maintenance, and training costs (Koopmans, 1998).

Installing and operating costs for biogas plants vary significantly as a function of their capacities. For example, in Germany a small biogas plant (output of 100-500 kW), owned by a few farmers working together, cost about 1,5 million Euro. The government doesn't supply any funding for the construction of the plants, but because the revenue that these plants earn is guaranteed for 20 years, it is easy to get loans at a low-interest rate from commercial banks. A large capacity biogas plant which generates an electrical output of 4 MW needs an investment up to 15 million Euro. In USA, for a biogas plant with loading rate of 82 - 110 m^3/day organic waste and a biogas production of 850-1150 m^3/day, the investment costs reach 290000 - 600000 USD. A biogas plant installed at Gordondale Farms, having ca. 800 milking cows and an electrical output of 876000 kWh per year, costs ca. 520000 USD (digester system costs 290000 USD and energy generation equipment costs 230000 USD). The biogas plant installed at New Horizons Dairy Farm (owning 3750 cows), costs 1.526 million USD. Food and Agriculture Ministry of SUA brings an important funding contribution at biogas plants building, which may reach 50% of total costs.

According to the experience of biogas plant development in the past 15 years, it can be said that biogas technologies development in Romania depends on political decisions for funding renewable energies. Each country has got its own development rate and this shows that it is not possible to develop these energies without political and governmental support (Fischer and Krieg, 2005).

In making a decision to install a biogas plant, one must realize that the system will require continuous monitoring and routine maintenance and repair that should not be underestimated. The majority of digester failures over the past few decades were the result of management problems, not technological problems. All the problems of a biogas plant can be minimized or removed completely with a good design and proper operation and management.

Biogas plant projects have significant capital and operating costs and, therefore, may not be financially viable for any application. The biogas experience of some developed countries having great practice in biogas technology (Denmark, Germany, Austria etc) has demonstrated that biogas technology is not applicable for all farms and all climates. In many situations, it can be a cost-effective and environmentally friendly method for treating manure and liquid waste. Biogas production is best suited for farms that handle large amounts of manure as a liquid, slurry, or semi-solid with little or no bedding added (Widodo and dan Elita, 2005). Since anaerobic digestion is a biochemical process that occurs properly at temperatures around 35-37^{0}C, small farm-scale biogas plants are not economically feasible in the long winter climate countries like Romania (Balasubramaniyam et al., 2008). Low temperatures during the nights and the added capital investment are a significant obstacle for successful implementation of biogas plants in Romania.

In addition, operating a biogas plant involves complying with some very important specific safety

requirements. The digester should be located away from farm buildings. Methane can cause explosions even at concentrations as low as 5 percent to15 percent in air. It is desirable to install a gas detector (to monitor either the level of oxygen or methane in the room or space) and alarm devices in buildings with potential explosion hazards. Apart from being explosive, methane can displace the oxygen in a confined space and may result in injuries or even death due to asphyxiation.

The biogas plants must be designed by experienced digester designers, who are well versed with the common problems associated with these types of systems.

6. Conclusions

The energy from biogas is a renewable energy and reduces greenhouse gas emissions (carbon dioxide, methane and nitrous oxide).

Biogas technology is popular for treating biodegradable waste as valuable fuel and ecological fertilizer can be produced along with destroying disease-causing pathogens and reducing the volume of disposed waste. The production of biogas is sustainable, renewable, carbon neutral and reduces the dependency from imported fossil fuels.

In Romania, biogas has been used in the past to a larger amount. Due to socio-economical and political aspects, after 1990 the biogas production has slowed down significantly. The development of biogas plants was limited by weak domestic financial resources for investment and lack of governmental financial support. Nowadays, there are operational only few biogas plants within wastewater treatment plants.

The development and implementation of biogas technologies could bring many environmental, energetically and economical benefits, solving important problems such as waste disposal and renewable energy supply.

Romania has a significant potential in organic waste, including waste generated in forestry sector, agro-food industry, municipal biodegradable wastes and effluents from wastewater treatment facilities. This fact provides a good opportunity to develop anaerobic digestion technologies in Romania, since the funding for R&D of renewable resources and waste management has increased for the last years.

The energy policy focused on efficient and economical energy supply must be changed with a policy towards clean and environmental energy resources.

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