Manure Management Systems – Biogas Systems

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■ Introduction

After reunification of East and West Germany the image and the structure of agriculture changed fundamentally. While in the west part the more "family type" of farmer was characteristic, in the east part the "industrial" large-scale agricultural operations were dominating the scenery.

In the 1990's the fundamental problems arising from the traditional way of farming and agricultural activities – in particular handling of the raw manure – were in the focus of public awareness and discussion. Problems like:

- foul smelling odour
- ground- and surface water pollution
- uncontrolled methane emissions (35 times higher greenhouse effect than carbon dioxide)

and the increasing affects on the overall environment were seen as major reason for a significant reduction of tourist numbers.

The economy of the Island of Ruegen (Germany's largest Island, 974 km^2, Baltic sea area) was based on two main sectors: Agriculture/fishery and tourism. As an outcome of a German Government funded integrated energy concept for this Island (Provincial Government of Ruegen, 1993; Fachinformationszentrum Karlsruhe GmbH, 1993), the location and the basic design as well as the positive economic evaluation for the biogas plant Pastitz were prepared by the company ECB.

The biogas plant started operation in February 1997 with a treatment capacity for organic waste of 100,000 tonnes/yr. The plant produces approximately 3.8 Million m^3 biogas per year, which is transferred into heat and electricity in a

cogeneration unit with a total power of 1.0 MW_{el} and 1.5 MW_{th} energy, respectively. The electricity is sold to the public grid for a fixed rate per kWh (0.10 €cent according to German Renewable Energy Law, Federal government of Germany, 2000). The heat energy is sold to a nearby residential area through a short district heating system (hot water and heating). The system is producing 95,000 t/a fertiliser, which is applied to the fields of the farmers in a liquid form. The farmers also deliver the raw manure to the plant and own the plant in a cooperative model (farmers and local transportation companies).

■ German and EU Policy on Renewable Energy

In the first section of their Renewable Energy Sources Act the German Federal Government states, that it is the purpose of the act, *"…to facilitate a sustainable development of energy supply in the interest of managing global warming and protecting the environment and to achieve a substantial increase in the percentage contribution made by renewable energy sources to power supply'*. The share of renewable energy sources in total energy consumption shall be at least doubled by the year 2010 in keeping with the objectives defined by the European Union (EU) and the Federal Republic of Germany."

The EU countries showed a rapid expansion of renewable energy during the 1990s that is based on a long established policy of supporting renewable energy politically. The "feed in" law system such as the German Renewable Energy Sources Act, which combines guaranteed feed-in tariffs with an obligation on utilities to purchase renewable electricity, leads to high contribution of renewable energy in the market. For example, in Germany, Denmark and Spain about 13 % of gross electricity consumption was generated by renewable energy sources in 1999, without including hydroelectric.

The basis for the strong development and success of innovative technologies in this sector was the fiscal, financial, administrative support and also support with information, education and training. So called "energy agencies" have been established locally to stimulate the expansion of renewable energy and energy efficiency in their area through public and private sector initiatives and local community involvement.

The EU target is to have a market share of renewable energy of at least 12 % (1999: 5,9 %) of the gross inland energy consumption. Conversion of biomass (including biogas technology) is regarded as one of the most important technologies to reach this goal (European Environment Agency, 2001). The German Federal Government aims for a 25% reduction of CO_2-emissions based on the reference year of 1990 and was one of the leading countries in signing the Kyoto commitments.

■ Canadian Market and Conditions

Canadian farm operators know the level of commitment it takes to remain successful in an ever-changing environment. They routinely face significant challenges such as the diverse climate, varying soil conditions, and the cost of keeping current with rapidly advancing farming technology, changing legislation and regulatory reforms.

In order to ensure a sustainable future, those involved in the farming industry must rely on dedication, education, insight and innovation. One of the major opportunities for family farms today is the conversion of land from grain crops to pasture and forage production in response to a market shift favouring the livestock sector.

This growth comes with its challenges – especially increased demand for responsible manure management. Rules and regulations are in place to ensure that livestock expansion can occur while respecting the quality of life of all individuals within the surrounding community. The primary concerns with current manure management practices include:

- Surface and groundwater contamination
- Odour created from storage and spreading of manure
- Emissions of methane and nitrous oxide as greenhouse gases.

The need to find efficient and cost-effective manure management solutions are paramount. Odour and disease control, as well as water quality protection and new aspects of nutrient management, have become priority issues in Canadian farm operations and municipalities. Environmental concerns and the high rate of urban and suburban sprawl is changing the landscape of the farming industry and the way it is perceived by Canadian communities and municipalities.

There is need for a solution that can ensure this expansion is managed to the satisfaction and benefit of the farm operator, the municipality as well as the community.

■ Integrated Waste Management System (IWMS)

Incorporating an IMWS into a livestock operation will allow excess organic waste to be turned into resources that produce renewable energy, organic fertilizer and reusable water.

The IWMS incorporates wastewater treatment as well as aerobic and anaerobic digester systems. The anaerobic digester system is designed to hold decomposing manure under controlled, oxygen-free conditions that promote the

growth of naturally occurring bacteria. These bacteria digest manure, produce methane and an effluent that farmers can use in place of untreated manure.

Methane gas produced by digesters – biogas – can be captured cost-effectively and used as an energy source. Farmers can use biogas to produce additional electrical and thermal energy while almost eliminating odour and methane emissions. Production of this electricity reduces operating costs and makes the operation more self-sufficient by minimizing dependency on an outside energy provider. The process also prevents surface and groundwater contamination.

As the use of the system proceeds, treatment could involve aerobic digestion or composting of manure solids into compost fertilizer. Processed, digested solids could be marketed to farmers or gardeners as a high quality fertilizer. Liquid effluent can be processed through a wastewater treatment process and reused in farm applications. Excess electricity produced from captured methane could be sold off to electric utilities.

It doesn't matter in Germany at what time you will feed your electricity into the public net because any single kWh is paid with 0,10 €. Under Canadian market conditions an effective load management considering peak hours and peak prices of local utilities will be more important. Modern engines or CHP-units (Combined Heat and Power) are producing near to 40 % electrical energy and more than 50 % thermal energy and are running without any problems at any stage of power down to 50%, in combination with modern H_2S removing processes. So in combination with biogas storage systems, which are able to store daily biogas production for 4-6 hours and even longer, the energy can be used at the most "valuable" time. Such benefits represent significant potential revenue and cost savings, which are critical to the viability of today's farm operators.

This system is an economically viable and environmentally responsible technology for managing manure and its emanating valuable resources. Livestock producers who set up this system can:

- derive economic benefits from organic carbon and nutrients contained in the manure
- offset greenhouse gas emissions
- eliminate adverse environmental impacts.

All levels of government – Federal, Provincial and Municipal – are seriously seeking to create incentive programs that protect our water supply and reduce greenhouse gas emissions. Programs currently under consideration include grants, cost sharing, low-interest loans, demonstration projects, information and technical support. Taking advantage of this opportunity means that farm operations could take advantage of the assistance programs. In addition, the

farmer will be seen as a concerned and progressive leader in the industry and your community.

The timing is right. Here is a chance for farmers to positively impact current farming concerns, increase the productivity of their operation, and create a sustainable business model for future farm generations:

- Offset fluctuating revenues from crops and livestock
- Realize additional source of income to ensure sustainability and growth of operation
- Reduce dependency on crop insurance and government assistance programs
- Contribute positively to reducing greenhouse gas emissions (GHG).

No matter what the farmer's primary objective may be, this is an opportunity worth investigating.

■ Lethbridge Pilot Project – Results of the Feasibility Study

The results of an in depth feasibility study into the adaptability of a European-based agricultural waste management technology to North American standards has delivered very promising results. The study demonstrates conclusively that the IWMS is an economically viable as well as environmentally efficient solution for the Canadian agricultural community (Federation of Canadian Municipalities, 2002).

The feasibility study analyzed the manure mix in the County of Lethbridge, determined an optimal and efficient treatment process with identified recoverable resources capable of sustaining an economically viable manure treatment operation. It concluded that commercial viability and sustainability of the project was based on a recommended IWMS treatment facility utilizing 100,000 metric tonnes of agricultural manure and organic wastes per year. This facility will reduce GHG emissions by approximately 15,000 metric tonnes of CO_2 equivalent per year, while generating almost 15 GWh of electrical energy and of thermal energy – enough to supply all of the energy consumption for over 900 Canadian households.

The project was conducted in partnership with Outlook Pork Ltd. and the County of Lethbridge, in Alberta. It was also supported by the Industrial Association of Southern Alberta. Outlook Pork, as well as many other farmers, has been proactive in the search for new ways to manage livestock manure for some years.

The advent of such a promising technology comes at a time when governments, both federal and provincial, are struggling with the increasing pressures put on the environment by large scale farming operations. Several provincial governments have already adopted nutrient management legislation and the issue of water and air quality continues to fuel public debate. Putting to together the right ties, the IWMS solution can be a win-win solution for Canadians - farmers and associated businesses, governments and communities.

Conclusion

The IWMS demonstrates how to move towards to a more sustainable society in the agricultural sector while also fulfilling the aims of the Kyoto commitments. IWMS solutions offer:

- environmental responsibility (controlled manure discharge, reduction of odour, reduction of greenhouse gas emissions, producing a renewable green energy)
- enhanced farming efficiency (streamlined operations, increased productivity, effective utilization of recycled farm manure)
- community development (integration of new technologies, protection of natural resources, economic stimulus, community partnerships, public private partnership opportunities),
- economic benefits (farmers, business, communities, government)

Mindful of the economic and social benefits of being environmentally responsible, Integrated Waste Management Systems can be regarded as an pro-active approach to energy conservation, clean air, waste reduction and recycling.

For the Canadian market, Integrated Waste Management Systems can improve operational performance of farms. Both large and small family agricultural operations can benefit from this technology while improving environment and quality of life for everyone in the communities.

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