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Innovation Forum: New Markets for Biogas

Agrienergy Producers' Association of Ontario

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Backgrounder:

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Innovation Forum: New Markets for Biogas
Backgrounder

This backgrounder is intended to provide participants in the Innovation Forum a high-level common understanding of new market opportunities for biogas. These opportunities include injecting upgraded biogas into the natural gas grid, use of biogas as a vehicle fuel, or biogas as a fuel for stationary heat uses. This backgrounder, prepared by the Agrienergy Producers' Association of Ontario (APAO), draws on the biogas and biomethane experience in Canada, US and Europe. Funding for this project was provided by Growing Forward, a federal-provincial-territorial initiative.

1. Opportunity Overview

Raw biogas from agricultural, food and sewage sources is generally made up of 55-60% methane, 40-45% CO_2 and some small amounts of impurities, mostly hydrogen sulfide. There are additional impurities in landfill gas. Biogas can be "upgraded" to almost pure methane, called biomethane, by removing the CO_2. Renewable natural gas (also known as RNG) is biomethane that has been cleaned to meet natural gas pipeline quality standards. It can be injected into existing pipeline infrastructure and delivered anywhere the network serves. Both raw biogas or biomethane can also be used to fuel vehicles, and as a fuel for stationary heat.

Natural gas utilities are confident that commercially available technologies and suppliers can clean the fuel, addressing fuel quality concerns that can arise from using biomethane. One dairy farm in BC (Catalyst Project) is supplying biomethane into the natural gas grid. A Montreal area landfill (Dépôt Rive-Nord) supplies gas to the pipeline that is being wheeled to a food-processing user (Kraft Canada's Dad's Cookies plant) in the Toronto area. Other projects are in development.

In addition to injecting biomethane into the natural gas pipeline, biogas and biomethane can be used as a transportation fuel. Several farms in the US (Fair Oaks, Hilarides) are supplying biomethane to natural gas vehicles. The City of Guelph operates a pick-up truck that runs on 60% methane biogas (from a sewage plant) that has been blended with natural gas to an 86% methane blend.

It is estimated that there is enough fuel from the manure from one milking cow to drive a pick-up truck roughly 5000 km per year. This calculation assumes that the manure from a milking cow (including its offspring) produces roughly 1350 cubic metres of biogas per year, and that 60% of the biogas is methane.[1]

[1] OMAFRA, *Producing Biomethane and Renewable Natural Gas (RNG) from Farm and Food-Based Biogas Systems,* August, 2011

A third opportunity for biogas or biomethane is to compress the gas and transport in pressurized containers to be used on-site or at remote locations. This may be attractive to fuel users who currently have more expensive fuel alternatives, for instance, when heating livestock facilities or greenhouses.

Why should we work to expand markets for biogas? Reasons include the following:

- Decrease reliance on fossil fuels to reduce greenhouse gas emissions and increase reliance on a made-in-Ontario renewable energy resource. Ontario's electricity profile is relatively non-carbon intensive, relying on nuclear and hydro, while heating and vehicle fuel markets are primarily fossil-fuel based.
- Biomethane is a highly efficient use of biogas; there are significant inefficiencies associated with generating and transporting electricity.
- Biogas can be a fuel source alternative for users not located on a natural gas pipeline.
- Biogas is a hedge against rising fossil fuel prices and access to fossil fuel supply.
- For those who desire a green fuel or locally-sourced fuel, biogas can be used with only minor modifications to existing heating equipment instead of switching to equipment that can utilize biomass fuels.

These points are specific to biomethane, and build on the broader benefits of biogas to our environment, agricultural sector, and innovation base in Ontario. These benefits are referenced at the end of this backgrounder.

Biomethane is emerging as a market opportunity, but is not yet advanced in Canada or abroad. For example, in Germany, less than 60 of the 7,000 biogas plants generate biomethane. Only 4.5 per cent of the feed-in target of 6 billion cubic metres by 2020 had been reached so far.[2]

The APAO is currently researching and writing a Developers' Guide to Biomethane for farmers to expand knowledge in the sector and stimulate interest in the opportunity.

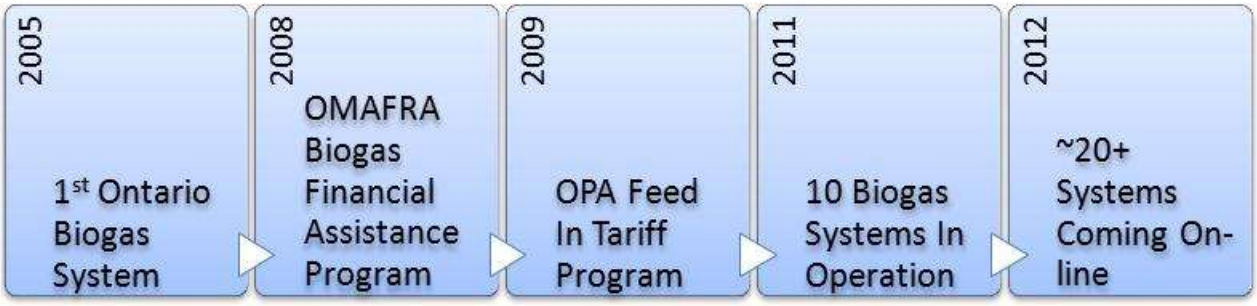
There are several ways to introduce biogas into new markets including the following:

1. Supplement existing fossil fuel supply with a percentage of renewable fuel to supply all customers in regulated markets. This is the proposed Union/Enbridge approach and has been successfully deployed for vehicle fuels in Canada with ethanol (5% blend) and beginning January 2012 for biodiesel (2% blend).
2. Target "green" customers and negotiate contracts to deliver renewable fuels at a premium, outside the market price. This was the approach used by Bullfrog Power with the Dad's Cookies contract.
3. On-site production and use, leveraging green marketing advantages.

[2] German Federal Networks Agency, *Biomethane Plant Development in Germany*, August 3, 2011

2. Current Ontario Market

Biogas development was initially quite high and responsive to government support towards growing a green energy sector in the Province; however, since 2009, interest has tempered. The following timeline illustrates the development path for biogas in Ontario.



Since the operation of the first biogas system in Ontario, the biogas experience to date can be summarized as follows:

- There are a total of 10 biogas systems operating in Ontario delivering approximately 5 MW of electricity to the power grid.
- The majority of biogas projects built to date are sized between 250 to 500kW. One project at a greenhouse is 1.3 MW.
- An additional 20 biogas projects are in development in any stage of planning, design or construction.
- Biogas development has been in conjunction with existing farm operations (dairy, greenhouses, beef, other), that are large in size and financially sound businesses capable of supporting the financial security and risk associated with new developments.
- One known municipal biogas system is operating using wastewater inputs and some additional feedstock.
- No additional funding support provided by government to offset the capital investment of biogas projects.

The biogas potential from various sectors is as follows:

2.1 Agricultural Waste

Agricultural waste is predominately comprised of animal manure, but can also include crop residues, energy crops, and slaughterhouse wastes.

- Ontario livestock farms produce an estimated 12,000,000 t/yr of manure.

- Crop residues are the unused parts of plants that may be gathered after a crop is harvested for use in an anaerobic digester.
- Energy crops grown for biogas complementing a larger biomass framework[i]
- There are approximately 140 slaughterhouses operating in Ontario today.

2.2 Food Waste

Food waste, also referred to as municipal solid waste (MSW) or source separated organics (SSO), is made up of residual materials collected from residential green bin programs, commercial operations such as greenhouses, food processing plants, and institutions (hospitals, government buildings, schools).

- There are approximately 3,000 food processing plants in Ontario.
- Over 220 greenhouses in operation.
- Estimated 5,000,000 t/yr of useable organic waste.

2.3 Municipal Waste

Other sources of municipal waste, excluding MSW (categorized above as food waste), include landfill gas and wastewater treatment systems.

- Prior to recycling and source separation practices, landfills received all of wastes including organic materials. Some municipalities with closed landfills are capturing the gas that is generated from these organics that are naturally breaking down in a similar anaerobic digestion process. Environment Canada indicates a total of 19 landfill gas projects in Ontario.
- Municipalities have long been applying anaerobic digestion principles in their treatment of wastewaters collected through sewers.

3. Renewable Natural Gas

Currently, the primary opportunity in Ontario for biomethane arises from an interest by the two natural gas utilities to purchase biomethane from producers and pay them a premium price for the fuel. Union Gas and Enbridge propose to purchase RNG from landfill sites and anaerobic digesters as part of their gas supply to an annual maximum volume cap of 58 million (2.2 million PJ) for Union Gas and 87 million cubic meters (3.3 million PJ) for Enbridge, which is less than 2% of overall supply.[3]

The application before the Ontario Energy Board (OEB) includes the following points:

- The gas utilities will establish a 20-year price contract with proponents
- The price shall stay in effect until volume is reached, or 5 years from the program launch, whichever is first
- Customers surveyed by the utilities were willing to pay up to 4% more on their gas bill to have RNG included in the system [4]
- The utilities state that following this maturation process, RNG should be able to compete with natural gas supplies in price
- Prices are based on analysis by Electrigaz and claim an 11% ROI, which is the same as the feed-in-tariff (FIT) for electricity production in Ontario. The price is $17/GJ for producers under 50,000 GJ/year, and $11 for producers over 50,000 GJ/year. [5]
- The $/GJ price recognizes the fact that the upgrading technology is only deployable at a large biogas production facility. The OEB application shows potential positive economic returns for RNG systems at very large livestock farms (1315 cows) or larger facilities receiving material from multiple farm locations. Currently there is one very large biogas facility in Ontario (Seacliff, 1.6 MW) that would have sufficient gas production to qualify economically for the program. The remaining "large" biogas systems in Ontario are all less than a third of that size, operating at ~500 kW.
- Producers will be required to pay the entire cost for their connection to the natural gas grid.

According to a study submitted by the natural gas utilities to the Ontario Energy Board (OEB), the inventory potential for RNG is as follows[6]:

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[3] Union Gas and Enbridge Gas Distribution, *Renewable Natural Gas Application to Ontario Energy Board EB-2011-0283 and EB-2011-0242,* September, 2011

[4] Ipsos Reid, *Bio Methane Survey, Residential and Commercial Natural Gas Customers*, November, 2010

[5] Electrigaz, *Economic Study on Renewable Natural Gas Production and Injection Costs in the Natural Gas Distribution Grid in Ontario – Biogas Plan Costing Report*, September 2011

[6] Union Gas and Enbridge Gas Distribution, *Renewable Natural Gas Application (EB-2011-0283) and (EB-2011-0242),* September, 2011

Table 10. Annual Potential RNG Production from Ontario Wastes											
	Agriculture Wastes				Forestry Residues	Municipal Wastes					Total Methane Production
	Manure		Crops			MSW		Landfill	WW	Biosolids	
	Near-Term (AD)	Long-Term (Gas)	Near-Term (AD)	Long-Term (Gas)	Long-Term (Gas)	Near-Term (AD)	Long-Term (Gas)	Near-Term (AD)	Near-Term (AD)	Long-Term (Gas)	
	(M m^3/yr)										
Enbridge	41.2	64	69.1	322	4.85	18.2	297	395	41.5	41.8	1294
Union Gas	156	241	309	1440	184	27.2	441	289	26.6	26.9	3141
Ontario	197	306	378	1762	188	45.4	738	684	68.1	68.7	4435
Note: AD = anaerobic digestion process; Gas = gasification process											

Market potential data is considered proprietary information to the relevant industries, so efforts to collect market potential data did not produce results for this report. According to Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA), raw biogas can be produced at ~30¢/m^3 on-farm, and 1 m^3 has about the same energy value as 1 L gasoline. [7] This compares well to ~$1.20/litre of gasoline, and could have promising market potential if sufficient fleet and local biogas supply can be identified.

3.1 The BC Experience

British Columbia is Canada's leader in biomethane for a combination of reasons, mostly cultural. Environmental protection is a strong force, and BC's carbon tax is an economic driver for many initiatives, including those related to biomethane. Political direction supports policies and programs involving support for biomethane. A key driver is also a utility, FortisBC, which applied to its regulator to enable it to create both supply and demand for biomethane.

FortisBC now offers customers up to 10% of their gas as biomethane after a December 2010 decision by the BC Utilities Commission. This is an option for customers, who pay a premium on their gas bill for this fuel if they choose it. FortisBC pays the connection cost for the biomethane producer to connect to the grid, and pays an average 12¢/m^3.[8]

A facility in Abbotsford, BC built a project to sell biomethane gas to the local utility using 140 tonnes/day of feedstock from manure, crop residue, slaughterhouse waste and fats, oils and grease. Upgrading and purification is done to reduce hydrogen sulphide particulates, water vapour and siloxanes, and remove carbon dioxide to increase methane concentrations and the energy content of the gas.[9] Biomethane is continuously sampled to ensure it meets the utility's specifications.

Locally produced biomethane has a carbon tax exemption worth $1.50/GJ in 2012. Locally produced methane also lowers the cost of transporting natural gas from Alberta and Northern BC.[10]

[7] Jake Debruyn, OMAFRA, correspondence, December, 2011
[8] Andrew McVie, FortisBC, interview, November, 2011
[9] Chris Bush, Catalyst Power, interview, November, 2011
[10] Electigaz, *Feasibility Study- Biogas upgrading and grid injection in the Fraser Valley, British Columbia,* June 2008

3.2 The California Experience

California's first farm-based biomethane project had design flaws that caused project failure (the lagoon was too large and the manure got too cold in winter). [11]California allows farm-based projects, where feedstocks are known and trustworthy, and does not allow landfill gas projects.

California has Renewable Energy Credits, carbon credits and federal tax credits to financially support biomethane. However, this only adds a value of $1.28/GJ.

3.3 The German Experience

- Germany has a natural gas consumption rate of 100 billion cubic metres/year and has set itself a target of substituting 6 billion cubic metres of biomethane by 2020 and up to 10 billion cubic metres by 2030.[12]
- The rate of injection into the grid increased from 3,000 cubic metres/hour in 2008 to 14,000 cubic metres/hour in 2009.[13]
- Grid access costs are split between the grid operator and biomethane supplier. Grid access consists of connecting pipeline (up to 10 km), the gas pressure metering plant, the compressor and the calibrated measurement plant. A fixed connection cost of 250,000 Euros is paid by the plant operator, and the grid operator covers the costs of maintenance and operation.[14]
- By law, 14% of buildings must use renewable energy sources for heating.

3.4 Other European Experience

- The biogas industry in Europe is very mature, with over 10,000 biogas-producing digesters in operation.
- France passed a law in July 2010 allowing biomethane to be fed into the natural gas grid, following Austria, Switzerland and Germany.
- Following the European Commission's request, the Biogasmax consortium has developed recommendations for the establishment of a European standard on biomethane
- England announced an incentive for renewable heat in November, 2011

[11] Ken Brennan, PG&E, interview, June, 2011
[12] Gerrit Volk, Injecting Biomethane into the German Grid (article), July 2009
[13] Ibid
[14] Dr Thomas Stephanblome, *Biomethane the Climate-Friendly Substitute of Natural Gas*, August, 2011

4. Natural Gas Vehicles

The market potential for vehicle fuel use is significant; however, adoption of natural gas vehicles (NGVs) has been low to date. Costs and technology performance add to operating risk, high upfront vehicle costs, lack of widespread infrastructure, and non-economic issues, including lack of information, experience and comfort with NGVs. Because of low demand, Shell closed a series of natural gas filling stations in Ontario in February, 2011, signaling a further setback for the industry.

Biogas would need to see that sector take off in order to supplement natural gas supply, and would require a similar price premium as for natural gas. Using unrefined biogas is possible, as City of Guelph has done by supplementing biogas from its wastewater treatment with natural gas to fuel its municipal fleet. The vehicles are dual fuel (gasoline or natural gas) and cost $5,000 each to convert, plus the cost of a vehicle refueling appliance ($3,400). (See photo at right.) 15

Alicia Milner, Executive Director of Canadian Natural Gas Vehicle Alliance, recommends new vehicles be used instead of retrofitting existing vehicles. This is due to concerns with warrantees and maintenance support.[16] However, municipal fleets may not have these concerns and are likely the primary target market.

Biogas as a vehicle fuel in the near term will make the most sense where a number of vehicles can reliably access the biogas fueling site. That may transpire as a municipally-operated fleet accessing landfill or sewage biogas, or a partnership with a near-urban biogas system and a fleet. In Europe, compressed biogas cylinders mounted on trailers transfer biogas to fueling stations where the gas is then pumped to natural gas powered cars. In general, a farm will not have sufficient vehicle use (at ~$2500 of regular fuel use per vehicle, plus occasional or seasonal tractor use) to fully finance a biogas system on fuel replacement. Alternatively, vehicle fueling could be an additional component at a biogas system that produces electricity or RNG.

Biomethane has a high energy yield per hectare of cultivated land compared with biodiesel or bioethanol when corn silage is used as the primary input into the biogas system. Comparing fuel sources per kilometre travelled, Biomotion Biofuels calculated yield of biomethane is 67,600 km/ha, compared with 23,300 km/ha for biodiesel and 24,400 km/ha for bioethanol, meaning biogas is the most efficient way to harvest energy for vehicle fuels from land.[17]

[15] Bill Barr, City of Guelph, *Biogas Pick-up Quick Facts*

[16] Alicia Milner, Canadian Natural Gas Vehicle Alliance, interview, November, 2011

[17] Biomotion Fuels, quoted in *Vehicle Conversion to Natural Gas/Biomethane*, OMFRA, by Steve Clarke, August, 2011

Natural gas vehicles (NGVs) provide benefits including lower GHG emissions, lower cost fuel than oil/gasoline, and helping meet rising demand for fuel with diversified options.[18]

Natural Resources Canada created the Natural Gas Use in Transportation Roundtable to create a roadmap and series of recommendations for stakeholders. The recommendations include de-risking investment and early adoption, addressing information gaps, increasing capacity to sustain markets, and ensuring on-going competitiveness.

High pressure direct injection technology allows a diesel engine to perform with up to 96% replacement of diesel fuel using replacement natural gas or biogas. In the US, these engines are eligible for federal tax credits or state-specific emissions credits. Honda recently announced their Natural Gas Civic will now be available to any buyer, not just fleets.

In Europe, a three year study published in 2010 found the following[19] :

- Biomethane works to augment natural gas and provide renewable fuel content (0-100% mix)
- Vehicle operation is not affected negatively by switching to biomethane, based on monitoring of 4.5 million km
- Positive attitudes toward biomethane by drivers
- Increased sales of vehicles in Italy, Sweden and Switzerland due to government incentives
- Driving forces for further expansion include environmental awareness, economic incentives, green marketing advantage
- Limiting factors for further growth include high purchase cost and limited supply of natural gas vehicles, lack of economic advantage of biomethane over natural gas, lack of refueling stations

In addition, Sweden has 20 biomethane plants and runs 2,300 vehicles on biomethane, mostly buses. Biomethane accounts for 55% of methane used in transportation[20]. A series of dedicated filling stations (see image at right)

A California dairy fuels (Hilarides) its vehicles with biomethane, reducing the farm's diesel consumption by over 650 gallons/day[21]

[18] Natural Gas Use in Transportation Roundtable, *Natural Gas Use in the Transportation Sector – Deployment Roadmap,* December 2010
[19] Biogasmax, *Biomethane Vehicles in Five European Cities*, February 2010
[20] Peter Boisen, NGVA Europe, Biomethane potentials as a vehicle fuel
[21] Ben Mack, Wired Magazine, *Got Manure? These Trucks Run on It,* February, 2009

5. Stationary Heat

Currently, farm-based biogas systems can use the heat produced by their systems to offset their own heating needs. However, biogas has not yet been used as a replacement for propane for stationary heat requirements in Ontario.

Data that would assist in understanding the market potential in this sector is not available. The Ontario Greenhouse Vegetable Growers does not have data on the percentage of members that use propane, although they are aware that some supplement their fuel with biomass, including miscanthus and wood pellets. This switch started when natural gas prices were high; biomass is supplemented periodically when prices rise. The industry group stated that the members are in favour of new practices that benefit the environment, provided there is an economic case to undertake them. [22]

According to regulations governing fuels, the Technical Standards & Safety Authority (TSSA) needs to perform a field approval when a fuel type is switched. In the case of switching from propane to biogas, there are some issues related to emissions from impurities in biogas. Specifically, sulfur and excessive moisture can corrode the metal, and affect the performance of components such as valves and vents. Appliances with drafts hoods need to be carefully considered due to the potential byproducts in the flue gases. These concerns would need to be addressed as part of the field approval TSSA would require.[23]

Tube trailer biomethane delivery to fertilizer plant, Northwest US Dairy (image at right)

[22] Justine Taylor, Ontario Greenhouse Vegetable Growers, Interview, November, 2011
[23] Marvin Evans, TSSA, Interview, December 2011

6. Considerations

For both end-users and producers, there are issues with these new market opportunities that need to be considered, that don't apply to electricity production, which has been the predominant application for biogas used to date in Ontario. These issues will be explored at the Innovation Forum.

End-user issues include the impact on engine and appliance performance, fuel consumption, emissions, and technology implications for using non-upgraded biogas. Codes will need to be revised to reflect changes in technology. For example, input is being collected by the TSSA as part of the work involved with connecting the Hamilton digester gas to the natural gas pipeline.

OMAFRA points out that producers need to consider the following factors, among others:

- **Seasonal variability**: There are few consistent fuel users with constant daily demands. The biogas system may have to respond to daily or seasonal variations in fuel demand by changing input feeding rates, or by identifying alternative biogas uses to manage excess biogas.
- **Increased biogas storage**: It is likely that there will be daily variations in fuel usage, whether the gas end user is a food processor or a fleet of vehicles, accounting for weekends and holidays and changes in business activities. Pressurized or non-pressurized gas storage may be required at the biogas system or at the end user site to facilitate the ongoing daily production of biogas.[24]

[24] OMAFRA, *Producing Biomethane and Renewable Natural Gas (RNG) from Farm and Food-Based Biogas Systems,* August, 2011

7. Benefits of Biogas

7.1 Environmental Benefit

While wind and solar do not harm the environment, biogas **improves** the environment:

- Clean Water: Processes animal manure reducing pathogens and protecting source water while capturing energy value
- Clean Air/GHG Reduction: captures and uses methane a greenhouse gas that is 20 times worse than CO_2; reduces odour in digestate (treated manure output)
- Waste Diversion: diverts organic waste, including grease trap and other food production, wastewater pre-treatment residuals away from landfill while capturing its energy

7.2 Farm/Community Benefits

- Value Added Nutrients: enhanced fertilizer value for crops from processed manure
- New revenue source for farmers while implementing strong nutrient management practices
- Local job creation and rural economic development
- Odour reduction
- No NIMBY factor

[i] PPD Inc.: Literature Review and Study Energy Market Alternatives for Commercially Grown Biomass in Ontario, March 15, 2011.