

BIOGAS IN SOCIETY
A Case Story

COMPACT AND AUTOMATED ON-FARM BIOGAS PRODUCTION

IN SOUTHWESTERN ONTARIO, CANADA



IEA Bioenergy Task 37

IEA Bioenergy: Task 37: April 2020

BACKGROUND AND OPPORTUNITY

Canada has 37 operating on-farm anaerobic digestion systems, with most of these located on larger dairy farms in the Province of Ontario. To date, the Province of Ontario has had the most supportive policies, programs and incentives to develop biogas production, including both a cost-shared financial assistance program and feed-in-tariff (FIT) system. Its FIT and micro FIT programs have offered the highest rates for electricity produced from biogas of any province.

The first farm to connect to the Province's electricity grid, in 2003, was Fepro Farms located in Foresters Falls. This 290 cow dairy farm installed a biogas system produced in Switzerland, manufactured by Thomas Böhni Energie & Umwelt. Subsequent to this, Ontario's capital support program and green power incentives led to the construction of 30 on-farm anaerobic digesters. The most significant adopters were larger dairy farms, with 250 to 1,000 head of cows, that co-digest dairy manure with locally available organic material from restaurants, grocery stores, abattoirs and food processors. With a more decarbonized electricity grid in Ontario and the ending of the FIT program, larger farms are now investigating the production of renewable natural gas (biomethane). Under the current energy and climate change policy framework, biogas upgrading is financially viable only at a large scale of production. This leaves smaller livestock farms with very few options to adopt anaerobic digestion (AD) systems.

MICRO BIOGAS CONCEPT

The micro biogas concept emerged in Europe about 10 years ago, and has been demonstrated in a variety of system designs. These are small scale AD systems, typically in the 5 to 50 kW range, that produce biogas from a single feedstock source to meet the farm's energy needs. Many of the EU systems are agriculture based, located on smaller farms. One of the main motivations for building micro scale systems was the high cost of co-substrates such as food waste that had been inexpensive or even cost negative years ago but now had become more difficult to procure. Smaller biogas systems allowed farmers to derive the many benefits of AD technology, such as manure valorization, pathogen reduction, improved nutrient availability and new revenue streams, without incurring the extra management and capital investment associated with larger systems.

THE BIOELECTRIC CONCEPT AT A SMALL SCALE DAIRY FARM

In Canada, the first demonstration of the micro biogas concept is Harcolm Farms in Beachville, Ontario. This farm has a 75 dairy cow operation and 80 hectares of arable land. A compact system designed by the Belgian company, Bioelectric, specifically for smaller dairy farms, was installed by Martin Energy Group in January 2018. Over 125 such units have been sold in Europe. The

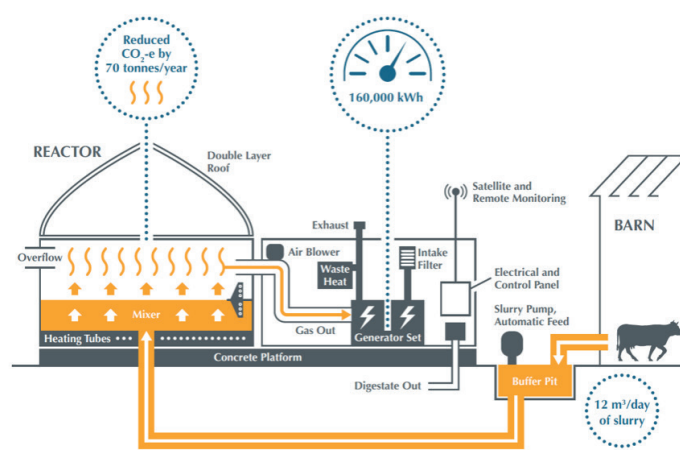


Figure 1: Components of the small scale anaerobic digester installed at Harcolm Farms (Source: BLOOM Clean Technology Demonstration Program – Case Study)

Bioelectric system was selected because the technology was proven, it had a relatively low capital cost and a well developed, automated system that could reduce operational requirements (figure 1).

The Bioelectric system was manufactured and pre-packaged in Belgium, and shipped to the farm to allow for a quick deployment that reduced the overall costs of the system. The digester arrived in sections of stainless steel insulated panels and was rapidly assembled in less than one week in cold January temperatures. As shown in Figure 2, the mechanical, electrical and automation equipment are housed in a 20 foot shipping container. A trench is used for connection to the electrical grid, laying of insulated hot water pipes and the manure pipe connected to the digester. A digester screw press was installed at the exit of the digester tank to reuse the undigested straw and hay fibres as animal bedding.

The dairy manure is directly pumped to the digester. There is neither manure storage nor pasteurization. The digester is stored outside until field application. As with manure, digester application is prescribed according to a nutrient management plan that is approved by the Ministry of Agriculture, Food and Rural Affairs. Fugitive methane emissions from the digester tank are minimized with the use of a floating straw cover, and the digester solids are used as animal bedding.



Figure 2. Bioelectric System installed at Harcolm Farms

BIOGAS IN SOCIETY – Compact and Automated On-Farm Biogas Production, Canada

EXPENSES / REVENUE / COST SAVINGS	EXPENSES (\$ CDN)	ANNUAL REVENUE / COST SAVINGS (\$ CDN)
Capital and installation expense	\$395,000	
Annual operating and maintenance expenses (including labour)	\$15,000 to \$20,000	
Electricity sales (MicroFIT contract)		\$20,000
Electricity displaced purchases (Net Meter contract)		\$12,000
Heat displaced purchases (propane)		\$10,000
Cost savings on manure handling		\$8,000
Cost savings on animal bedding		\$15,000
Cost savings on chemical fertilizer		\$3,000

CDN = 0.7USD

Table 1. Pro Forma for the Harcolm Farm Demonstration Project

From: The Bloom Centre for Sustainability, Case Study: Demonstrating the Performance of a Small-Scale Anaerobic Digester Systems at an Ontario Dairy Farm. BLOOM Clean Technology Demonstration Program. September 2018

PROJECT FINANCING AND THE MICRO FIT CONTRACT

The capital cost to install a digester system has to be affordable and meet farm equipment return on investment (ROI) of 8 to 12%. The AD system installed at Harcolm Farms operates two combined heat and power (CHP) systems on separate electrical grid connection contracts. The first CHP operates under a net-metering contract (paying approximately \$0.20/kWh) that offsets the farm's electrical use costs in the order of \$ 12,000 per year (in 2018 CAN\$). The second contract is under the Province's micro FIT scheme with the Independent Electricity System Operator. Under this contract, surplus electricity is sold back to the provincial grid at a price of \$ 0.258/kWh (including 20 percent inflation over 20 years) which translates into approximately \$ 20,000 per year (in 2018 CAN\$). The micro FIT contract is considered to be bankable and was required for the farm to obtain financing (Table 1).

The system's revenue could be further improved by, for example:

- Using more heat from the CHP systems during the summer to dry the digestate, hay, cordwood or wood chips, or to generate hot water for farm use.
- Installing a small scale district heating network to increase the use of the heat (from the CHP) by neighbouring properties. Recuperating more of the heat from the radiator and the flue gases would increase the energy efficiency of the system and also the revenue stream from the sale of heat energy.

KEY BENEFITS

The Bioelectric system installed at Harcolm Farms has been shown to be an affordable, easy to operate and maintain on-farm system for converting dairy manure from a 75 cow operation into: electricity and heat for the farm; nutrients that can be reapplied to the land; animal bedding; and surplus electricity sold to the grid. It enabled the valorization of manure and facilitated the farm to be energy self-sufficient. A non-exhaustive list of the main advantages of the system, including the socio-economic

benefits, follows:

- Very quick installation and deployment, installed in under 7 days in winter conditions in Southwestern Ontario, and started up in a matter of weeks.
- The entire system is fully automated and can be easily monitored and managed from a smart phone.
- Digesting fresh manure results in lower fugitive emissions and greater methane yields from the digester.
- Lower management requirements because the system is not receiving off-farm materials.

Larger AD plant operators can spend many hours "chasing" organic materials which are competing with other sectors of the organic recycling industry, such as composting plants and other solid waste management businesses.

- No land use change concerns as energy crops are not fed to this system.
- Similar cost per kW installed when compared with larger AD systems because Harcolm Farms received a grant from the BLOOM Clean Technology Demonstration Fund that reduced the project expenses for the farm.
- Fewer peak electricity demand charges from the Local Distribution Company to the dairy farm. Typically demand surcharges occur when a peak demand event above 50 kW occurs once during a monthly billing cycle.
- Fewer odour issues associated with manure storage.
- Pathogen reduction in digestate applied to crop land, i.e. 2 log reduction.
- Improved nitrogen bioavailability (in the digestate) as nitrification of organic nitrogen in the manure takes place in the digester. This reduces the requirement for nitrogen fertilizer in the same year as the digestate is applied.
- Annual reduction of on-farm GHG emissions is estimated to be 70 t CO₂e for each of the 20 years of the life of the project. This calculation, carried out as part of the BLOOM Clean Technology Demonstration Program, is presented by source of emissions in Figure 3. The baseline scenario was a typical Ontario dairy farm that purchases electricity from the grid, uses propane for heat and sand for animal bedding.

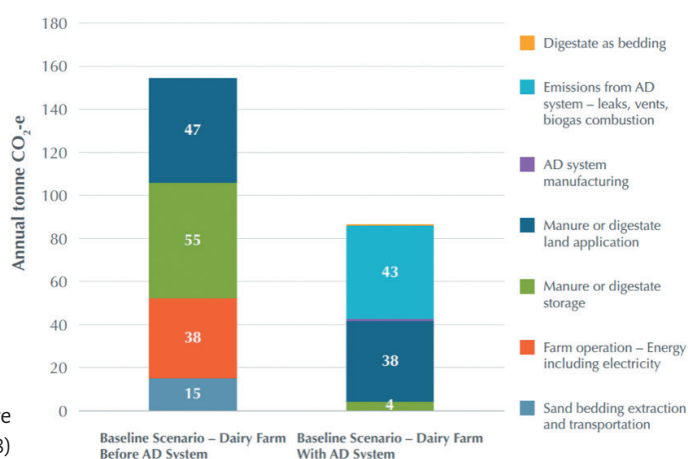


Figure 3. Estimated GHG Emissions from Farm Operation, Manure Storage and Land Application of Manure or Digestate (BLOOM, 2018)

FUTURE OPPORTUNITIES AND NECESSARY FRAMEWORK CONDITIONS

Anaerobic digestion of organic waste streams can provide many environmental benefits, and technologies exist for small as well as large scale applications. In Canada there are close to 11,000 dairy operations. Adoption of AD on Canadian farms has remained low due to the significant capital investments and the lack of a long-term energy and climate change policy framework that enables the financial viability of AD systems. As Provinces maintain most of the jurisdiction in these areas, the frameworks need to be set by each Province according to their priorities and operating context.

As renewable natural gas (biomethane) production is not an option for small scale systems, a micro FIT-type program with net-metering, capital assistance or some form of innovative financing where farmers could pay a lease cost for the system would be required for small farms to make the business case to invest in an AD system. In this case, the micro FIT power purchase agreement was seen as essential to receive financing. The power purchase agreement is considered to be bankable, while the net metering contract and carbon credits cannot be used as guarantees or collateral at this time. Valorization of the system's GHG emissions reduction and other environmental improvements would help to shorten the payback period and attract greater interest in AD systems. Dairy producers in Canada have adopted the Dairy Farmers of Canada proAction program - an on-farm customer assurance program that addresses milk quality, food safety, animal care and welfare, livestock traceability and biosecurity. The next version of the proAction program, to be released in 2021, will also address environmental sustainability. As this case study has shown, compact and automated AD systems offer an affordable and practical option for smaller farms to reduce their environmental footprint, provided the supportive policy framework exists.

IEA Bioenergy task 37
“Energy from Biogas”
<http://task37.ieabioenergy.com>

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A substantial amount of information was drawn from the September 2018 factsheet produced by the BLOOM Centre for Sustainability. The organisation and website has been shutdown following funding cuts to this program area. We would like to thank Kevin Jones and his staff for developing the original factsheet and hope to preserve some of the valuable learning in this case study of IEA Bioenergy Task 37.

Further Information

IEA Bioenergy Website
www.ieabioenergy.com

Contact us:
www.ieabioenergy.com/contact-us/

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IEA BIOENERGY

The IEA Bioenergy Technology Collaboration Programme (www.ieabioenergy.com) is a global government-to-government collaboration on research in bioenergy, which functions within a framework created by the International Energy Agency (IEA - www.iea.org). As of the 1st January 2016, 23 parties participated in IEA Bioenergy: Australia, Austria, Belgium, Brazil, Canada, Croatia, Denmark, Finland, France, Germany, Ireland, Italy, Japan, the Republic of Korea, the Netherlands, New Zealand, Norway, South Africa, Sweden, Switzerland, the United Kingdom, the USA, and the European Commission.

The mission of IEA Bioenergy is to increase knowledge and understanding of bioenergy systems in order to facilitate the commercialisation and market deployment of environmentally sound, socially acceptable, and cost-competitive bioenergy systems and technologies, and to advise policy and industrial decision makers accordingly. The Agreement provides platforms for international collaboration and information exchange in bioenergy research, technology development, demonstration, and policy analysis with a focus on overcoming the environmental, institutional, technological, social, and market barriers to the near- and long-term deployment of bioenergy technologies.