Agricultural Bioenergy Conference Report

for the

5th Annual Growing the Margins and

3rd Annual Farm and Food Biogas Conference

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Executive Summary

The Agrienergy Producers Association of Ontario (APAO) has partnered with Queen's University to deliver this report, summarizing the 5th Annual Growing the Margins and the 3rd Annual Farm and Food Biogas Conference. These meetings, held jointly between February 28 and March 1 2011, welcomed over 300 attendees, 50 exhibitors, and 60 presenters to the conference centre in London, Ontario.

The following report provides highlights from each of the plenary and parallel sessions in these meetings summarizing the challenges and opportunities facing the agricultural bioenergy sector as identified by speakers at these events as well as selected interview subjects, with emphasis on biogas-to-energy pathways. The report is intended to serve as a record of the presentations and discussions in each session based on notes taken by members of the research team present at each session. The purpose of this work is to accelerate the pace of innovation in this sector, and to facilitate the adoption of new technologies and management approaches within the Ontario agricultural industry.

Funding for this project was provided by Growing Forward, a federal, provincial, territorial initiative.

APAO has a mandate to develop biogas to its full potential as a clean, green energy source for Ontario and grow Ontario's biogas industry in the new sustainable energy economy. Queen's University is an educational and research institution with expertise in the areas of agricultural bioenergy and bio-foods.

List of Abbreviations

AD – anaerobic digestion
CHP – combined heat and power
FIT – feed-in tariff
GHG – greenhouse gases
LDS – local distribution system
OPG – Ontario Power Generation
OPA – Ontario Power Authority
OMAFRA – Ontario Ministry of Agriculture, Food and Rural Affairs

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Growing the Margins/Canadian Farm and food Biogas Conference

The 5th Annual Growing the Margins Conference and 3rd Annual Canadian Farm and Food Biogas Conference and Exhibition, held jointly between February 28 and March 1 2011, welcomed over 300 attendees, 50 exhibitors, and 60 presenters to the conference centre in London, Ontario. This document summarizes the lessons taken from this conference.

The opening plenary included talks from Elizabeth McDonald (Canadian Solar Industry Association), Don Jones (Agrienergy Producers Association of Ontario) and Don McCabe (Ontario Federation of Agriculture). The dominant message from this session was that Ontario is leading the way in the green energy field. Other provinces are watching to see what we do right or wrong - leading one to ask about how Ontario might work with other provinces to move this energy initiative forward. An important issue to address is the restructuring and decentralization of the energy industry, and the role of the government in picking 'winners and losers' when it comes to power. One message that could be taken from this session is the feeling that localized power does not seem to be prominent in the Ministry of Energy's plan, which is a concern particularly in relation to biogas-to-energy options.

A second plenary welcomed Karen Farbridge (Mayor of the City of Guelph), Bryan Goulden (Union Gas), and Colin Anderson (CEO of the Ontario Power Authority). The role of local government in promoting renewable energy was explored. While the City of Guelph has a target of 50% per capita reduction in energy use, and 60% less GHG per capita, the City does not see itself as being in the energy business, and sees their role in approvals and leadership facilitation in partnership with the private sector. At a regional scale, development of renewable energy was discussed; an issue with Ontario's Feed-in Tariff program is that it focuses on electricity, and not on developing other energy commodities such as gas in the form of biomethane injected into the gas pipeline. Broadening the scope of green energy in Ontario is encouraged. This led into a discussion of the OPA's agenda for the coming year, during which up to 4,000 MW of new power generation is expected. It was suggested that the vast majority of microFIT (small renewable electricity) projects will be connected, although some localized connection issues were acknowledged, and a backlog in applications for new projects exists. There were also questions about the potential role of heat and nutrients associated with biogas production, setting the stage for much of the discussion that followed throughout the conference.

The following sections provide a summary of the concurrent sessions for both conferences.

5th Annual Growing the Margins Conference

Update on Solar Market Landscape (G1A)

This session featured Barry Buchanan (Electrical Safety Authority), Patricia Lightburn (Ontario Power Authority), and John Fuerth (Hydro One). The discussion covered the existing FIT and microFIT programs and suggested that a third program, the CFIT, will be introduced to accommodate projects by commercial aggregators. A key issue in the Ontario power landscape is system constraints; there are physical limits to how many connections can be made, and because of rapid uptake these limits are quickly being reached. This means that even capacity allocation exempt projects must now be screened for system upgrade requirements. Another concern is attrition rates, as the application barriers are minimal – it costs nothing to apply. A new rule requires confirmation from their local distribution company (LDC) before the OPA gives a conditional offer; this means that it will take longer to get a conditional offer, but increases certainty of ultimate success. The regulations around electrical connections are guided by Ontario law and must meet the Ontario electrical safety code. Some requirements are specific to the LDCs; the high degree of variability in available technology has caused challenges to standardizing the installation techniques and rules. This was an unexpected element of the FIT program because there was a general assumption that it would be fairly simple and a cookie cutter approach. The program will likely be reviewed in 2011.

While this session focused on solar projects, the discussion highlighted delays in the FIT and microFIT process. It was recommended that all projects be submitted as quickly as possible to deal with this problem. It was pointed

out that biogas projects tend to be located in rural areas where there are no connection capabilities. Unfortunately, some have already been constructed and are ready to go on line; each applicant who was refused has received information about the specific connection issue. MicroFIT projects that were submitted last summer (pre-July) have been provided an extension until May 2011, but now some face further delay because of the connection issues. These will be connected but there is no guarantee when, so some people have made the investment and have no recourse but must rely on their LDC to figure out when. If there is still no connection availability after the 1 year extension has passed, it is unclear what will happen next.

Purpose Grown Biomass Crops – Opportunities, Innovations, Barriers (G1B)

This session featured Donna Speranzini (Ontario Ministry of Agriculture, Food and Rural Affairs), Aung Oo (Bioindustrial Innovation Centre in Sarnia), and Naresh Thevathasan (University of Guelph). The session explored the use of biomass crops as a means of offsetting high energy prices in various operations. It is estimated that energy crops in Ontario could supply 8.75 Mt of biomass annually using ~ 15% total agricultural land (includes conversion of hay land and use of less productive land), and that corn stover and cereal straw could add an additional 4.5 Mt. The utilization of perennials such as miscanthus, switchgrass and willow as part of the long-term rotation could improve the soil and overall yields. Mixed energy crops minimize the risk of unsteady biomass supply, and native perennial grasses, such as tall grass prairie, can also be included in the fuel mix. The supply chain needs to be further developed, with third party harvesting organizations included and biomass supply contracts secured ~4 years in advance. Intercropping systems are shown to enhance soil organic C and biomass yields in a trial using willow clones, and winter drying reduced moisture content from 52% to 10%, bringing it to levels suitable for end-use processing. It appears that a close correlation exists between belowground root biomass, litter fall and biomass yield.

Operating Your Solar System Efficiently (G2A)

Speakers in this session included Terrence Sauvé (Ontario Ministry of Agriculture, Food and Rural Affairs), Jaret HenHoeffer (Penguin Power) and Steve Ray (Essex Power Corporation, LaSalle, Ontario). This session explored ways of increasing the efficiency of solar systems but some of the lessons learned apply to a number of renewable energy technologies. Some solutions are technical: for instance, installing tracking systems, optimizing site and placement considerations, and choosing newer technologies can all provide major benefits. As with other sectors, the ground-mount solar sector is becoming more pragmatic as farmers realize individual projects have a life span and there are many hurdles along the way. Actual long-term downtime/operational issues centre on panel maintenance, inverters, and trackers. The same panel may make $2 some days, $50 others; variation is particularly pronounced over different months. There are reports of theft and vandalism, which are particularly of concern in remote locations; the importance of having good insurance for all projects was underscored. One issue that was emphasized was the impact of company evolution - when investing in new renewable energy technologies, will the company still be there in five years, or can parts be fixed by regular electricians or other tradespeople? Questions were also asked about the evolution of new technologies, but the consensus seemed to be that commercially established companies are going to continue to use traditional techs until new options are proven.

Biomass Crop and Processing Residues (G2B)

Hilla Kludze (University of Guelph), John Mann (University of Guelph), and Nick Ruzich (University of Western Ontario and CENNATEK Bioanalytical Services Inc.) discussed the use of biomass crop and processing residues. Earlier Canadian studies have indicated that the cool and humid ecoregion of Ontario are characterized by higher soil organic carbon (SOC) decomposition rates, implying that more residual C input is needed to maintain certain SOC levels in Ontario soils. In terms of energy crops, the current focus in southern Ontario has been on *Panicum* (switchgrass), *Miscanthus* (miscanthus), *Populus* (poplar) and *Salix* (willow), which can be grown with minimal fertilizer inputs. Preliminary results indicate yield is influenced by planting dates; poplar, switchgrass, and the native mix all survived the establishment year while miscanthus and willow both had very low survival rates and were replanted the following year. Some specialty crops, such as Jerusalem Artichoke, have also been explored with positive results. The need for additional carbon input through effective rotation systems and the use of supplementary C inputs (including fertilizer applications, or potentially solids from anaerobic digestion) is shown to

be very crucial. The University of Guelph has developed a five- step approach that allows for the estimation of removable residue under any type of cropping system in Ontario.

Carbon Trading I (G2E)

Josh Lamont (Atlantic Dairy and Forage Institute), Charles Lalonde (CJ Agren Consulting Inc., Guelph, Ontario) and Fatima Abdulrasul (Ontario Ministry of Environment) discussed the impacts of carbon trading on bioenergy projects. Because the dairy industry is not a regulated greenhouse gas (GHG) emitter, farms can generate GHG offset credits and will not be expected to buy credits if GHG emissions increase in the future. On-farm emissions are dependent on management of barn and feeding, and handling of manure. One case study found the potential for significant income (>$7,000 per year) based on a low carbon price of $15/tonne. The Ontario government recently indicated it would proceed to implement a regulated offset program as a tool that supports the development of a low carbon economy for Ontario. Anaerobic digestion carbon credits belong to the OPA, as pursuant to Feed-in Tariff contracts, but there are strong concerns that a variety of green energy contacts pass on risks to producers and the revenue share is inadequate; there is need for an agriculture-friendly option as a negotiation tool. An opportunity may lie in pooling carbon credits from several farms, which can create sufficient volume and keep the benefits within the agricultural sector. A business model for a prospective aggregator entity is being explored; this type of organization would trade offsets, address farm contracts and record infrastructure through partnerships, direct scientific priorities to support agriculture's interest and encourage commodity based approaches for Carbon Footprint determination that will identify areas for future carbon reduction.

Looking to Future Solar and Wind Systems (G3A)

This session featured Mathias Leon (University of Guelph) and Lori Gallaugher (Ag Energy Co-operative Ltd.), and discussed the future of some renewable energy technologies. Interesting new opportunities include a solar-biomass hybrid air heating system with thermal storage, being designed for greenhouse applications. Such an opportunity could provide a reliable and economic alternative to fossil fuel-fired air heaters. A study on such a system reveals promising thermal performance in 45-50^{0}C range, and the ability to supply hot air at 55^{0}C & 80 m^3/h continuously during day & night, at both sunny/partially cloudy and fully overcast/rainy weather conditions. Such combinations may eventually be combined with flexible thin-layer solar panels, which is lightweight, durable, can be rolled for easy installation; challenges remain with efficiency, but such systems would have the advantage of easy deployment on existing structures.

Biomass Conversion Technologies (G3B)

Idris Sule (University of Guelph) and Mohammad Rahbari (CENNATEK Bioanalytical) discussed development in biomass conversion technologies. One approach that is being explored is torrefaction, which provides advantages for storage and transportation as well as increased energy density by producing a solid fuel with lower moisture content, hydrophobic properties, and reduced smoking. Experiments using rice husk, sawdust, peanut husk, banagrass and water hyacinth show that original water content of biomass feedstock has a significant impact on the length of time and energy input of torrefaction process. Recovery of nutrients from various agricultural residues and purpose-grown crops was also considered; these include alkali metals, alkaline earth metals, silica and chlorine, the presence of which adversely impact reactors, furnaces, heat exchanger, turbines, and emission control devices. Technologies such as the electrostatic extraction of silica through corona charging or induction were discussed, as was industrial leaching of nutrients through immersion or spraying/pouring and recovery through reverse osmosis or chemical precipitation. Nutrient recovery technologies may be a significant opportunity in many types of bioenergy production, including anaerobic digestion, as the value of these nutrients can help drive the economics of conversion.

Carbon Trading II (G3E)

In this session, Mahendran Navaratnasamy (Alberta Agriculture and Rural Development), Susantha Jayasundara (University of Guelph), and Morgan McDonald (Offsetters, Vancouver, British Columbia) discussed issues around carbon trading. The amount of bio-energy that may be produced using manure and agricultural residues is estimated to be 21-39 PJ in Alberta, or approximately 50% of the total energy demand by the agricultural industry in the province. The impact of anaerobic digestion (AD) technology may reduce annual CH_4 emissions from manure management by as much as 81%, based on an analysis done in Ontario. Close to 4% of volatile solids that are

currently managed as liquid slurry in the dairy cattle sector could be managed using AD systems with biogas recovery. If AD technology were extended to all dairy farms with 363+ animals per farm, a potential reduction of 42% of the total annual CH_4 emissions from dairy manure management could be expected in Ontario. Carbon taxes, such as those implemented in British Columbia, remains a relatively small premium on the cost of energy and our use of energy is fairly inelastic – we need to buy it no matter the price. Interestingly, the carbon tax can be stacked with other carbon market instruments. In combination, these can put real pressure on companies to incentivize energy conservation, fuel switching, uptake of renewables, and changes in facility design and operation.

Business Considerations for Solar Systems (G4A)

Kris Taylor (Essex Power Corporation, LaSalle, Ontario), Albert Schoeley (KPMG LLP, Waterloo, Ontario) and Use Baker (Ontario Mutual Insurance Association) discussed business consideration in developing renewable energy technologies. A number of factors significantly alter the perceived return of investments, including rates of asset depreciation, taxation rates, and insurance. Each of these areas must be considered in developing renewable energy projects, and it is important to understand how these differences work. Taxation rates for renewable energy projects, including solar systems as well as anaerobic digesters, are different than those applied to farm income. In addition, Capital Cost allowances, ownership, and the role of renewable power on residential properties must be considered. The specific risks to each project must be clearly identified in advance, as these will affect the overall rates and the time required for an appropriate insurance policy to be developed.

Biomass Markets – Small and Large (G4B)

Hilla Kludze (University of Guelph), Harold Rudy (Ontario Soil and Crop Improvement Association), and Richard Painchaud (Innovente Inc.) discussed small and large biomass markets. Developing these markets starts with developing feedstocks; the University of Guelph suggests that miscanthus, switchgrass, and sorghum look best for cropping, with miscanthus being best for combustion, and sorghum best for versatility. Miscanthus as a C4 perennial offers good growth rates after the first year, receiving an extra month of sunlight interception and having good winter standability. Switchgrass is currently the most planted; because it is native to Ontario it involves no technology change. Yields were switchgrass are reported as between 10-13 dry tonnes/hectare, compared to miscanthus at 7-15 dry t/ha, and native grasses at 5-10 dry t/ha. Most of the current biomass projects are in southern Ontario. New technologies and approaches, such as the 'biodrying' system being developed by Innovente, may provide new avenues to increased efficiency and economy. The Innovente process, which combines anaerobic digestion with biodrying and combined heat and power production, can handle 50,000 tonnes/year organic waste, provide 4.6 MW of electric (or 40,000 MWh/yr), 10 MW heat, and 7,000 tonnes/yr of fertilizer (N-P-K) at a cost of about $25 million per plant.

Beyond MicroFIT – Farm based Solar Systems (G5A)

Dan McDonald (Ontario Ministry of Agriculture, Food, and Rural Affairs), Rolf Maurer (Arntjen Solar NA Inc.), and Thomas Boehn (Solarzentrum Ostschweiz Ltd., Switzerland) discussed the development of larger solar power projects on farm, both on buildings and in fields. While many rooftops on rural buildings provide large, unobstructed surface areas for solar PV installations, some rural landowners are uneasy about making significant investments on the rooftops of these buildings because eligibility and regulations are unclear. Issues include shading, how to utilize back slopes, and how to set up systems with access points to allow for cleaning and maintenance. In fields, there are methods to minimize the crop land foot print of the project (such as planting crops between the panels or installing the panels in fence row or laneway lines). Minimizing capital cost while optimizing performance of the system is necessary to achieve adequate financial returns for these projects.

Biomass Markets for Large Projects (G5B)

Chris Young (Ontario Power Generation), Lovleen Bassan (Ontario Power Generation) and Helma Geerts (Ontario Ministry of Agriculture, Food and Rural Affairs) and Kaji Kado (PPD Technologies Inc.) focused on biomass markets for large renewable energy projects. Ontario's Long Term Energy Plan includes phasing out coal-fired electricity generation, maintaining nuclear power at 50% of capacity, and increasing hydro and renewables (particularly wind) under an increased conservation program. To meet this plan, OPG is currently looking for agricultural and woody biomass partners, but seems to be downplaying the role of smaller projects (including biogas). Commercial agricultural biomass could be used for extensive combustion-to-electricity capacity; a working group is currently

active in developing business plans, recommendations of appropriate crops, analyses of the supply chain, and OPG needs. A key issue is not just the production of biomass, but the heterogeneity of this feedstock and the logistics involved in transport and storage - for example, GM has used biomaterials to make autobody parts but could never get a uniform quality of biomass, which killed the project. Use of biogas as a 'processed form' of biomass may help to meet some of these challenges - a biogas industry allows methane gas sales, electric sales, local hot water/heat sales. Policy issues and high investment risks need to be worked out to address market uncertainty, production variability, and viable lifecycle analyses; essentially, we do not know enough yet to know we are making the right decisions.

Community Energy (G5E)

The Partnerships Grant Program application workshop provided step by step instructions on how to apply for up to $200,000 in early stage development grants for biogas and other renewable energy projects. One on one meetings with potential proponents followed, led by Evan Ferrari & Laura Tozer (Program Managers with the Community Energy Partnerships Program).

Monitoring and Trouble Shooting (G6A)

Steve Ray (Essex Energy Corporation, LaSalle, Ontario), Adam Webb (Sentinal Solar Systems, Woodbridge, Ontario) and Steve Clarke (Ontario Ministry of Agriculture, Food and Rural Affairs, Kemptville, Ontario) talked about monitoring and trouble-shooting issues around renewable energy projects, particularly solar projects. Specific issues addressed include the monitoring of small systems; many solar owners have opted out of monitoring, either because their provider did not offer it, or because a 'do-it-yourself' installation was chosen. Recurring issues of concern to operators, particularly those without monitoring services, include high line voltage, weather, and panel and connector concerns. The evolution of technology - such as new inverter development for solar projects - may take cost out of the system and save installers and proponents money, but the rapid state of development emphasizes the need for highly trained personnel who are aware of the current state of technology and who can ensure that installations are carried out correctly. Increasingly, standards (such as those available for solar panels) allow proponents to compare different technologies by properties, improving the potential for optimal technology selection.

Bioproducts and Biofuels (G6B)

This session featured Leon Hinger (Highmark Renewables Research), Rob Nicol (University of Guelph) and Lloyd Helferty (Biochar Ontario), who focused on bioproducts and biofuels development. An integrated biorefinery approach can deliver multiple benefits - for example, a case study in Alberta produces 40 million litres per year of wheat-based ethanol, as well as 5 MWe biogas from 36,000 head of beef cattle fed on mixed grasses and grains. In this case study, the avoidance of coal-fired electricity, production of urea, land spreading of digestate, and substitution of natural gas, a total reduction of 83,800 CO_2e / year was achieved. A second case study, exploring ethanol production in the Midwestern US producing 200 MLPY corn and 17 MWe of biogas, achieved reductions of 381,700 CO_2e / year. One potential coproduct of biorefining, biochar, is a climate mitigation tool as it sequesters solid carbon in a form that can remain stable in the soil for thousands of years, allowing farmers and land holders to potentially gain carbon credits while improving soil quality. Challenges include tight margins, volatile competition for commodities, cost of ASTM quality control testing for retail (particularly for biogas and biodiesel), and the US blender's credit (not available in Canada). Solutions include extending the value chain, expanding the Federal government's ecoEnergy program, and developing carbon credits.

3rd Annual Canadian Farm and Food Biogas Conference

Lower Cost Methane Recovery (B1C)

William Jewell (Cornell University), Benjamin Strehler (CH-Four Biogas Inc.), and Theirry Ribeiro (Lasalle Polytechnique Institute, France) explored low-cost methane recovery systems. An opportunity is small-scale farm-based biogas projects (i.e. farms with 100 or fewer milking cows). The Rural Management Act caps off-farm substrates for bioreactors at 25% of total feedstocks, which is a major regulatory barrier to small scale operations that require closer to 50% additional inputs. Currently, production becomes viable at 250 kW (milking 300+ cows

to provide enough manure). One opportunity to handle this problem is the use of biomass feedstocks in addition to manure and other residues. A four year study was conducted comparing various stains of reed canary grass with switchgrass and wild grass in terms of biodegradability and kinetics. Nutrient and water requirements, changes in storage over 4 years, and potential energy were measured. Reed canary grass and switchgrass were close in efficiency though switchgrass requires more management; the conversion efficiency of reed canary grass was higher than expected but slow, with a long retention time required. No apparent biodegradability change was found after 4 years of storage. One important factor was that, while moisture content didn't affect digestibility, dry grass requires much more water (10 times water to feed ratio). Challenges include storage of biomass, different digestion rates, and different retention times. It may be possible to deal with these challenges through specific technological applications, such as microware pre-treatment which can increase organic matter accessibility and improve degradability (bringing digestion rates and retention rates in line for different feedstocks). A test case found that more methane is produced in less time, but that the energy balance is unfavourable under these experimental conditions; this could potentially be improved by decreasing water volume and/or increasing sample mass. There is also a need to develop microwave equipment in order to optimize heating rate and to scale up to pre-industrial and industrial scales. The regulatory climate needs to be more flexible in order to encourage new technologies.

Innovations in Europe and Around the World (B1D)

Nadeem Afghan (BIOFerm Energy Systems), Catie Lewis (entec Biogas USA), and Ben van Ree (Maple Reinders) reviewed some global innovation in biogas production. One innovation is the BIOFerm™ dry fermentation anaerobic digester, which can recover energy from organics that would otherwise be landfilled and produces a usable by-product, pre-process compost. The first North American facility will be built in Wisconsin with Oshkosh, using up to 8000 tonnes of agricultural waste and source-separated organics (SSO) (6000 tonnes to start) with an installed capacity will be 370 kW (the engine manufacturer is GE Jenbacher). A project in Benet, France has been developed to handle a variety of post-market waste (including waste alcohol, bakery waste, sewage sludge, food waste, yeast, pet food, etc. from grocery stores, other commercial generators, food processors, and grease traps). Preprocessing aims to produce a clean slurry material for the digester; food waste diversity is the most challenging part of a food waste-to-energy plant. Another project treats wastewater from an ice cream plant, which has very high fat content (36-42% fat based on COD). Fat is skimmed from the wastewater and then processed via the Compact BIOPAQ® AFR process, followed by desulfurization using THIOPAQ®, a biotechnological process that converts H_2S to elemental sulphur. Desulfurization enables efficient reuse of biogas in engines and boilers by reducing corrosion, allows biogas to be upgraded to natural gas quality, and reduces SO_2 emission. The importance of matching wet vs. dry streams with appropriate feedstocks was discussed.

Managing Digestion (B2C)

The issue of managing digestion was explored by Tom Ferencevic (Yield Energy), Victoria Hilborn (PlanET Biogas Solutions) and Torsten Fischer (Krieg & Fischer Ingenieure GmbH). New solutions such as simulation modelling, physical and chemical analysis of feedstock and in-situ digestate, are available to help avoid problems, particularly during the five stages of starting up a project, which include (1) initial fill, (2) heating, (3) initial feeding, (4) ramp-up to full feeding and (5) evaluation and response to technical difficulties. Specific advice for new projects include not starting construction until 100% of feedstocks are known, as well as alternative feedstock availability. Dairy manure is preferable at start-up because typical cow manure doesn't have the right organisms. The aim of a new plant is a full load in a preferably short period of time: cannot start too fast because biology will collapse and cannot start too slow because you will lose money. Most liability lies on the operator so it is important to ensure enough training. A standard start-up and commissioning approach in the Ontario biogas industry would help increase the success of AD facilities. There is a record of success in Ontario to build on: for example, there have been no explosions in Ontario, which might ultimately support the entry of more actors to this space, and perhaps lead the insurance sector to lower premiums.

Tying Municipal Organics to Biogas (B2D)

Ross Slaughter (Genivar Consultants), Graeme Millen (CH-Four Biogas Inc.) and Trevor Nickel (Highmark Renewables Research) explored the concept of tying municipal organics to biogas. One small project, located in

Ontario, can manage 40 m^3 of dewatered septage per day plus about 5 m^3 of farm or other organic waste. Interestingly, while this plant originally looked to co-digesting waste and biomass, it was found that costs for corn stover would be too high. The project is about 100 kW, with expansion to 300 kW expected. The total project cost was $3.8 million and will receive 16 c/kWh (about $1.667 M provided by government under stimulus funds, so actual price is somewhat lower). Some broad benefits to the uptake of biogas-to-energy were discussed. One benefit is the ability to add new technologies on to existing or new projects; for instance, it's relatively easy to improve nutrient recovery associated with a pre-built AD plant. There is also synergy between the human capital required to manage municipal waste and to install and manage on-farm AD technologies. Feedstocks are the most critical aspect to the development of the project, and need to be quantified in every proposal. Barriers that need to be addressed include management of expectations, feedstock availability and suitability, and renewable energy approval (regulation and legislation). The Green Energy Act is seen as a barrier - although it was supposed to streamline the process, no biogas projects have been approved, and costs are high and unpredictable. An opportunity that exists with municipal wastes is the addition of tipping fees, which are not present with on-farm wastes.

Co-Digestion Substrates (B3C)

The potential for co-digestion of different substrates in anaerobic reactors was discussed by Ashwani Kumar (Global Water and Energy, OVIVO), Doug Carruthers (Organic Resource Management), and Abdel Samie Felfel (George Morris Centre). Co-digestion is a clear opportunity for anaerobic digestion, but optimizing feed mixture development for full scale co-digestion projects is a challenging task which becomes more complex with stringent fertilizer and digestate treatment requirements. Economic evaluation of each of the feed substrates is necessary to determine the risks vs. gains in co-digestion. The mixture of substrates should remain approximately the same, with a little bit of room for variation. Separating trash or contaminants from waste streams can be carried out via technology (i.e. bioseparators) or via education - generators need to know that they are producing organic residuals, and not waste. Feedstock opportunities include expanding sources, expanding capacity, and feedstock optimization, while facing challenges of substrate characterization, collection and processing logistics. The existing FIT does not really support this approach, as it does not allow sufficient flexibility. Improvements in project planning, and OPA and the Ministry of Energy must get more involved with the workings of biogas. Waste management is very cost sensitive and it is easier to throw something out than to hire someone to use it, so substrates with higher energy value require a lower tip fee and vice versa. The estimated value of food waste in Canada is $27B annually. Right now, it is too easy and too cheap for processors to dump and policy supports farmers to overproduce.

Direct Pipeline Injection (B3D)

Sean Mezei (Flotech Services), Scott Graham (FortisBC), and Drew Everett (Union Gas) talked about incorporating biogas directly into pipelines. Biogas upgrading, which is required to facilitate this type of use, involves enriching the methane component of biogas to make it interchangeable with natural gas: it costs from about $2.5/GJ for larger systems, and up to $10/GJ for small systems. There is a trade-off between cost and biogas purity but cost for a purer product will likely go down over time. Agricultural feedstocks are better for biogas production when pipelining is being considered, as industrial waste streams can contain sulphur compounds and other contaminants. There were questions about shale gas and the impact it might have on future pricing of natural gas, and whether this might reduce demand for biogas. In British Columbia, Terasen actually sees biomethane as a separate product and is trying to avoid linking it with natural gas costs. Union Gas is interested in enabling the injection of renewable natural gas from agricultural and municipal waste, as well as landfill sources, but cautions that there is a one-way flow through the gas grid, so adding new production to the line can only happen "upstream"; therefore there are limited locations where the addition can happen. Union Gas is working towards a renewable biomethane reference price - i.e. a premium price that can be put forward to the Ontario Energy Board. A key lesson is transparency: there is a need to show reference pricing and providing a means by which companies can see exactly what the offer is. Finally, there was speculation on the impact that OPG might have on natural gas availability and pricing, if the Nanticoke plant were shifted from coal to natural gas (instead of biomass). This is apparently being incorporated into planning, but the lessons do not seem to be communicated with the farms and municipalities that might be called upon to produce biogas.

"Show & Tell" Session on Engine Technologies

Gerhard Klammer (MWM Canada Inc.), Jan Buijk (European Power Systems), and Aaron Tasin (Capstone Turbine) provided some demonstrations of new engine technologies. The boom in the biomass fermentation segment in Europe has greatly increased the knowledge of biogas operation both qualitatively and quantitatively – especially in regard to critical factors. Harmful substances in biogas – sulphur compounds, silicone compounds high moisture content influence the engine, maintenance and operating costs, the gas supply, the exhaust system and the availability of the engine. Engines are operating at three Ontario based biogas plants. Recent technology developments bring gas engine based CHP technology to a new level of operating experience with the first high efficiency gas engine CHP systems now being introduced into the Canadian market. A new technology, the microturbine, has emerged on the biogas market that simplifies installation and daily operation. Benefits range from no need for H_2S cleaning and simple electrical integration, to once a year scheduled maintenance with no oil changes.

Economics and Operations (B4C)

Robert Anderson (University of Guelph), Donald Hilborn and Chris Duke (Ontario Ministry of Agriculture, Food and Rural Affairs) and Jonathan Cheszes (Navigant Consulting) explored some of the challenges associated with economics and operations of biogas-to-energy projects. The Ontario Agricultural AD Calculator, a tool for assessing the economic feasibility of biogas facilities on Ontario farms, has been developed to help farmers assess expected quantifiable benefits and costs associated with construction and operation of these projects. The variables with the top 3 most significant effect on return on investment were price of sold power, price of system (capital cost) and electrical efficiency. Costs of material input (on farm or tipping fees) ranked fourth and project lifespan fifth or lower. Transportation costs did not rank very high. Spreadsheet predicts current practices should not include energy crops, should blend off-farm materials, and systems >100kW will be most viable. The Ontario FIT program can provide farms with return on expenditures (ROE) of greater than 20% when considering all contract provisions and outperforming base case assumptions.

Urban Sourced Organics for Biogas Systems (B4D)

David Sanscartier (University of Toronto/ University of Saskatchewan), Rolfe Philip (Yield Energy) and Michael Brown (Bio-Methatech) explored the use of urban-sourced organics in biogas systems. In one case study, it was assumed that AD replaces landfill systems, and that coal and natural gas are used for electricity (pre- and post-2014). The estimated net GHG reduction associated with replacing landfill with AD technology could be as high as 860 kg CO_2-equivalent/t organic waste, and there is a large improvement in Internal Rate of Return as the scale of facility is moved from 2.3 MW (50,000 t HSSOW) to 7 MW (200,000 t HSSOW). It is estimated that there is about 6.6 million tonnes of residential and commercial waste available in Canada per year. Because restaurant feedstocks can have up to 15% contaminants, it's important to plan for the impacts that these contaminants can have, including decreased volume for processing and ultimately reactor shutdown. The solution is to know your feedstock, which can help define solutions ahead of time in a proper planning process. A project in the city of Saint-Hyacinthe (just north of Montreal) was showcased, which is using anaerobic digestion technologies to deal with sewage sludge, a project that will eventually include additional process steps and capacity to accommodate both residential brown bag and local food producer waste streams, with the majority of product being upgraded and injected into the natural gas grid.

Case Studies (B5C)

Presentations on specific case studies were given by Elise Villeneuve (Bio-Terre Systems), Jean-Claude Corbeil (Valbio Canada) and Kevin Shiell (New Brunswick Community College). The first of these case studies was built on a farm with 725 dairy cows by a company (Revolution Energy Solutions LLC) which designs, owns and operates projects on privately held farms. The system takes manure directly, with no concentration or mixing of feedstocks required within the process, except at start-up. The second case study, by Valbio Canada, uses phased AD technology for better control and higher pathogen destruction, as well as greater reactor productivity. This case study highlights the need to stick with a robust design, and do a feasibility study in advance; attempts to lower costs led to long and costly delays in this project. The feasibility of 100 kW projects was discussed, and the value of digestate as a fertilizer which can be used to replenish phosphorus and potash in soils was emphasized - the

project is seeing increases of 100% in the value of hay on land that is being treated with the digestate, reducing costs for protein by half, which in turn increases feasibility. The final case study presented is Atlantic Canada's first on-farm biogas plant, which has been installed on a dairy farm which has about 100 milking cows, in partnership with McCain Foods in Grand Falls NB. McCain provides food waste (pizza crusts, French fries, and potato peels), avoiding landfill costs of about $300,000 per year. In this project, as in others, the digestate is used as a liquid fertilizer. Future projects attached to this study include adding a hydrolysis tank (working with Novozymes, which would be potentially the first Novozymes biogas project in North America). This process is currently only viable because of the tipping fees from McCain for food waste - particularly given the absence of FIT incentives.

Community / Co-op and Large Biogas Systems (B5D)

The role of community or cooperative programs for large biogas systems was explored by John Stephenson (FVB Energy Inc.), John Hawke (Angus Power), Daniel Bida (ReGenerate Biogas), and Ron Cocking (Toromont CAT Power Systems). Combined heat and power, supported through district energy systems, is seen as a bridge to renewable energy because it addresses the economic challenges of biomass to energy conversion technologies; heat sales are key, and an ambient temperature of 21°C can be supplied from a waste product. Denmark now has well-thought out policy initiatives to support expansion of CHP. A community biogas system is being installed at the Toronto Zoo, which is shifting from composting to a 500 kW biogas project that will process strictly zoo waste (mostly manure) and food waste. The original plan, which would run multiple pipes to carry waste heat back to zoo structures, encountered problems; the project is now using excess heat to warm a greenhouse to grow bamboo. This project will reinvest any profits, doubling the intake from the waste food supplier; if additional funds remain, they will support start-up of other community biogas initiatives. The solid digestate will be marketed, but liquid will be sold directly to local farmers. It is estimated that 80% of carbon credits generated will go to the government. Obstacles to expanding community-based power systems include the high likelihood of remote siting, as many landfills are located a long way from the end user, as well as connection cost and the type of incentive offered. This last point has been demonstrated by the absence of biomass/biogas representation in the latest FIT announcements.

Fitting into Smart Grid (B6C)

Jennifer Green (Agrienergy Producers Association of Ontario), Chris Ferguson (Carbon Control Systems Inc.), and Benjamin Strehler (CH-Four Biogas) discussed the integration of biogas-to-energy options into the smart grid. It is important to examine projects seeking grid connections to analyze barriers. It is emphasized that farm power = manure plus house waste + anaerobic waste = electricity, digestate and heat. The experiences to date for biogas developers have demonstrated that a plug and play approach to support renewable energy developments is not yet available in Ontario. Key policy barriers include the need for long term power contract, faster environmental approvals, and a more equitable FIT rate. Technical barriers include operations and maintenance, fuel reliability, geography, and grid connections. Connection challenges involve the location of the biogas production facility, which needs to be located next to fuel source in rural settings, so connections in rural areas are further down the road and generally are connecting to the lowest-quality, poorest part of the grid system. Utility feeders are designed to distribute electricity, not connect generators, adding complexity. Single phase lines are predominant in rural areas, which limits biogas plant capacity to 100 kW (long distances make it cheaper to run a single line, but quality is poor). Small farms on average have 50 -70 cows, and the FIT requires feedstock for biogas to come mostly from manure which limits size. It was emphasized that costs for substrates are changing and increasing – what was once free now has a price tag, and the transport cost remains a significant component.

Management and Business Practices (B6D)

This session featured Patrick Ley (Miller Thomson LLP CleanTech Group), Johan Veldhuis (Landmark Projecten B.V., Hengelo (Ov.), Netherlands), and John Hawkes (Angus Power). Good management includes knowing your neighbours, and developing good lines of communications about expansion plans. It was emphasized that in litigation, being right doesn't matter - take things seriously and deal with concerns promptly and genuinely. If a farmer is taken to the Farming and Food Production Protection Act (FFPPA) due to odour, noise, etc., and wins their case, it is unlikely that the neighbour can still sue them for nuisance, as this step has transformed the activity into a normal farming practice. Projects require (a) technical feasibility and (b) financial support. There are a few reasons that biogas hasn't moved as quickly as other technologies - solar and wind are simpler technologies with

very predictable costs, and the FIT incentive in Ontario is substantial relative to the cost of each. One of the key elements is a guaranteed feedstock for an extended period (i.e. 20 years), which is unlikely unless the ecosystem is completely closed - i.e., unless the farmer owns the land and can reasonably guarantee the production levels over that period. The Ontario Power Authority seems to have a bias against biogas - the fact that power outputs are relatively low on a per installation basis doesn't seem to work well within the OPA system.

Summary

The 5th Annual Growing the Margins Conference and 3rd Annual Canadian Farm and Food Biogas Conference and Exhibition of 2011 showcased a number of interesting speakers and topics directly related to biogas-to-energy pathways. This report has summarized the presentations and discussions and therein captured the current challenges and opportunities facing the agricultural bioenergy sector. In having documented the status of the sector in this manner, it is anticipated that greater discussion and dialogue can continue to accelerate the pace of innovation in this sector, and to facilitate the adoption of new technologies and management approaches within the Ontario agricultural industry.

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