Briefing Note

Biogas Potential in Ontario

January 7, 2011

Biogas power is the one of the most economical and environmentally sustainable forms of renewable energy available today. As the primary voice for the biogas industry in Ontario, the Agrienergy Producers of Ontario (APAO) believes that voters will appreciate the cost effectiveness of biogas as a means of strengthening agriculture, stabilizing power generation, managing organic wastes, stimulating economic growth at multiple levels, and reducing greenhouse gases.

Biogas Power Economic Potential

Based on available organic feedstock from food processors and farmers, the APAO estimates that 250 MW of baseload power generation (1% of peak demand) could come from biogas. Using current market pricing, this translates into the following economic benefits for the province of Ontario:

- $1.5 Billion worth of development and construction funds invested in facilities (about 500 in total) that are inherently domestic in their content. This investment total includes 1250 man-years of local engineering and construction, which amounts to about $75 Million.[1]
- 500 direct full-time, long-term jobs to operate said facilities, or $700 Million over 20 years in wages.[2]
- $1.6 Billion worth of fertilizer cost reductions for farmers over 20 years.[3]
- $700 Million worth of heating cost reductions for farmers over 20 years.[4]

The total potential economic benefit of biogas to the province of Ontario is at minimum $4.15 Billion over the next 20 years.

Rural/Agricultural Benefits

- Diversifies and strengthens the rural agricultural sector by:
    - Providing farmers and growers with additional revenue streams
    - Lowering fertilizer and heating costs for farmers and greenhouse operators

[1] See "*Biogas Power Generation Potential*" section in Backgrounder.
[2] See "*Development and Construction Investment Potential*" section in Backgrounder
[3] See "*Operation Labour Potential*" section in Backgrounder
[4] See "*Fertilizer Cost Savings Potential*" section in Backgrounder

AgriEnergy Producers' Association of Ontario · Association Des Producteurs d'AgriÉnergie De l'Ontario
275 Slater Street, Suite 900, Ottawa, Ontario K1P 5H9
T: 613 822-1004 www.apao.ca exec_coord@apao.ca

  - Providing the green image farmers need to stay competitive in the global food supply chain
  - Creating stable, long term jobs in rural Ontario

- Ontario can become a focal point for the biogas industry in North America resulting in increased investment, expertise, and job creation in the province.

Electrical Grid Benefits

- Biogas is justifiably a good investment for the provincial electricity system because it costs 60 to 80 percent less than other renewables in electrical system maintenance costs per unit energy delivered to users.[5]
- Biogas power is base-load and non-intermittent, meaning that it reliably generates during peak hours
- Biogas power can be produced widely throughout the province without overloading the system like large centralized generation.

Environmental Benefits

- Biogas can utilize organic waste now going to land fill without negatively impacting the food-processing sector.
- Biogas facilities protect ground water from contamination by harmful pathogenic organisms; avoiding another situation like that which occurred in Walkerton.
- Biogas in Ontario can reduce approximately 3 million tonnes of greenhouse gas emissions[6] by diverting organic wastes from landfills and livestock manure from long-term storage.

In summary, it is clear that biogas is a cost effective renewable energy source for Ontario taxpayers and an essential part of a successful and sustainable agricultural sector. APAO would be pleased to continue dialogue with you to provide you with the information required for making informed policy decisions.

---

[5] See "*Electrical Grid Benefits*" section in Backgrounder

[6] See "*Greenhouse Gas Reduction Potential*" section in Backgrounder

Briefing Note

Biogas Potential in Ontario

Backgrounder

Biogas is produced from the anaerobic digestion of food and agricultural waste. Similar to natural gas, it is comprised primarily of methane and is ideal for power and heat generation. The outputs from the biogas process are electricity, heat, and a nutrient rich "digestate" that can be used by farmers to grow more food.

Biogas Power Generation Potential

Ontario food processors produce 5,000,000 tonnes of useable organic waste every year. Much of this material is sent to land fills where it produces land fill gas and leachate over time. They also estimate that Ontario livestock farms produce some 12,000,000 tonnes of manure per year. If all of this organic material were used to produce biogas in the conventional manner, APAO estimates that approximately 250 megawatts of baseload electrical power could be produced. This is enough to provide power to approximately 150,000 to 200,000 average Ontario households[7]. See simplified calculation below.

OMAFRA estimates that between 1.2 and 9.8 Million tonnes of food waste are produced annually in Ontario[8]. Considering the breadth of the range identified, we feel that it is safe to assume that 5 Million tonnes are available for biogas production annually. Using an averaged assumption for biogas production from food wastes of 150 cubic meters of biogas per tonne of waste with a methane content of 55%, the total production from food waste is 412.5 Million cubic meters per year of methane. Using a standard assumption for the heating value of biomethane of 10 kWh per cubic meter, Ontario's annual energy production from biogas equates to 4.125 Million MWh. With a typical cogeneration unit able to achieve an electrical efficiency of 38% and operate 95% of the time (including maintenance) the electrical power potential from food waste converted to biogas is approximately 190 MW.

Applying the same logic to manure, but with an averaged assumption for biogas production from manure of 20 cubic meters of biogas per tonne of manure with a methane content of 55%, the electrical power potential from manure converted to biogas is approximately 60 MW.

Combining the food waste and manure biogas power generation potentials brings us to conclude that 250 MW of continuous biogas power production is possible in the province of Ontario.

Development and Construction Investment Potential

With an industry average cost of construction of $6000 per kW of installed generation potential[9], the total investment opportunity equates to $1.5 Billion for the range of plants that

---

[7] http://www.newswire.ca/en/releases/archive/May2008/28/c5163.html
[8] http://www.omafra.gov.on.ca/english/engineer/facts/food_input.htm
[9] Based on APAO members' experience with installing biogas power systems in Ontario.

are expected to be constructed over the next 20 years (250 MW or 250,000 kW). With an industry average construction labour requirement of 5 man-years per MW of installed biogas generation, there is the potential for 1250 man-years of labour, which equates to approximately $75 Million of labour wages paid if a man-year is assumed to have 2000 hours, and an average labour rate of $30 per hour is applied[10].

Operation Labour Potential

With an industry average of 2 full time facility operators per MW of installed biogas generation[11], with the expected 250 MW of generation will come 500 full time operator jobs in rural Ontario. Assuming that these operators will receive, on average, a salary of $70,000 per year (with benefits), the total potential job benefit to the province over the 20-year length of the FIT contracts associated with the facilities is $700 Million.

Fertilizer Cost Savings Potential

Using industry standards for hog[12] and dairy[13] manure nutrient values, as well as average recorded nutrient values for typical organic feedstocks[14], it is possible to determine the approximate quantity of additional nutrients that are captured through biogas systems for use as agricultural fertilizers. Pegging these nutrient quantities to Canadian market rates for agricultural fertilizer allows for the approximation of $80 Million worth of annual fertilizer cost savings for farmers. Spreading this savings over the course of 20 years, the total projected savings for Ontario farmers is approximately $1.6 Billion. This approximation does not take in to account the expected rise in fertilizer prices over the next 20 years, and as such, is largely understated. The table below contains the assumptions used to calculate the fertilizer cost savings for Ontario farmers.

[10] Based on APAO members' experience with installing biogas power systems in Ontario.
[11] Based on APAO members' experience with operating biogas power systems in Ontario.
[12] http://www.agriculture.gov.sk.ca/Default.aspx?DN=4f62b99a-ae55-407a-bc0b-9f6bfa43b94c
[13] http://www.omafra.gov.on.ca/english/crops/field/news/croptalk/2005/ct_1105a6.htm
[14] Based on APAO members' experience with analyses of organic wastes.

Briefing Note

Biogas Potential in Ontario

	Average Nutrient Content in Food Wastes (as is basis)	Annual Food Waste Contribution (tonnes)	Average Fertilizer Price (per tonne)[15]	Total Annual Fertilizer Cost Savings for Ontario Farmers
Nitrogen	0.3%	17,000	$700[16]	$ 26 MM
Phosphorous (as P_2O_5)	0.2%	18,500	$1000[17]	$36 MM
Potassium (as K_2O)	0.2%	11,000	$1000[18]	$18 MM

Heat Cost Savings Potential

Assuming that 10% additional thermal power is produced for every unit of electrical power[19] calculated above (250 MW), the total thermal generation potential from biogas in Ontario is 275 MW. If 25% of this is used for the biogas system[20], approximately 205 MW remains for use by farmers and greenhouse operators. When converted to cubic meters of natural gas equivalent, this thermal potential can be pegged to the current cost for delivered natural gas in Ontario ($0.21/cubic meter)[21,22] to come up with an approximate 20-year savings of $700 Million. This approximation does not take in to account the expected rise in natural gas prices over the next 20 years, and as such, is largely understated.

Electrical Grid Benefits

Comparing the total distribution and transmission operation, maintenance and administration (OM & A) cost ($1.755 billion) associated with the installed capacity of Ontario's electrical system in 2006 (31,000 MW)[23,24], it is possible to derive a specific transmission and distribution OM & A cost per installed megawatt of grid capacity ($56,642.74/MW/year). Applying this through to three renewable energy technologies (i.e., solar, wind and biogas), and normalizing to the typical annual amount of electrical energy generated from these technologies (i.e.,

[15] www.agr.gc.ca/pol/mad-dam/pubs/.../rmar_02_07_2010-11-26_eng.pdf
[16] 2009 Canadian average urea fertilizer cost
[17] 2009 Canadian average mono-ammonium phosphate (MAP) cost
[18] 2009 Canadian average potash cost
[19] Based on standard thermal efficiencies for cogeneration systems operating with biogas.
[20] Typical heat usage at on-farm biogas systems according to APAO members.
[21] http://www.uniongas.com/aboutus/rates/residential/pdf/m2CI.pdf
[22] http://www.oeb.gov.on.ca/OEB/Consumers/Natural+Gas/Natural+Gas+Rates#prices
[23] http://www.oeb.gov.on.ca/documents/abouttheoeb/yearbook/2006_electricity_distributors.pdf
[24] http://www.ieso.ca/imoweb/media/md_supply.asp

capacity factor multiplied by hours in a year), it is possible to approximate a transmission and distribution OM & A cost per unit energy (MWh) delivered the Ontario electrical system. This gives some perspective on the value delivered to the province by biogas, compared to other forms of renewable energy.

Renewable Technology	Typical Capacity Factor	O, M & A Cost per MWh Energy Delivered to Consumers
Wind	30%	$21.50
Solar	15%	$43.00
Biogas	80%	$8.00

Based on the above analysis, it is evident that biogas delivers value to electricity consumers by costing 60 to 80% less than other forms of renewable in operations and maintenance costs per megawatt-hour of energy delivered to the electrical system.

Greenhouse Gas Reduction Potential

Currently, large portions of the total organic waste quantity that have been identified by the APAO as being suitable for biogas production are being disposed of in landfills; 50% of that identified above or 2.5 million tonnes per year.

The total potential for greenhouse gas reduction from biogas from organic wastes has been calculated by applying a carbon dioxide equivalent (CO_2eq) reduction factor - developed by Environmental Technology Verification (ETV) - for one of APAO's members companies. The CO_2eq reduction factor is calculated through the comparison of: A) disposal of source separated organics (SSO) at an engineered landfill with leachate collection and gas flaring, to; B) processing SSO at a biogas facility with cogeneration of power and heat. For the assessment, the upstream, project, and downstream elements for the biogas plant were identified and evaluated. As part of this, a complete life cycle analysis (LCA) was performed for each option that included: construction, operation, maintenance, transportation, natural gas use, application, residuals disposal, and decommissioning[25,26].

The assessment identified that approximately 1 tonne of CO_2eq is reduced for every tonne of SSO that is diverted from landfill to a biogas plant. When applied to the current estimated

[25] ISO 14064: Greenhouse Gases – Part 2: Specification for the quantification, monitoring and reporting of project emissions and removals; Aug 2004 – Committee Draft 2; ISO/TC 207.

[26] TEAM: Requirements and Guidance for the Systems of Measurements and Reporting for Technologies (SMART); January 2004.

amount of organic material sent to landfill that could be processed at a biogas facility, this equates to 2.5 million tonnes of CO_2eq reduced annually.

Also considered in the greenhouse gas reduction assessment is the amount of liquid manure from livestock operations that is currently being stored in open lagoons. Using methodologies and global warming potentials (GWP) developed by the International Panel on Climate Change (IPCC)[27] and Emission Factors developed by Environment Canada (EC)[28] for calculating emissions of methane (CH_4) and nitrogen oxide (N_2O) from liquid manure storage lagoons/tanks, the total current greenhouse gas emissions from liquid manure storage can be calculated. When this is compared to greenhouse gas emissions from a biogas plant co-generating power and heat (standard stoichiometric combustion equations) it is estimated that 500,000 tonnes of CO_2eq can be reduced each year through generating biogas.

Combining the greenhouse gas reduction potential for processing SSO and livestock manure in biogas plants, the APAO estimates that 3 million tonnes of CO_2eq can be reduced annually in the province of Ontario.

Biogas Facts

- Biogas power is not the same as biomass power. Biogas is a process where "wet" organic matter is converted into methane gas through anaerobic digestion. The methane is then combusted in an engine to generate electricity, and the nutrients from the organics remain in liquid form for use as fertilizer. Biomass power is the process of directly combusting "dry" organic matter using high temperatures. In the process of combusting dry organics, many valuable nutrients are lost to the atmosphere or converted into inert ash that is not as valuable as a fertilizer.

- Anaerobic Digestion occurs when organic materials break down in an oxygen free environment. The gas that is produced is called biogas which is 50% to 75% methane. This methane is similar to natural gas and can be used to run an engine to generate electricity and heat.

- Because organic material is widely available, the construction of biogas plants is possible throughout Ontario thereby contributing to a distributed generation system for the province which improves the security and reliability of the supply of electricity.

- Anaerobic digester systems provide farms with an additional agricultural-based investment opportunity to diversify the operation and add revenue, especially in light of closed quota markets (dairy industry).

[27] http://www.ipcc-nggip.iges.or.jp/public/gp/english/4_Agriculture.pdf
[28] http://www.ec.gc.ca/ges-ghg/default.asp?lang=En&n=B36AFBCF-1

Agrienergy Producers' Association of Ontario

Briefing Note

Biogas Potential in Ontario

- Biogas systems expand the existing agricultural operation and create additional opportunities to entice the next generation to remain on the family farm.

- Anaerobic digestion technology reduces Greenhouse Gas emissions, such as Methane (CH4), oxides of Nitrogen (NOx) and Carbon Dioxide (CO2). The only amount of CO2 that is released from the process (from the combustion engine) is that which already was absorbed by vegetation (CO2 neutral).

- Methane is the second most damaging greenhouse gas, with a global warming potential of 25 times higher than CO2. Methane emissions from agriculture contribute up to 33% of the global green house gas effect. Anaerobic digestion captures methane so that it is no longer released directly into the atmosphere.

- Anaerobic digestion of manure and organics reduces the odour emissions because the smell-intensive substances, such as fatty acids in gaseous form or phenols, are dramatically reduced. Because anaerobically treated manures are low in odour, land application can occur closer to populated areas.

- The anaerobic digestion process significantly reduces the number of pathogenic germs (such as coli-bacterias and salmonellas) and weed seeds. Destruction of pathogens and germs avoids source water contamination.

- The output from anaerobic digestion (digestate) is a natural part of the nutrient cycle and can effectively replace synthetic fertilizers, eliminating the fossil fuels required to produce these synthetic fertilizers.

- Anaerobic digestion provides a mechanism to divert organic waste from landfill and ultimately complete the carbon and nitrogen cycles.

- As a result of the increased ammonia content in the digested manure, accelerated plant uptake occurs. When ammonia is absorbed by plants faster and in higher amounts, it cannot be transformed into nitrate which leaches through the soil to the groundwater level. Reducing the creation of nitrates prevents pollution of groundwater.

- Combined heat and power (CHP) systems utilized to burn the biogas produce both renewable electricity and thermal energy. Thermal energy can be utilized on the farm to offset heating costs and fossil fuels consumption.