THE BENEFIT OF BIOGAS IN AGRICULTURE

VANGELICA JOVANOVSKA, MILA ARAPCEVSKA, KATERINA BOJKOVSKA
University "St. Kliment Ohridski" Faculty of biotehnical sciences – Bitola, Macedonia

The growing awareness of the pollution problems, associated with inadequate management of animal manure and organic waste, emphasises the need for appropriate solutions to deal with the problem. A strengthening of the overall policy on environmental protection, as regards waste as well as manure handling, with well defined enforcement measures, will stimulate the dissemination of the appropriate biogas technologies.

The application of animal manure, organic waste and other types of biomass as energy sources will depend to a large extent on availability. Availability and implementation is strictly dependent on governments and EU agricultural, environmental and energy policies.

Why biogas ?

Co-digestion of animal manure and other types of suitable organic waste in biogas plants is an integrated process. On the background of renewable energy production, the process includes intertwined environmental and agricultural benefits, such as:
- savings for the farmers,
- improved fertilisation efficiency,
- less greenhouse gas emission,
- cheap and environmentally sound waste recycling,
- reduced nuisance from odours and flies,
- possibilities of pathogen reduction through sanitation, all this connected to renewable energy production.

The attached flow diagram shows the main streams of the integrated process.

CURRENT SITUATION ON BIOGAS/ANAEROBIC DIGESTION

Austria

In the federal states Upper Austria and Lower Austria there are regions with excess of cattle manure. The animal production sets free about 260.000 t CH_4 every year. Regions with more than 7 tons C144 per km 2 will benefit from centralized biogas plants. The potential of biogas from agriculture is about 23 PJ, 78% based on cattle manure and 18% on pig manure. Only 0.1% of it is currently used.

There is no national programme for biogas in Austria, but the federal states, the Ministry of Agriculture and the Ministry of Environment support the new plants, under specific circumstances. The support differs between federal states. Financial support of the installation costs of biogas plants is given by federal agricultural organisations and by the "Osterreichsche Kommunalkredit Bank". The main Austrian companies offering anaerobic digestion plants for manure are: ENTEC Environment Technology GmbH, ESU Energiesparunternehmen GmbH and VSP Anlagenbau.

The planning and building of biogas plants is stimulated by standardisation of the plants. This is carried out with national and EU- support (ALTENER- project: "Typenpldne fiir Biogasanlagen"). Education and training courses for the operators of the biogas plants are tacking place.

46 biogas plants, mainly farm scale, are now operating in Austria, most of them having CHP-production (40-80% CH_4; 14-50 days retention time; 14-29 MJ/m^3). None of them are connected to the gas grid. Co-digestion of manure with other waste is not taking place in Austria. One plant in Salzburg digests separate collected biowaste, MSW and sewage sludge. Centralised plants with a wider range of suitable substrates are proven to be more economic than farm scale plants, but subsidies on the investment costs are necessary for both of them. Anaerobic digestion and composting are seen as complementary technologies. However, most of separate collected biowaste from the municipal collection system is composted.

The driving force to integrate biogas in the energy sector will come from solving environmental and energetic aspects. The target is to increase the number of biogas plants to 150 until year 2000.

The lack of public information about the environmental benefits of using biogas, together with the economical reasons, are the main barriers in Austria. Odour, emission problems as well as legal problems are also limiting the development of biogas. The public acceptance of biogas plants is very good in Austria, in opposition to waste incineration plants.

State of art 1997/98 :

The biogas sector in Austria is expanding in recent times, as in 1997 10 farm scale biogas plants (about 100 t/a) and 5 large scale biogas plants (3000-5000 t/a) have been built. 15 more biogas plants are expected to be taken into operation in 1998. However, most of the separately collected bio-waste, from the municipal collection, is composted.

The main possibilities to increase the number of biogas

plants in Austria, are seen in expanding the biogas technology in farm scale plants, eventually connected to with codigestion of organic industrial waste and MSW.

The building of I I landfill gas utilisation plants will be finished in 1998 and 10 more plants are in planning stage. In 17 landfill sites, the gas is just collected but not used to energy production, for the time being.

The aim of the federal authorities is to install additional landfill gas collection systems at the existing landfill sites. The problem is to utilise the collected gas, as the majority of the sites are rather small and located in sparsely populated areas.

Concerning financial incentives, there is no national support for biogas plants in Austria, but the federal States and the Ministry of Environment support the new plants under specific circumstances. The target is to increase the number of biogas plants from 67 to 150, until year 2000.

Research & development activity focuses on improving anti odour measures at biogas plants, by using bio-filters, improving the purification and utilisation of biogas and making available the long distance gas supply systems for the purified biogas.

Denmark

The concept of centralised biogas plants has been developed in Denmark since 1987. At a present 20 plants are operating, with capacities ranging from 50 to 500 tonnes biomass 1(feedstock per day. Approximately 80% manure, mainly as slurry, is co-digested with 20% organic wastes from abattoirs, other food industries and municipalities. A few plants co-digest sewage sludge or the organic fraction of source-separated household waste, as well. The resulting biogas is mainly used for combined heat and power generation, and the digested biomass is redistributed to a wide range of crops at farms, as nutritionally defined fertiliser. All the plants received investments grants, ranging from 30-40% in the late 1980s to 20% today. The aim is to continuously reduce the investment grants, as the technological and economical improvements are achieved.

20 farm-scale biogas plants were built from 1980 up to now, most of them co-digesting animal manure and small amounts of organic waste. New actions concerning farm scale biogas plant development are ongoing from 1995 and forwards. Special targets are large scale pig farms in Denmark with a high consumption of heat and power.

Operational experience shows considerable improvement in the working economy of the centralized biogasplants. Gas production has increased, primarily due to co-digestion of manure and suitable organic wastes.

The focus is now on further economic improvements that will enable new plants to be built without public investment grants. Operational and capital costs as low as DKK 50 per tonne of feedstock are attainable. In addition, renewable energy equivalent to 20-25 litres oil per tonne is produced. This shows that centralised blogas plants can provide the link to a recycling option, which is often cheaper than traditional waste treatment and other biotechnological treatment. Biogas, as a renewable energy source, is exempted from Danish state taxes, whereas taxes are paid for the energy produced on fossil fuels.

The current situation of biogas production in Denmark is 2.4 PJ per year, as it can be seen below in table 1. Before year 2005 we are heading 4-5 PJ production of biogas. This doubling of biogas production shall mainly originate from manure based codigestion in biogas plants and from full use of landfill gas. An 10-fold increase of biogas production aimed until year 2020, means 20 PJ energy from biogas per year. The actual biogas potential in Denmark is 32 PJ, where 80% is represented by animal manure. The programmes for year 1997-2000 will make possible to double the biogas production and to integrate biogas in to the existing natural gas grid.

Table 1. **Biogas plants and production in Denmark**

Type of biogas plant	Amount of plants	Production TWh/year	Production PJ
Wastewater treatment plants	64	0.18	0.680
Landfill plants	10	0.17	0.622
Industrial waste treatment plants	5	0.04	0.150
Centralised biogas plants, co-digestion	20	0.26	0.941
Farm scale plants	20	0.01	0.032
Total :	119	0.66	2.425

Finland

There are 6631 pig farms in Finland, totalling approximate 1,3 mill. pigs. The total amount of manure is 14 mill. tonnes per year. The farms are reasonably small and located relatively far from each other. There are no problems with excess manure and the costs of transport would be very high in a centralized biogas plant situation. Biogas production is almost non-existent because of the current legislation, that allows cheaper ways to handle animal manure. The common method of manure treatment is composting. ASJ Stormossen biogas plant in Vaasa, produces about 1,7 mill. Nm^3 biogas per year (10200 MWh) by processing MSW. Some experimental farm scale biogas plants processing animal manure are operating as well.

There is no actual national program on biogas, but the association “Biogas Centre” is promoting the use of biogas. The University of Joensuu is doing some research about anaerobic digestion. Feasibility studies concerning establishment of new centralised to plants are going on, but no deci-

sion has been made so far. Support on R&D and demonstrations programmes can be obtained.

Organic waste is landfilled and four of the sites are now equipped for landfill gas collection. The practice of landfill gas collection is expected to increase in the near future, while the development of co-digestion will be slower. In order to promote biogas development, environmental aspects are to be taken into consideration.

The main barriers for implementation of biogas technologies are: the current Finnish legislation that allows cheaper ways of treating manure, relatively low price level for electricity and fuels compared with other European countries and the high costs of biogas caused by the relatively dispersed location of the farms. The public opinion is favourable to landfill gas collection, while centralised waste treatment in large plants is considered less attractive, because of traffic and odour problems. Farm scale biogas in systems will probably develop.

Environmental legislation will be stricter in the future, and landfill will be avoided. Energy production is allowed as a possible solution of waste handling.

Italy

There are tree regions in Italy (Emilia Romana, Lombardia and Umbria), where the density of manure is higher than the capacity for land utilisation.

Five centralised biogas plants are built or under construction in Italy, and more than 150 farm scale plants. Approximately 50 of the farm scale plants are still,operating. The number of biogas plants has increased in the last two years. Pre and post treatment systems are under development. The post treatment systems aim at an improvement of the AD by reducing the dilution of waste.

There is no longer a program on biogas in Italy, but the Electric Company of Italy is obliged to buy the electricity produced from biogas, at almost 80% more than the electricity price for end users.

The legal problems connected with the reutilization of the treated water is considered to be the main barrier concerning biogas development. A reinforcement of a recycling post treatment program of the digested manure is needed. Cleaner technologies to post treatment of the digestate, resulting in exp. clean water, organic and inorganic fractions, are to be integrated.

The Netherlands

At present all centralised biogas plants for manure digestion are closed for financial reasons, as a consequence of expensive processing and transportation of biomass and low value of the product. Among them was PROMEST B.V., in Helmond, the national demonstrations plant for pig manure digestion, with a designed capacity of 100.000 tonnes. It started operating in 1990 with a to steps process, anaerobic digestion in a 4000 m^3 digester, followed by processing the digested manure to dry granules.

Around the year 1980 more than 30 farm-scale biogas plants were installed. The high operation costs and low fertilizer value of the digested manure led to today's situation when most of the plants are no longer in operation. No new plants were built since then. Some innovations in farm scale pig manure treatment has been made concerning volume reduction (drying/de-watering) in which pig manure is directly pumped away, NH_3 is converted and produces distilled water in a two steps process. Manure volume is reduced by 90% and NPK fertiliser with high dry ash content is produced.Anaerobic digestion is at present mainly used for sludge treatment and for waste water cleaning. A large scale plant for organic industrial waste is operating in Breda and a number of pilot plants are operating in Balk. 2 large scale AD-plants are planned to be installed at Moerdjik and Grononge, as national demo-sites for the digestion of the mechanically separated organic fraction of MSW (municipal solid wastes). Both initiatives are still very uncertain. An implemented technology is the one promoted by BIOCEL, consisting in a three steps process for treatment of solid wastes: preprocessing, digesting (15days , at 35OC-) and product valuation, implemented in Lelystad at Heidemij, the first anacrobic digester for VGF (vegetables/ garden/fruit). National anaerobic digestion - VGF measuring programmes were implemented at two locations Tilburg and Lelystad aiming to examine the advantages of AD over composting, the current practice in the Netherlands. Conclusions are expected to be drawn in January 1998.

For many years, a discussion concerning a large scale introduction of anaerobic technologies for the treatment of the organic fraction of MSW has taken place in the Netherlands. The discussion is closed for the time being, and DAAD, the largest Dutch organisation of companies offering AD systems has recently ended all activities. The current choice made in the Netherlands are in general not in favour of AD-solutions. For the future of AD as a treatment method for the organic fraction of MSW, it will be relevant to find out whether AD can offer an alternative for composting, by producing biogas and a better quality compost. AD combined with mechanical separation of the organic fraction of MSW can have a major impact on the Dutch waste infrastructure.

The main parameters affecting feasibility of biogas plants are:

- The legislation concerning introducing minerals into the soil is very strict in the Netherlands. Value of digested manure is very low.
- The same legislation strictly prescribes the high quality of compost, and implies import restrictions on bringing digested manure to the market.
- The main focus concerning manure policy is on ammonia reduction (Ammonia Reduction Plan-ARP. December 1995).
- Co- digestion of manure with other organic wastes is not allowed.

- Values of biogas and heat are low in the Netherlands.

The main barriers for introducing biogas based energy systems in the Netherlands, that makes the large scale transition to anaerobic digestion technologies unlikely within 5 years, are assessed to be the already established infrastructure of aerobic composting of VGF (vegetables/garden/fruit), completed in 1995-'96 and the low price of natural gas.

Portugal

In Portugal there are regions with high concentration of pig farms in Santarem, Leiria, Montijo and Rio Maior. In these regions are operating 4 centralized biogas plants at Lourinh.q, Rio Major and Leiria. About 60 farm scale plants are operating in the central and the southern part of the country.

The centralised biogas plants operate with not very satisfactory results, due to an inappropriate choice of treatment method. The most common used technologies are anaerobic digestion with biogas production (plug-flow, up-flow anaerobic sludge blanket, conventional digestion and anaerobic filter), activated sludge, composting treatment lines. Co-digestion of manure and other substrates do not takes place in Portugal. The actual distribution of biogas systems in each economical activity are shown in table 2.

Table 2. **Actual distribution of biogas systems in each economical activity.**

Economical activity	Installed systems
Pig-breeding	71
Poultry	8
Bovines	5
Milk-food	3
Distilleries	1
ETAR (Intergraetd systems in domectic sludge tretment stations)	12

The national programme "Energia" supports the biogas production activities as part of the renewable energy production. Further support projects are promoted by public or private entities. Workshops are an usual method to promote and stimulate biogas production. Environmental benefits as well as the possibility of the initial investments amortisation, in reduced periods of time (3 to 7 years), with the commercialisation and/or use of the produced energy, are underlined as the driving force to integrate biogas in the energy sector.

The main problems are the insufficient incentives, high investment costs and low income. The lack of monetary incentives affects the possibilities of improving the technical knowledge and results in a low quality of constructions and equipment, a low level of maintenance of the existing plants and a deficient control and exploration of the systems.

There is optimism in Portugal about the future of biogas, even though there is very little public awareness about it. The public is aware of the problems concerning water effluent pollution and everybody wish solutions to be found. That brings biogas in a favourable position, as a possibility of non-pollution and energetic valorisation of drains built by combined agricultural and food-industries and sludge from domestic effluents' treatment stations.

Spain

The importance of waste treatment is increasing. Environmental aims are the main driving force. Currently, there is no activity in this area in Spain. However, sizeable subsidies were given ten years ago for constructing anaerobic digestion plants.

There is also very little public awareness about biogas from anaerobic digestion. The efforts in information dissemination will increase, as more environmental measures will be implemented.

Sweden

Sweden has problems with inefficient utilisation of manure nutrients, resulting in leaching to lakes and sea along the western coast. Part of this nutrients originates from pig manure. The number and the production of the Swedish biogas plants are shown in table 3.The potential energy production is estimated to 3 TWh/year for the year 2005, and 5-6 TWh/year for the year 2020.

Several actors are showing interest in anaerobic digestion. Increased at-source separation of MSW and industrial waste demands sustainable solutions for treatment of organic waste. Stricter regulations for landfilling and the expected introduction of a landfill tax are also anticipated to lead to the development of alternative treatment methods for waste. The agricultural sector have an interest of using the residues from anaerobic digestion of crops and clean organic waste, in order to return nutrients to the soil and to decrease the dependence on mineral fretilizer.

A number of technologies, mainly regarding MSW and organic waste -rom in ustries, A restaurants and households are put into practice. Manure is a minor fraction of the sub-

Table 3. **Biogas plants and production in Swenden.**

Type of biogas plant	Amount of plants	Production TWh/year	Production PJ
Wastewater treatment plants	134	0.18	2.92
Landfill plants	59	0.43	1.55
Industrial waste treatment plants	8	0.09	0.32
Centralised biogas plants, co-digestion	4	0.02	0.07
Farm scale plants	6	< 0.01	< 0.04
Total :	211	1.36	4.9

strate in all cases. The technologies are mainly traditional slud-e in continuous reactors, combinations of composting with limited biogas production and landfill gas collection. In 1997 NUTEK intends to start a R&D programme regarding Energy from waste, including anaerobic digestion. Since 1993, NUTEK/Swedish Farmers Foundation for Agricultural Research, are jointly operating a development programme for biogas from crops. Research, development and demonstrations efforts also concern landfill gas. During recent years, the interest in building biogas plants has increased, aiming energy supply as much as environmental benefits. There is also a growing interest in using residue from anaerobic digestion for soil improvement. This implicates the digested material must fulfil strict environmental demands, such as sanitation, free of hazardous residues etc. Under this circumstances, the public acceptance of biogas is generally good. The main driving force in Sweden are a combination of several factors such as the restriction on using landfill and the taxes on CO Additional taxes on other emissions 2' $NO_{,,}$) would increase the market value of biogas as motor fuel. The main barriers for biogas development in Sweden are the low value of electric power and the abundance of woody fuels at low costs used for district heating. The Swedish Environmental Protection Agency have developed an Action Plan for Waste (Aug. 1996), where more specific goals for waste management are suggested, such as to ban landfill of organic waste by the year 2005. This will most likely increase the interest for anaerobic digestion and composting.

State of the art 1997/98 :

A new research programme, with funding of 10 MSEK per year, will start in 1998, managed by the Swedish National Energy Administration (which is, from now one, replacing NUTEK). The programme is motivated by the changes in waste management and waste streams, and will focus on system analysis, changed conditions for waste incineration, and production and utilisation of biogas from anaerobic digestion and landfill gas. !0 pilot projects are selected for the first phase of the programme, 1998/99. 3 or 4 new installations for anaerobic digestion are expected to be taken into operation in 1998. Biogas is used in Sweden as vehicle fuel. Seven units for upgrading and filling of biogas are in operation at present. the cost of upgrading biogas to vehicle fuel standards is between 0,15-0,2 SEK per kwh.

More developed systems for at-source separation will facilitate material recovery but also create cleaner fractions of waste for anaerobic digestion. A landfill tax will come into force, which will create increased economic incentives for other forms of waste management.

Table 4. **The status of digestible biomass in the 15 EU countries**.

	Animal manure				Municipal waste generation			
	Total cattle manure (1993)	Total ping manure (1993)	Total manure (1993)	Population (humans) (1993)	Total waste (450 kg/ capita)	Organic waste (30% of total)	Sewage sludge (1990)	Industrial oragnic waste disgestible < 35 % DM (100 kg/cap)*
	mill. t	mill. t	mill. t	mill. t	mill. t	mill. t	mill. t	mill. t
Austria	25	8	32	7.7	3.5	1	2.3**	0.8
Belgium	35	14	49	9.9	4.5	1.3	0.7	1
Denmark	22	22	44	5.1	2.3	0.7	1.3	0.5
Finland	14	3	17	5.1***	3.1***	0.7	0.1	0.5
France	211	26	238	56.5	25.5	7.6	0.6	5.7
Germany	167	51	218	62.7	28.2	8.5	1.8	6.3
Greece	6	3	9	10	4.7	1.4	-	1
Ireland	66	3	69	3.5	1.6	0.5	0.6	0.4
I taly	80	15	95	57.6	25.9	7.8	3.4**	5.8
Luxembourg	2	0.2	2	0.4	0.2	0.02	0.02	0.04
Netherlands	48	28	77	14.9	6.7	2.0	0.3	1.5
portugal	14	6	20	10.3	3.4***	1.0	-	1
Spain	53	37	89	38.9	17.5	5.3	10	3.9
Sweden	19	5	24	8.6	3.9	1.2	0.2	0.9
U. Kingdom	125	16	141	57.3	25.8	7.7	1	5.7
Total EU :	887	237	1124	348.5	156.8	46.9	22.32	35.04

Table 5. **Estimated potential of energy production from biogas - year 2020**

	Total biomass mill. tonnes	Total energy from biogas TWh/year	Total energy biogas PJ
36.1	6.1		22.0
Belgium	52.0	8.8	31.7
Denmark	52.5	8.9	32.0
Finland	18.5	3.1	11.3
France	251.9	42.7	153.7
Germany	234.6	39.8	143.2
Greece	11.4	1.9	7.0
Ireland	70.5	11.9	43.0
Italy	112.0	19.0	68.3
Luxemburg	2.08	0.4	1.3
Netherlands	80.8	13.7	49.3
Portugal	22.0	3.7	13.4
Spain	108.2	18.3	66.0
Sweden	26.3	4.4	16.0
U. Kingdom	155.4	26.3	94.8
Total EU :	1 234.3	209	753.0

Table 6. **Number of biogas plants based on animal manure in EU countries and biogas production**

	Number of biogas plants	Biogas production	
Austria	23	1.410	32.900
Denmark	39	45.150	1.052.090
Germany	500	-	-
Greece	2	0.001	33
Netherlands	3	1.960	45.630
Italy	70	6.880	160.250
Norway	4	0.620	14.450
Portugal	16	1.520	35.300
Spain	6	0.026	625
Sweden	12	19.430	452.700
Switzerland	59	1.790	41.700
U. Kingdom	31	-	-

United Kingdom

The main concentration of pig manure is in Yorkshire, Humberside and Suffolk areas.

At the present no centralised anaerobic digestion plants (CAD) are operational in UK, but 18 applications are included in the Non Fossil Fuel Obligation (NFFO) programme.

40 farm scale plants were built, but only 20 are operational. Governments grants for construction of manure storage capacities are available.

Considering the implemented technologies, the current NFFO round (IV) allows up to 20%(dry weight) food processing waste to supplement agricultural waste. Co-digestion of MSW and agricultural waste is not tacking place, due to waste licence implications and to implications for marketing the fibre and the digested material.

Stimulation of AD has been principally through three mechanisms:

1. Extensive support of biogas projects for research and development as well as demonstrations. The renewable energy programme has covered all sectors of the biogas industry, including farm scale plants, landfill gas extraction, AD of MSW and digestion of industrial effluents.

2. The NFFO has provided a premium electricity price to schemes ranging from landfall gas and digestion of source

separated organic fraction of MSW to digestion of agricultural and food processing wastes.

3. Increasing the costs of management disposal through the increased licensing requirements on waste producers, landfill tax and increased standards of landfill.

The value of energy from AD is low in comparison to the value of environmental benefits. However, the energy contribution to the economic performance of the plant is necessary for the system to be viable. Both aspects are considered to be needed environmental benefits and energy sales. UK Government energy policy is to encourage renewable energy production to 1500 MW, through NFFO and the renewable energy programme.

The public reaction to AD is variable and depends of previous experience and the amount of exposure to the technology.

INVENTORY

Table 4 presents the status of animal manure, organic fraction of municipal waste and sewage sludge in the 15 EU countries. Table 5 presents the estimated potential of energy produced on biogas, considering biomass data in table 4 and a minimum gas yield of 25 Nm^3 biogas per ton biomass.

THE FUTURE DEVELOPMENTAL STEPS9 FOR INTRODUCTION OF BIOGAS / ANAEROBIC DIGESTION (AD) IN EUROPE.

The conclusions that can be drawn at the moment, considering the present situation of biogas in EU countries are as follows:

The last years meant a breakthrough for biogas production and technologies in most of the European countries. The interest for biogas is also growing outside Europe. After a period of stagnation, caused by technical and economical difficulties, the today's revenue mainly consists of the sale of energy, while the biogas plant and the organisation behind it can simultaneously contribute to solving a series of environmental problems. An actual shortage of fossil resources and the evolution of energy prices have an important role to play in the future development of biogas production.

Concerning the development of biogas production, the last period of time involves huge steps forward, towards a mature biogas technology and economic sustainability for both small and large scale plants in Denmark, development of small and large scale plants in Germany and Switzerland, with interesting organising experiences and a new "do it yourself' method, successfully developed in South Germany, utilisation of biogas as transportation fuel in Sweden, interesting perspective and concrete biogas projects in England and Ireland, as well as a come back for biogas in the Netherlands due to public support and interest for the issue.

Denmark has 20 centralized plants and 20 farm plants in operation. In addition there are 5 plants at industrial companies. Sweden has 4 large plants based partly on household wastes, 8 industrial plants and 6 farm plants in operation. Germany has more than 200 rm plants,,and there are a number of farm plants in Austria, taly,'@oftdfal-and ng and. T main conclusion is that the use of biogas in Europe is modest in relation to the raw-material potential, and biogas produces only a very small share of the total energy supply.

The most commercial and technically mature anaerobic digestion systems are those designed for the digestion of animal manure, both on and off-farm and in some cases for CO-digestion of animal manure and residues from slaughter houses, breweries and a wide range of other food-processing industries as well.

Future development includes the use of new feedstocks, by-products from food processing industries as well as the biological degradation of toxic organic wastes from pharmaceutical industries or other industries by safe and secure sanitation. More careful control of digester temperature and retention time, and optimising the C:N ratio will increase gas yields. Reducing capital costs and management costs are as well targets of the future development of biogas systems.

Sewage sludge is another main input considering digestion and co-digestion. Digesting sewage sludge is a common practice in the EU countries, especially for medium and large plants, conducted by the municipalities or related companies, but major environmental concerns about the content of heavy metals and non-degradable organic chemicals must be taken into consideration.

Anaerobic digestion of MSW is the least commercial and the least mature of the inputs. There are considerable mechanical problems in handling and preparing the feedstock and a need for specially designed digestion systems for this purpose but there are quite many future perspectives concerning recycling and combining AD and composting.

Some countries have implemented biogas development programmes or have the financial instruments, among others state subsidies to do it, but no strong developmental and co-ordinated AD-programmes are implemented yet between the 15 EU countries.

A number of biogas projects, including centralized and decentralized digestion, are already included in some of the national energy programmes as part of renewable energy programmes or as demonstrations programmes. There are as well countries where the present legislation or the insufficient incentives are barriers in the development of biogas systems.

One of the drivingforcesfor integrating biogas production into the national energy systetm is the necessity of solving environmental and sanitation problem". Biogas must not only be seen as a renewable energy source, but even more as one of the promising solution to the huge environmentalproblenu concerning waste and manure handling, waterpollution, CO_2 emission etc. The establishment of all centralized and decentralized biogas plants in the EU countries is directly or indirectly a consequence of a strengthening of the enforcement of environmental policies in fitose countries.

The public perception of biogas is generally positive, especially concerning the decentralized concept and small scale projects. It differs from country to country, according to previous experiences with biogas systems, and according to the level of information about biogas, energy and environmental issues There is scepticism concerning large scale projects because of logistic and fear of odour problems and because of large investment costs of the new integrated technologies.

The public awareness will increase, as more restrictive the environmental laws become as more information about it is disseminated. The best way to overcome public epticism is to implement successfully full scale operation of different sizes in each country, regarding optimisation of aspects concerning energy production, environmental and agricultural benefits, pathogen reduction etc.

What should be done ?

The main strategy concerning the promotion of biogas production in particular and of energy production from renewable sources in general, as well as overcoming of the existing barriers on an overall level, could be directed as:

* Programmes to stimulate recycling of organic waste/ organic resources, especially wet organic waste containing less than 35 % dry matter.

* Harmonisation of animal manure storage and handling requirements throughout EU 15. Focus on industrialised animal production, such as large scale big production, with no or little land area to recycle organic waste through crop production.

* An overall strategy of mandatory harmony between animal stoking rate and farmland area, or demands for maximum limits of nitrogen and phosphate fertilisation, following EU environmental strategies, exemplified as the nitrate directive.

* Improvement of the present technologies.

- The need to reduce costs of advanced technologies.
- Concentration on developing suitable scale systems.
- R&D on small systems.
-Improved post treatment/separation technologies,

due to the need to overcome transport and processing constraints. Finding and implementing new post treatment technologies.

- Concentration on finding solutions to avoiding the odour in the vicinity of plants.

* Programmes for active promotion and dissemination of biogas technologies and knowledge transfer.
* An overall policy to stimulate electricity production from renewable sources. Clearer energy policy and strategy for encouraging use of renewables in combined heat and power systems.
* Stimulation of wider use of district heating networks or heat recovery to processing industries, converting heat to cooling, especially in the Mediterranean areas.

Penetration of biogas on energy market is expected to grow rapidly, as soon as problems of economics and market acceptability are overcome. This is expected to happen in relatively short time, as a consequence of the growing share of renewables in the worlds energy supply.

In EU, where only about 5% of the gross consumption is renewables, which is lower than in many parts of the world, the share of renewables is expected to double by 2010, and the share of biogas, as part of it, is expected to rise to 12%, according to the white book of the EU-Commission from 1997.

However, the rate at which biogas can enter the market is often dictated by significant subsidies. And even though environmentalists are positive about this kind of energy, there are still a lot of opposition an barriers that must be overcome throughout Europe. It is only by everybody's continuously joint forces that progress can be made year by year in this direction.

LITERATURE

1. Dimitrovski, M., MOTORI SVS – Masinski fakultet – Skopje.
2. WEB:www.biogas.org
3. Jovanovska, V., M. Dimitrovski, Rezultati od merenjaa na emitirani stetni materii od vozila so MSVS " MOTO – AUTO ' 99 " Plovdiv- R,Bugarija.
4. Mirsad, D., 1986. BIOGAS , BEOGRAD

THE BENEFIT OF BIOGAS IN AGRICULTURE

V. Jovanovska, M. Arapcevska, K. Bojkovska
University "St.Kliment Ohridski", Faculty of biotehnical sciences-Bitola, Makedonija

SUMMARY

Becouse of pollution problems, specialy associated with inadequate management of animal manure and organic waste, emphasises the need for appropriate solution to deal with the problem. A streghtening of the overall policy on enviromental protection, as regards waste as well asmanure handling, with well defined enforcement measures, will stimulate the dissemination of the appropriate of the biogas tehnologies.

The application of animal manure, organic waste and other types of biomass as energy sources will depend to a large extend on availability. Availability and implementation is strictly dependent on governments and EU agricultural, environmental and energy policies.

Co-digestion of animal manure and other types of suitable organic waste in biogas plants is an integrated process. On the background of renewable energy production, the process includes interwined environmental and agricultural benefits, such as:

- saving for the farmers-improved fertilisation efficiency,
- less greenhouse gas emission,
- cheaper and environmentally sound waste recycling,
- reduced nuisance from odours and flies,
- possibilities of pathogen reduction through sanitation, all this connected to renewable energy production,

The attached flow diagram shows the main stream of integrated process.

Kew words: *anaerobic digestion, biogas, integrated proces*