

# What is Realistically Needed to Make Biogas Work? - Energy Policy, Financial Grants, Personal Conviction

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## ■ Introduction

Biogas production through anaerobic digestion is a technology option that has received increasing attention throughout North America over the past number of years. The technology, of course, is not novel, and was intensively explored during the 1970's energy crunch/boom depending on which side of the market one was on. As oil and gas prices plummeted during the 1980's so did interest in biogas production from organic residual materials, known in some circles as 'organic wastes'. This represents one of the key factors that must be considered in biogas system planning and assessment efforts. Biogas production is not a cheap source of energy, however, the adoption of anaerobic digestion technology provides a number of valuable products, some of which have been assigned value in today's society, and some that have not. The pros and cons of biogas production in Canada will be further discussed in the context of industry growth in select regions of the country and contrasted with efforts being expended in select EU member states.

## ■ What is Biogas?

Anaerobic digestion (AD) is a naturally occurring microbial process that converts organic material into a mixture of methane, carbon dioxide and trace gases in a warm environment free of oxygen, hence *anaerobic* digestion. Many of the by-products produced from primary agricultural production or food processing are suitable for AD treatment. Livestock manures are a preferred feedstock, but tend to be relatively low in energy density compared to products such as food processing or slaughterhouse wastes, or energy crops such as corn or cereal crop silage. AD technology is used quite extensively in

the food processing industry as the waste streams from these operations are often high strength (high Biological Oxygen Demand) and difficult to process. Treatment in a biogas plant reduces the strength of the residuals stream, allowing for more effective clarification, and the product of AD treatment (biogas) provides a source of on-site thermal or electrical energy production. This represents one of those win-win situations often discussed in reference to environmental management technologies, 'treat your wastes efficiently and get energy for the effort'.

## ■ Past and Current Technology Adoption around the World

Active anaerobic treatment has been used for centuries by various societies. Centuries ago, the Chinese used deep, cone shaped in-ground lined pits to store animal and human manures, food wastes and other organics and collected the methane gas that was emitted for use as a cooking and heating fuel. This approach has lasted throughout the centuries and thousands of family-based digesters operate in China, India and other developing countries today. In the more recent past, London's street lamps were built as an extension of the city's below ground sewage transportation network and the 'swamp gas' that was emitted from the sewers was burned to light the way for evening passers by.

The world energy crunch of the 1970-80's brought anaerobic waste treatment to the modern industrial world as oil and natural gas prices reached record levels. More than 100-biogas plants were constructed in North America during this period, many of which still stand as relics of the effort, but few continue to produce useful biogas. These early installations failed due to a number of factors including overbearing or poorly conceived engineering efforts, lack of understanding of the complexities of operating a biogas plant, and/or the physical, chemical and biological process at work in the anaerobic reactor.

Further to the technical challenges that were faced by early AD pioneers, as the price of hydrocarbon fuels returned to their pre-OPEC oil embargo prices, early interest in perfecting the industrial biogas energy production concept was largely diminished.

Despite societies' disregard for the environmental (cost) benefits that AD systems can provide, the concept was not completely lost in the 1980s.. Many individuals involved in the original North American AD push continued to work towards perfecting the technology despite low oil, coal and gas prices. Early programs such as AgSTAR, a collaborative effort between the US Departments of Environment, Energy and Agriculture have promoted the

installation of on-farm biogas plants as demonstration and learning sites. More recently Agriculture and Agri-Food Canada's Energy Cogeneration from Agricultural and Municipal Wastes program provided funding to a number of Canadian biogas installations to collect system performance data to verify that biogas plants can be effectively operated in Canada's cold northern climate.

Many European countries have successfully ushered in a modern age of green energy production with the creation of effective renewable energy policies. Germany, despite having large coal reserves is by far the world leader in biogas plant design and construction. Other European nations such as Denmark, Austria, Switzerland, Italy and Ireland have followed the German lead, installing policies that place an appropriate value on biogas energy production which has encouraged significant investment in the sector.

## ■ Making Biogas Work

To identify the policy, cash incentive and/or economic reality environments in which a thriving biogas industry may evolve, it is important to consider how biogas has gained a foothold in exemplary regions around the world.

### Policy

Policy is an extremely important driver in the development of a successful biogas sector within a given region. Greenhouse gas management is playing an increasingly important role in policy development and is one of the key selling points for the development of biogas energy policy. Elevated power purchase rates for biogas derived electrical energy often include a few cents per kilowatt hour produced to reflect the reduced GHG emissions that result from treating organic residual (waste) products using anaerobic digestion. Often policy makers are intrigued by the ability of a biogas system to turn odorous, nuisance products into quality fertilizer and renewable energies.

Germany is the most common reference for how a thriving biogas industry can be stimulated with renewable energy policy. With a goal of eliminating nuclear power from the power generation system, Germany placed a high value on a host of renewable energies, and established power purchase rates that reflected the costs of producing each type of renewable energy *individually*. Initial feed-in tariff rates for biogas power did not provide enough incentive to spurn the widespread adoption of biogas power generation, but rather promoted the construction of a small number of large industrial facilities. While a success in terms of gaining some biogas production momentum, subsequent revisions of renewable energy laws allowed for the construction of much smaller biogas plants, 100-250 kWh generation capacity, and small independent power producers to operate biogas plants in a profitable position.

Roughly 1200-MW of biogas energy generation capacity has been installed to date in Germany. Upwards of 4,000-AD systems are currently operating, many designed to operate using biomass energy crops such as corn or winter rye silage, which significantly boost power output, compared to manure only systems.

## Cash Incentives

There are typically two options for biogas industry support that have been adopted by world biogas leading nations, support biogas energy prices as described above, or make the energy cheaper to produce by subsidizing construction costs.

Germany has chosen to support the growth of the renewable sector through mandated power purchase rates, or feed-in tariff rates. Lawmakers there produced the Renewable Energy Sources Act which put in place specific rules that German utilities were obligated to follow. These rules included a pre-determined feed-in tariff rate that in some cases for biogas plant operators results in a payment of nearly \$0.28CAD/kWh produced. The Act also stated that if renewable power was produced, the utilities had no option but to buy it, no questions asked and no arguing about the purchase price.

Several Canadian provinces have installed renewable power purchase programs that would apply to biogas power production. Purchase prices, or top up incentives can range from a low of \$0.04CAD/kWh to a high of \$0.14CAD/kWh for power placed on the grid during peak consumption periods.

The US based AGSTAR program has provided grant funding for the development of biogas plants across the US. A number of state programs have also been designed around the grant-based incentive option, however, there have been recent developments in the development of feed-in tariff rates for biogas energy production in Michigan and other states. Ontario, Alberta and Manitoba to a much smaller extent, are currently offering grant based AND feed-in tariff incentives to stimulate biogas plant construction in their respective regions.

The EVER evolving carbon trading programs should not be discounted as a potential source of income in biogas plant feasibility analysis. A 600-sow farrow-to-finish operation located in Red Deer Alberta would produce enough biogas to operate a 50-kW generator continuously. **Table 1** provides a brief analysis on the value of carbon offsets that might be created by installing a biogas plant at a 600-sow unit.

**Table 1. Biogas Plant Greenhouse Gas Reduction and Value Estimate**

	<b>Baseline GHG Emissions (MT CO<sub>2</sub>e)</b>	<b>Digester GHG Emissions (MT CO<sub>2</sub>e)</b>	<b>GHG Reduction (MT CO<sub>2</sub>e)</b>	<b>Carbon Offset Value*</b>
Methane (CH <sub>4</sub> )	640	40	600	\$9000
Nitrous Oxide (N <sub>2</sub> O)	500	350	150	\$2250
<b>Total</b>	<b>1140</b>	<b>390</b>	<b>750</b>	<b>\$11250</b>

\* Based on \$15/MT CO<sub>2</sub>e

### Economic Reality

Where there’s coal, there’s cheap energy!! It is certainly difficult for some to consider paying at least \$11/MWh if not \$14-17/MWh for biogas generated electricity when coal consuming regions boast \$4/MWh prices for energy delivered to the doorstep. Seldom considered are the hidden costs of dirty power generation however, and true economic realities are simply not reported. Coal-fired power plants produce constant emissions of mercury, nitrogen and sulphur dioxides, particulate matter and of course carbon dioxide GHG emissions. Applying an environmental degradation fee, or estimating the costs to the health care system to address respiratory illness linked to coal burning emissions, is extremely challenging. Unfortunately, society seems quite happy to accept that there is a social and environmental cost to non-renewable power generation, and simply continue to pay \$0.04kWh on the power bill each month. If society would like to see enabling technologies such as anaerobic digestion take hold, it needs to become less complacent and place value where value is due. Clean water and clean air will support vibrant economies, despite higher energy costs. If the energy system status quo does not change, increasingly, our provincial and federal budgets will be consumed with healing people and the environments in which we live as opposed to supporting a quality living experience for Canadian citizens.

Biogas power plants in provinces such as Quebec, Manitoba and British Columbia will compete directly with hydro power for a share of the electricity market. Despite having significant livestock herds, and significant quantities of biogas feedstock (manure) available, these provinces also boast vast hydro resources, one of the least expensive sources of electrical energy available. Support through appropriate policy development is essential in these regions if a biogas industry is expected to flourish.

Although quite often overlooked in the discussion of enabling renewable energy production, energy efficiency will be extremely important to the success of the biogas industry. It is widely understood by energy management experts that individual Canadians use roughly twice as much power as necessary to enjoy current standards of life. If appropriate steps were taken by consumers to reduce energy use by one-half of current consumption, energy consumers could then afford to pay TWICE as much for electrical energy, without increasing the cost of living. Biogas plants would likely dot the entire provincial landscape if the sale price of biogas energy increased to \$20/MWh, a price not unreasonable if the concept of energy efficiency were intimately embraced by governments and energy consumers.

## ■ Conclusion

No one definitive solution exists for 'Making Biogas Work'. Government programs and policy development have been the cornerstones of successful biogas industries to date, not the economic realities. This is not to say that biogas energy cannot compete on a straight economics basis, but competing energy sources need to endure the same full life-cycle economic analysis, including both direct and in-direct costs, that often discredits a fledgling distributed biogas energy industry.

In conclusion, the following benefits of anaerobic digestion treatment of organic residual products is offered, each with a socio-enviro-economic benefit that may or may not be assigned a dollar value:

- Increased rural community infrastructure investment
- Rural job creation and increased municipal tax revenue
- Reduced powerline losses due to more distributed power generation
- Reduced GHG emissions from renewable power generation and enhanced waste management
- Improved plant nutrient (fertilizer) cycling, decreased nutrient runoff and leaching losses
- An increasingly diverse and reliable renewable energy sector

Biogas will likely not become a stand alone, financially viable energy source until appropriate value is assigned to these benefits.