MUNICIPAL GUIDE TO BIOGAS

MARCH 2015

Supported by:

About the Biogas Association

The Biogas Association is a not-for-profit, member-driven organization that drives the development and advancement of biogas. Our mission is to establish and develop the biogas industry to its fullest potential through capturing and processing organic materials to maximize the utility and value inherent within that material.

The Biogas Association's membership is comprised of owners/operators, technology developers, consultants, government and other affiliate representation – all with a focus on biogas development. The association was federally incorporated in 2008 and serves its members by way of promoting biogas opportunities, shaping policy that impacts biogas, providing resources and offering technical expertise to address challenges in development. Biogas Association offers its service to a growing membership and works collaboratively with other affiliations, institutions, government and agencies.

ieso
Independent Electricity System Operator

This initiative was made possible in part from the support through the Education and Capacity Building Program by the Independent Electricity System Operator.

Contents

MUNICIPAL BIOGAS SNAPSHOTS

Introduction

The *Municipal Guide to Biogas* was created to enable Ontario municipalities to better understand the biogas opportunity in several of their operations – green bin organic material collection, wastewater treatment, and landfill.

This guide outlines the benefits of biogas for your municipality, and showcases real examples of systems across Ontario.

Municipalities are increasingly concerned about expanding their diversion rates, treating waste within their own boundaries, and reducing waste treatment and hauling costs. Biogas provides solutions to these priorities.

When the time comes for your municipality to review its waste management options, use this guide to assist in your analysis, and help you plan next steps.

This initiative was made possible in part by financial support awarded through the *Education and Capacity Building Program* by the Independent Electricity System Operator (IESO).

In interviews with municipalities across Ontario, the Biogas Association learned about some key drivers that are contributing to greater interest in anaerobic digestion (AD) of organic materials from source separated organic (SSO) collection programs, and from wastewater treatment (WWT) facilities and landfills. While anaerobic digestion is used extensively by Ontario municipalities for WWT facilities, its application for treating SSO material is limited. Some key drivers include:

Waste Management and Planning

- More material, such as diapers and pet waste, can be diverted by using AD
- Pre-treatment results in ability to screen out contaminants such as plastic bags, glass and metal
- Small footprint and odour control technologies enable municipalities to treat organic material in their own borders
- Proximity of the treatment facility to the source of material translates to significant savings on trucking costs
- Handling material locally eliminates need for costly transfer stations

Sustainability and Policy

- Helps meet climate change policy targets since methane is captured and utilized, lowering GHG emissions. Shorter waste hauling distances also dramatically affects GHG emissions
- Upgrading the biogas to renewable natural gas, and using it as a carbon neutral vehicle fuel is also an option
- Pathogen destruction is effective
- After harvesting the energy, end products have value as a compost feedstock or soil amendment, returning nutrients to the soil
- Green job creation
- Contributes to resilience and utilizing waste as a resource, keeping dollars circulating locally

Revenue

- Energy produced can be captured and utilized on-site to reduce utility costs, or in some cases, sold on to the electricity grid
- The Process and System Upgrade Incentive (PSUI) of 40% of capital costs can be applied to new cogeneration units at wastewater treatment systems

While wastewater treatment plants and landfills routinely flare the biogas produced at the digesters and landfill sites, this guide urges operators to examine the economic case for converting the biogas into useable energy.

The business case for biogas depends on a range of variables, which are outlined in this guide. Municipalities can use the checklist in this guide to determine if anaerobic digestion should be considered, and initiate discussions with consultants and technology suppliers.

If the business case analysis favours biogas production from anaerobic digestion as the preferred option, municipalities can investigate logistics, grid connection and approvals using information and links in this guide. Consultants and technology providers can assist with specialized advice related to odour control, safety, traffic flow, site design and other elements.

Benefits of Biogas

The Biogas Association published the *Canadian Biogas Study* in November, 2013. The study documented many economic and environmental benefits of biogas. Some of the key findings are summarized below.

Big GHG Reductions

The capturing and utilization of biogas is a powerful tool for reducing **greenhouse gases (GHGs)** that are the principle cause of human-induced climate change. GHGs are reduced in two ways: first, the biogas produced is a source of renewable energy that can replace fossil fuels, and second, the capturing of biogas reduces methane, a very potent greenhouse gas that would otherwise be free to escape into the atmosphere. Shorter trucking distances to AD facilities can result in significant GHG reductions and cost savings.

Protect Water and Land

There are other important environmental benefits. As materials such as animal human or food wastes are processed in biogas systems, the **pathogens are significantly reduced**, and **nutrients** like nitrogen and phosphorous **are made more available to plants**. Biogas systems reduce and provide greater control of our air and water pollution sources.

Sound Management Option

All of these critical functions — **generating renewable energy, reducing solid wastes, managing nutrients, reducing greenhouse gases, and mitigating pollution risks** — can be realized from a biogas facility in an economically sound and sustainable manner. The technology is proven and reliable. The required components and services are available across Canada.

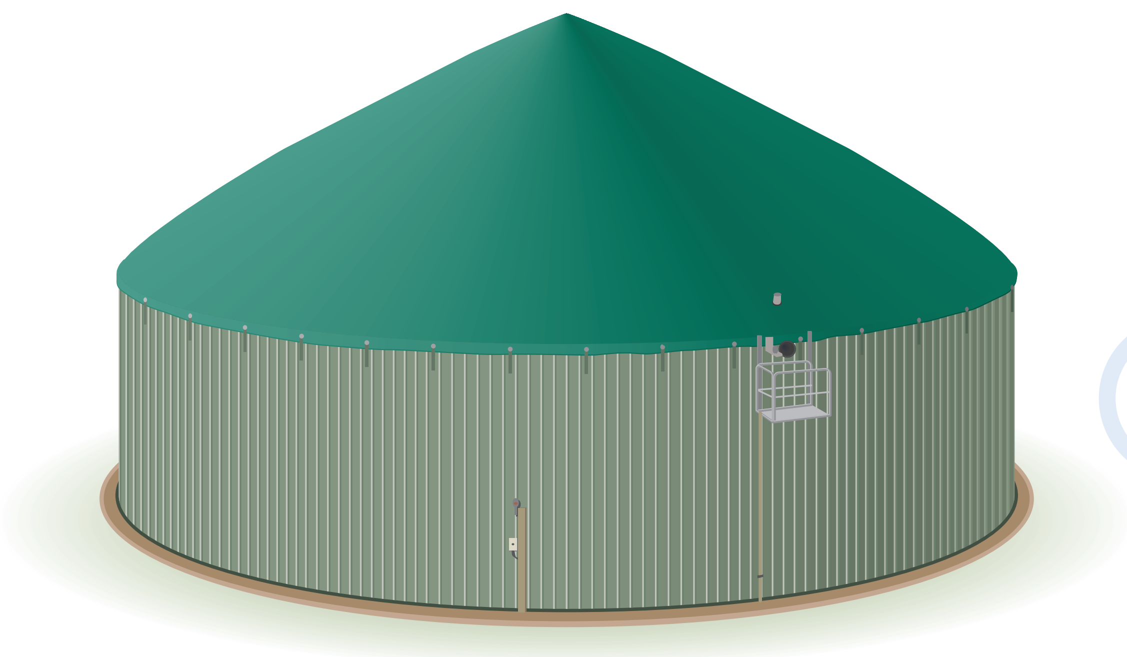
Biogas production can generate revenue to offset waste management costs for municipalities. In the case of wastewater treatment, energy bills can be a significant cost to a municipality. This revenue stays in the municipality, rather than leaving the region or province like most energy expenditures, and is used to create green and innovative jobs.

What is Biogas?

Biogas is a renewable source of methane, the main ingredient in natural gas. It can be used for heating and cooling, or to generate electricity that can be used on-site or fed into the distribution grid. It can be refined into renewable natural gas that can be injected into gas pipelines, or compressed and used as a vehicle fuel. The entire system, including the energy generating components, is typically referred to as a **biogas facility** or a **biogas plant**.

Biogas is produced when organic materials — anything from municipal organic wastes or bio-solids, food processing by-products, or agricultural manure and crop residues — break down in an oxygen-free environment. The process is called **anaerobic digestion (AD)** and usually occurs in a specialized tank or vessel – the **anaerobic digester**. AD is also the process that generates biogas or landfill gas (LFG) within landfills.

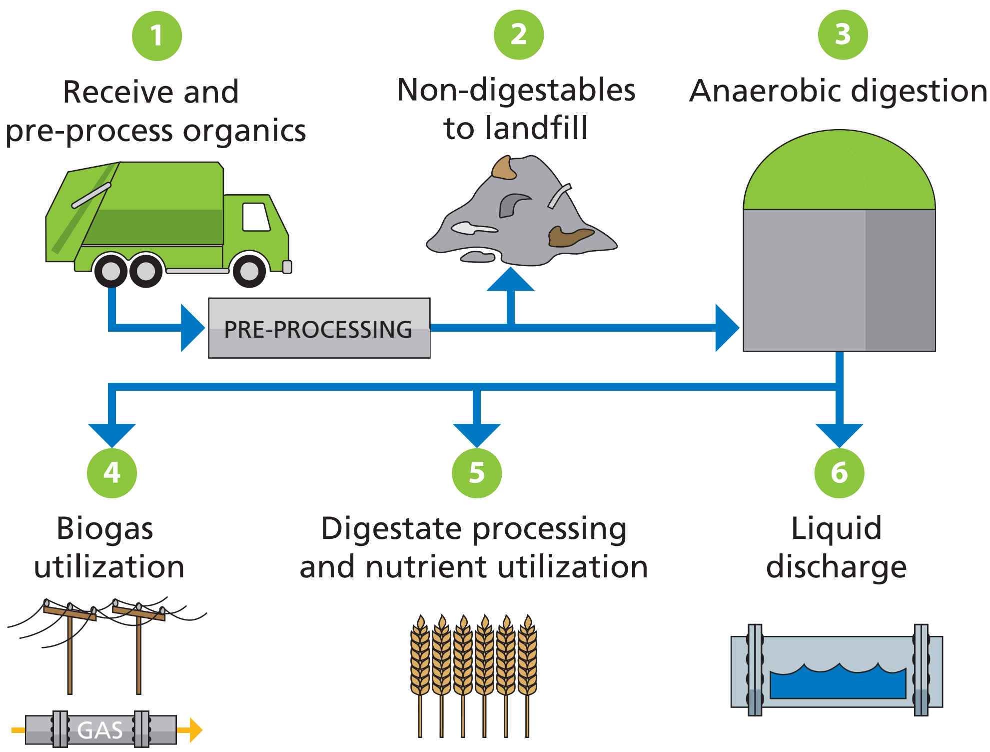
Anaerobic digesters have a number of end products, including **digestate**, a nutrient-rich slurry that can be applied directly on agricultural land, or material that is composted and then used for a range of purposes. Digester solids are materials from after de-watering that can be composted, and are well suited to be mixed with leaf and yard waste.



Municipalities and Biogas

Municipalities can generate biogas from wastewater and SSO treatment facilities, and landfills. This section of the guide addresses when AD makes sense for municipalities, starting with SSO, then wastewater treatment, followed by landfill gas, and then a short section on co-digestion of SSO and wastewater treatment.

SOURCE SEPARATED ORGANICS (SSO)



In this section of the guide, you will find information that will assist you in developing your business case, a technology overview, and references to studies and documents that have been used by other municipalities. It should be noted that the pricing and technology information sourced in this guide are related to specific municipalities and dated. As such, each municipality should conduct a thorough investigation of options based on its unique characteristics and circumstances as well as connect with qualified experts.

Business Case

In the case of SSO, the decision to anaerobically digest material relies on analysis related to the following five factors listed below. This section lists several questions for municipalities to pose to themselves as a checklist of considerations. Answering the questions and gathering the data listed below helps determine the business case for AD.

A 2012 study by Golder Associates for Barrie, Ontario contains information (Table 41) that may be useful for some municipalities. The table estimates capital and operating costs for "generic" AD plants.

SSO BY THE NUMBERS

- 1 tonne of SSO produces about **250 kWh** of electricity
- 1 tonne of SSO produces about **110 cubic metres** of biogas
  - Biogas is 60-70% methane, depending on materials
- Building capacity to treat SSO using AD costs **$500-$1,000/tonne/year**
  - Toronto's Disco Road facility was at the high end of the range, at $1,000/tonne. Put another way, Toronto spent $50/tonne to build capacity to process the material, assuming 20-year amortization and no-interest financing.
- Toronto's Disco Road facility costs **$110/tonne** to operate which includes digestate processing and haulage costs of approximately **$28/tonne**

1. MATERIALS AND DIVERSION RATES

Organic material breaks down into liquid, gaseous, and solid wastes, all of which need to be managed in a variety of ways.

- What materials are you collecting?
- What diversion rate are you striving to achieve?

The advantages of anaerobic digestion include the ability to increase diversion rates to include materials such as disposable diapers[1] and pet waste. Diversion also increases because pre-treatment technology now exists to remove plastic bags, and sort out contaminants such as glass and metal. Research indicates that increasing diversion rates and the ability to accept these challenging yet abundant materials is a significant driver in municipalities' investigation of AD as an organic materials treatment option.

1 Disposable diapers make up about 10% of City of Toronto's SSO material. Source: CCI Bioenergy

2. END PRODUCTS AND REVENUE

- How will you dispose of the end-products after treatment?

AD produces high quality and uniform digestate, which has potential market value. However, there is a cost to municipalities to have digestate processed.

Following the AD process, the volume of material is significantly reduced. Liquid is treated and discharged to the sewer according to regulations, or land applied as a nutrient. Solid waste material is partially broken down, and may require further treatment.

- What is the biogas yield?

This will depend on feedstock volume and composition. One can further understand biogas potential through testing. Generally, one tonne of SSO yields about 250 kWh.

- Will you generate electricity and/or heat with the biogas?

The biogas can be used to generate electricity by installing a generator. Electricity can be used on-site to help meets the needs of the processing facility. It may also be sold onto the electricity grid through a power purchase agreement with the Independent Electricity System Operator.

The biogas can be used to fuel a combined heat and power (CHP) unit, which also typically meets on-site demands, or can be used to meet heat requirements of a near-by facility.

If your municipality is considering selling the electricity to the Ontario electricity system, see the sections below called *Grid Connection* and *Approvals and Regulations*.

- Are you concerned with GHG reductions?

AD reduces GHG emissions significantly in several ways. First, methane emissions from landfill or composting are avoided because the gas is captured through AD and is either flared, producing a much lower GHG impact through the release of carbon dioxide, or is converted to useable energy. Second, fossil fuels are displaced if this renewable energy source is used to generate electricity or fuel vehicles. Third, emissions from transportation are typically lower because AD facilities can be located close to the source of materials due to the small facility footprint, and have odour control capability.

3. DESIGN AND DEVELOPMENT

- What site do you have? Is the land within your municipality?

Some municipalities choose to treat material within their boundaries, which in urban areas, can limit siting options, and be more costly than rural real estate. The treatment choice may be dictated by land availability, as composting requires a larger site than AD.

- Do you need to purchase the site?
- What is the current state of the site? How prepared is the site for an AD facility, in terms of road access for trucks, paving, access to utilities?

On-site wastewater treatment and discharge to the sewer is part of the AD process, in contrast to composting, which uses aeration, and then liquid material is discharged to a body of water, or is trucked to a suitable location.

- What equipment are you considering? Factor in the capital and construction costs

Municipalities need to consider a range of costs including tanks, pretreatment system, security system, and scales. Investing in high performance pre-treatment systems means municipalities are able to accept more materials, and screen out contaminants if material is liquified. This affects not only diversion rates, but also the end product quality and its ability to be land applied.

Municipalities may assume a cost of $500-$1,000 per tonne of processing capacity to build an AD facility.

Toronto's cost was $50/tonne, amortized over 20 years.

Odour control equipment is a high-priced investment, but is needed to secure an approval and for community acceptance.

Consider the efficiency of the engine when selecting this equipment; engine efficiency will affect the plant's operating cost, and revenue stream if selling the electricity.

- Consider soft costs related to design and development

4. OPERATION

Municipalities must consider how much of the operation they want to undertake themselves, versus outsourcing some or all of the design, building and operation.

- Will you design, build, operate, maintain, or outsource all or some or all of these elements?

There are many options available to a municipality, depending on the responsibility, cost and risk they wish to assume or outsource. This will affect the business case, and factors to consider include: available site options; available labour and human resources, including management; expertise in operation and maintenance; preference of elected representatives regarding risk management.

As one example, Toronto's Disco Road facility costs $110/tonne to operate which includes digestate processing and haulage costs of approximately $28/tonne.

Will the AD facility be co-located with another facility, such as wastewater treatment, or energy from waste through incineration? Several logistics considerations would flow from that, which are discussed in the *Co-digestion and Co-location* section below.

5. COSTS AND FINANCING

The following costs need to be taken into consideration in the business case analysis:

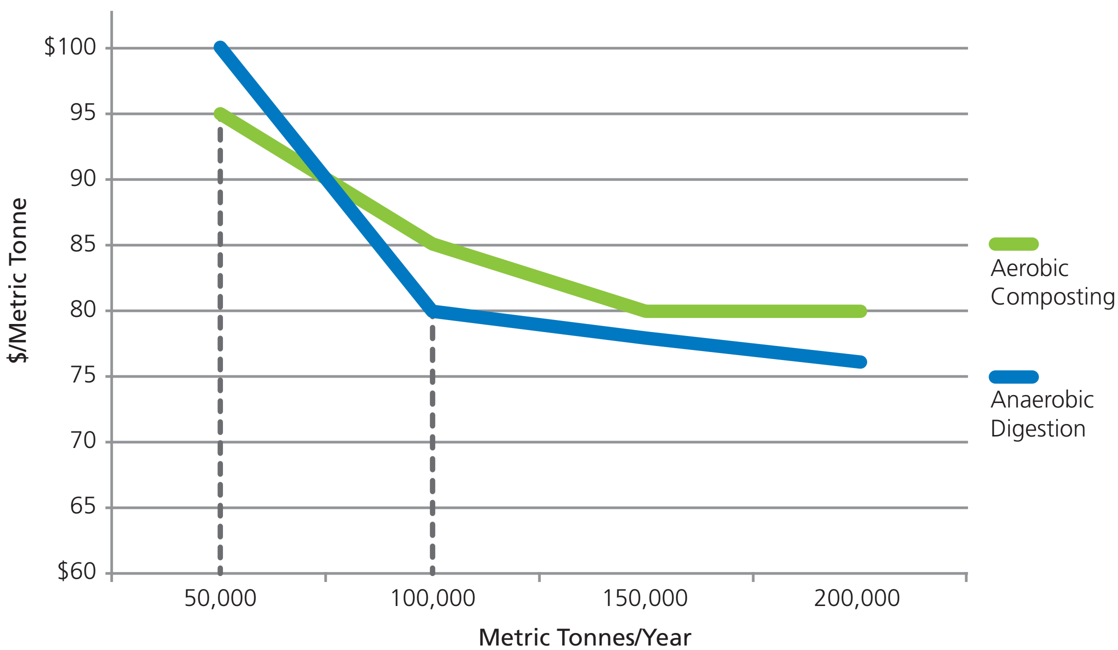
- project management
- stakeholder consultation
- council approvals
- legal
- contingency
- requirement for contractors to hold bonds

Municipalities will also need to determine the level of financing required for the project, and over what period of time.

Municipalities can also investigate public-private partnerships as a way to access infrastructure dollars from other levels of government, and address potential hurdles related to financing.

The costs to process SSO anaerobically can also be expressed in relation to declining cost as volumes increase, and in relation to aerobic composting. See below for one estimate of costs.

Cost of Processing Organic Food Waste



Source: Progressive Waste, 2013

Biogas Association

MUNICIPAL BIOGAS SNAPSHOT

Treating Toronto's Source Separated Organics Locally

Toronto's Disco Road Facility

The City of Toronto opted to treat its Source Separated Organics (SSO) within its own borders, making anaerobic digestion the preferred option, with its small foot-print and odour control technologies. The SSO is captured in kitchen and curbside containers that are lined with plastic bags to collect food scraps, soiled papers, disposable diapers, and pet wastes.

The 300 tonnes of materials received daily at the Disco Road facility are pre-treated to remove the inert materials (approximately 14%) and create a clean, homogenous slurry that is converted into biogas for on-site energy needs, solids for composting, and reclaimed liquids for reuse, with excesses treated on-site and discharged to the sewer.

The Disco Road facility, which processes 75,000 tonnes annually, cost approximately $75 million to build. This includes approximately:

- $15 million to prepare the site
- $10 million in odour control equipment
- $5 million in insurance
- 25% of the total cost was related to the digestion tanks, and pre-treatment equipment

The Disco Road facility costs $110/tonne to operate which includes digestate processing and haulage costs of approximately $28/tonne. Operation is currently out-sourced to the company that built the plant. (Aecom, with operating subcontracts to Veolia Canada and CCI BioEnergy).

The biogas is currently used to fuel the boilers that provide the heat for the digestion process, biofilter, and buildings. Any excesses are flared. In 2015/2016 the City plan is to procure and install a co-generation system to produce all the electricity and heat for the organics facility, the transfer station facility, and the adjacent works yard site.

The end product of digester solids is sent to a composting facility (All Treat Farms). The digester solids are mixed with leaf and yard waste, and ultimately sold.

Biogas Association

MUNICIPAL BIOGAS SNAPSHOT

Peel Planning AD for SSO

Peel Region has developed a comprehensive waste management plan, which includes AD. A detailed staff report, item 8.9, can be found at www.peelregion.ca . In summary, "the preferred system includes a new Peel-owned Anaerobic Digestion facility, a new Material Recovery Facility, and a new Peel-owned Leaf and Yard Waste transfer facility, all located within Brampton or Mississauga so as to allow for direct delivery by collection vehicles, and the enhancement and continued operation of the Caledon Composting and Peel Curing facilities over the medium term, with possible replacement to be evaluated after a period of operations of the new Anaerobic Digestion facility."

Estimated capital costs are summarized below:

Preferred System											
	Total estimated project costs for approval	Preliminary cash flow pattern (post-approval of total project costs, $ thousands)									
Description		2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Anaerobic Digestion facility	58,200							2,800	5,700	29,000	20,700
Material Recovery Facility (if Peel owned)	57,700		12,200	27,000	18,500				0		
Material Recovery Facility (if privately owned)*	12,200		12,200								
Enhancement of Peel Curing Facility	13,700								6,800	6,900	
Leaf and Yard Transfer Station	4,500		4,500								
Grand Total (if MRF is Peel owned)	134,100	0	16,700	27,000	18,500	0	0	2,800	12,500	35,900	20,700
Grand Total (if MRF is privately owned)*	88,600*		16,700	0	0	0	0	2,800	12,500	35,900	20,700
*Land to be acquired by Peel to maximize competition among bidders to build, own operate a new MRF located so as to allow direct delivery.											

Source: Waste Management Infrastructure Development Plan, June 26, 2014 p.105

Technology Overview

Digesting SSO requires three steps: pre-treatment; anaerobic digestion; and post-treatment.

1. PRE-TREATMENT

Pretreatment is a mechanical process whereby organic material, often collected in bags, or mixed with other waste, is converted to raw material that is fed into a digester. It involves removing contaminants such as plastic bags, glass and metal, and reduces volume. Material is screened through mechanical and manual sorting.

2. ANAEROBIC DIGESTION (AD)

A proper anaerobic digestion process produces biogas, and removes odour, and may remove pathogens and stabilize the material. Some differences in the technologies used for this process are outlined below.

Wet (liquid or low solid) AD systems are designed to process a dilute organic slurry with typically <15% total solids. For substrates with higher than 15% total solids, this slurry is created by adding water, re-circulated process water, or another organic waste with a lower total solids percentage to the incoming waste stream.

Wet systems require comparatively larger digesters, more and greater capacity water pumping and piping/valving, more extensive digestate storage and/or de-watering, higher capacity wastewater treatment facilities and more energy required to heat the larger volumes.[2]

The ability to remove contaminants is greater in wet systems, due to the floatation and gravity aspects of the systems. Regulating the temperature inside the digester is also critical to digestion. There are two main types of systems: those operating at a mesophilic temperature (operating at 35°C) or thermophilic temperature (operating at 55°C).

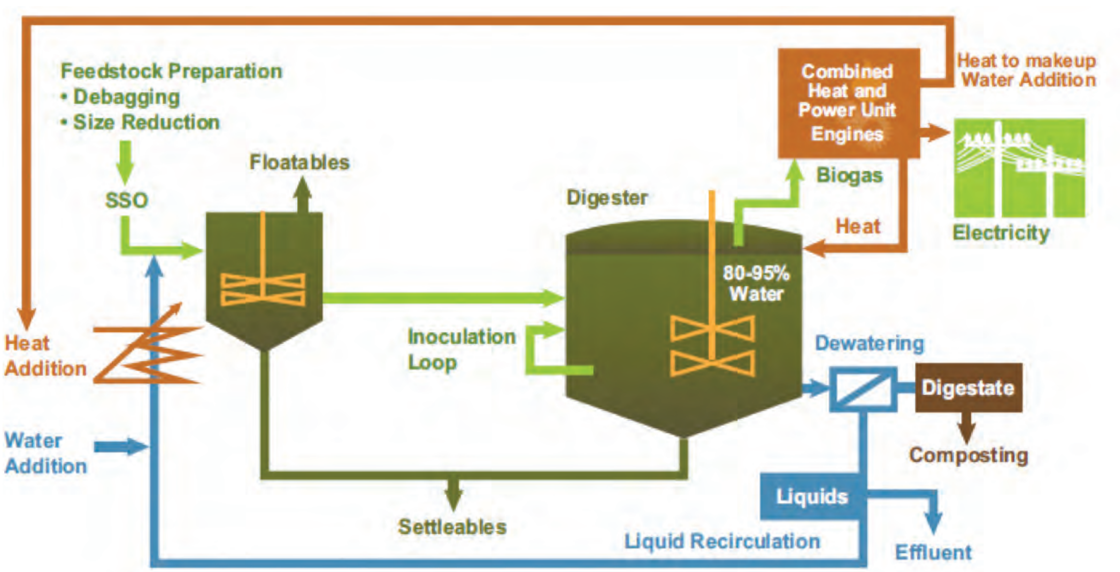


Figure 1: Typical complete mix CSTR wet (low-solids) AD process flow (Adapted with permission: Waste Science & Technology)
Source: Government of Canada, Technical Document on Municipal Solid Waste Organics Processing, 2013

2 The Wales Center of Excellence for Anaerobic Digestion

Dry (high solid) AD systems digest a waste stream of 15-40% total solids. The only pre-treatment which is necessary before feeding the wastes into the digester is the removal of the coarse impurities using screens and shredders.

Due to their high viscosity, the fermenting wastes move via plug flow inside the digesters, contrary to wet systems where completely mixed digesters are usually used. Therefore heat and nutrient transfer and homogeneity in dry AD systems is less efficient than in wet AD systems.

While dry systems may still require additions of water (or co-digestion with low solid wastes) to achieve a total solids content of around 30%, dry systems use considerably less water as part of the process than wet systems. This in turn leads to lower energy requirements for in-plant needs, because less energy is needed for heating process water, and for de-watering AD digestate. Dry digestion systems normally operate at thermophilic temperatures.

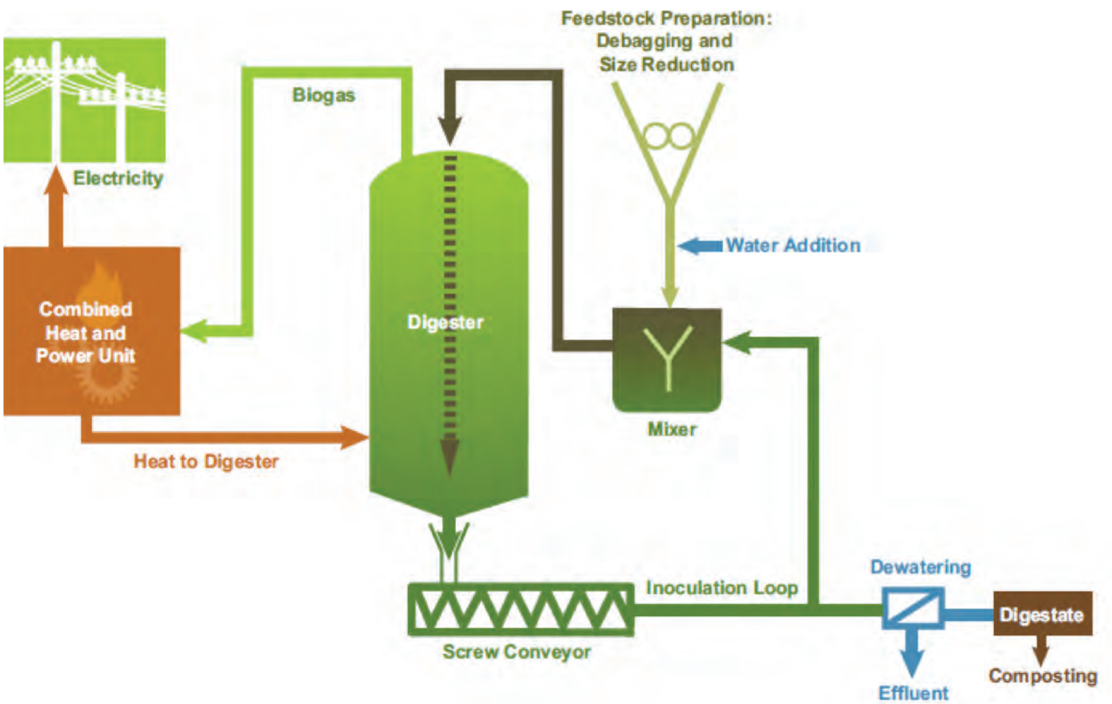


Figure 2: Vertical silo, one-stage, high-solids-slurry AD process flow (Adapted with permission: Organic Waste Systems Inc.)
Source: Government of Canada, Technical Document on Municipal Solid Waste Organics Processing, 2013

For details related to one-stage and two-stage systems, thermophilic vs mesophilic systems, Environment Canada published a resource in 2013 called *Technical Document on Municipal Solid Waste Organics Processing*. (Available by contacting enviroinfo@ec.gc.ca).

Bio-filter technology for odour control (of wet or dry AD systems) has improved significantly in recent years, enabling AD systems to be located adjacent to populated areas. Equipment prices increase with the size of area requiring filtration.

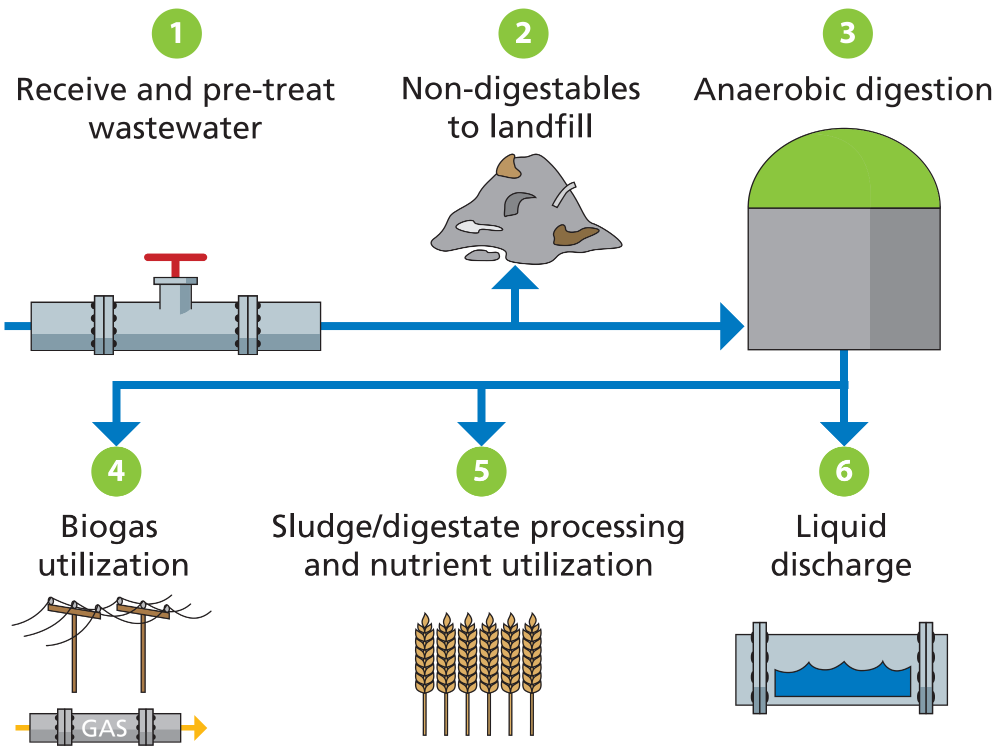
Biogas is captured and can be converted to useable energy, for heat or electricity, or both. To maximize the benefits of biogas from a financial and environmental sustainability point of view, biogas should be captured and converted to useable energy, rather than flared. While some of the energy can be used on-site for treatment operations, a portion of the biogas can be combusted to produce electricity for use at the site or sale to the grid, used for heat by a neighbouring facility, upgraded and either injected into the natural gas pipeline, or used to fuel natural gas powered vehicles.

3. POST-TREATMENT

Post-treatment usually involves composting to finish the digestion process. Fluids require treatment before being discharged to a sewer or waterway. Permits must be acquired from a municipality if discharging to a sewer, or from the province if discharging to a river or lake. Liquid digestate material can also be land applied as nutrient.

More detailed information on technology can be found in reports listed under *Resources* at the end of this document.

WASTEWATER TREATMENT



In this section of the guide, you will find information related to current practices in biogas production at wastewater facilities, business case considerations and a technology overview.

"Why are you burning my money?" Harrison McCain would pointedly ask his operator when he saw that gas was being flared at the biogas plant in New Brunswick treating his company's food processing waste.

Many Ontario citizens can ask their wastewater treatment operators the same thing; biogas is routinely flared due to a range of barriers that exist to installing generators or CHP units. These include:

- Unfamiliarity with the economic case for installing generators or CHP units
- Environmental approvals and electricity grid or natural gas connection permits or contracts
- Extra workload or lack of expertise to obtain approvals and operate equipment in an environment of scarce human resources
- No demands on waste management employees to earn energy revenue for the operations

Some municipalities agree that flaring the gas does not align with their core values, and have examined the economics more closely. There is a concerted effort in the US to utilize biogas, led by the Environmental Protection Agency in cooperation with the Combined Heat and Power Partnership.

In addition, a US publication, *Reframing the Economics of Combined Heat and Power Projects*, outlines how the payback period calculation should also take into account the following: net present value; benefit-cost ratios; internal rates of return; and equivalent uniform annual net value.

Uptake would also be improved if environmental approvals and grid connections were simpler to obtain. One key barrier is the amount of work involved in obtaining a Renewable Energy Approval (REA) for a site that processes waste. A municipality may opt to pipe the gas to a separate property with a generator or CHP, since REA requirements for such a facility would be much more straight-forward.

Consider these facts from the US[3]:

- About 4% of the electricity used in the US moves and treats water and wastewater
- Of the facilities with anaerobic digestion, only 8% generate electrical or thermal energy
- An additional 200 to 400 MW of power could be generated using biogas from the remaining plants

The preamble in the 2008 *Design Guidelines* promotes a site specific approach based on good engineering practice. When considering technology for treating municipal wastewater and sludge, the decision is typically based on a number of factors including: economic considerations, council preferences, geographic limitations, and other factors.

3 Water Environment Research Foundation, Barriers to Biogas Use for Renewable Energy, 2012

Business Case

The business case for biogas utilization at wastewater treatment facilities is affected by Ontario customers being able to access the Process and System Upgrade Incentive (PSUI), which can cover 40% of the capital costs of new cogeneration units.

When looking at biogas utilization, the following information is available from a study for the US Environmental Protection Agency and Combined Heat and Power Partnership:

- The size of facilities that have the greatest potential for employing cost-effective CHP
- Rules of thumb for estimating a CHP system's potential electricity and thermal outputs based on wastewater flow rate
- The emission reduction benefits associated with CHP at WWTFs
- The cost-effectiveness of CHP at WWTFs
- Strategic issues involved with employing CHP at WWTFs

The study targeted wastewater treatment facilities because of the energy production potential and because CHP has been underutilized to date in the US at these facilities, which is also the case in Ontario.

According to the American Biogas Council, there are about 1,500 of the 3,500 major WWTPs operating anaerobic digesters. Most of those WWTPs don't use the biogas that is created, though; they flare it. According to the US Environmental Protection Agency's 2011 study, biogas systems were being used at 104 WWTPs in 2011, but were technically feasible at 1,351 additional sites and economically attractive, meaning a payback on investment within seven years, at up to 662 of those sites.

Cogeneration systems utilizing biogas are generally considered for wastewater treatment plants due to the need for standby power (to provide reliability during utility power outages and shortages), availability of free fuel compared to natural gas, interest in green or bio-energy from renewable resources, and government incentives.

Since many municipalities require AD treatment for their biosolids, cost estimates have not been included here. However, many municipalities are looking at installing co-gen systems fueled by the biogas generated to offset their energy consumption costs, and potentially sell excess energy to the electricity grid. Where this use of the biogas is not possible, municipalities may look to generate and use renewable natural gas (RNG) as a vehicle fuel.

To investigate the business case for energy utilization from wastewater treatment facilities, a technology supplier or consultant will be able to advise, if you have the following information:

1. What is the volume of wastewater currently treated at your facility?
   a. What is the current average hydraulic load of the plant, and what is the plant's hydraulic design capacity?
   b. What is the current average chemical oxygen demand load of the plant, and what is the plant's biological design capacity?
   c. What population does it serve (number of people)? Is this number projected to change, and by how much, over the next 10 years?
   d. Are upgrades/ expansions anticipated within the next 5-10 years?
2. What is the volume of biogas generated by the plant daily/annually (if known)?
3. How much electricity is used annually by the plant?
4. What biogas related technology (i.e., anaerobic digesters, purification systems, combined-heat and power unit) is currently used, and when was it installed?

The business case will also be influenced by the level of financing required for the project, and over what period of time.

Technology Overview

The stabilization of wastewater sludge is commonly done through either aerobic or anaerobic digestion in Canada. The anaerobic digestion of sewage sludge consists of two main phases.[4]

In the first step of the anaerobic digestion of wastewater sludge, called hydrolysis, all incoming flows of sludge are combined, and the mixture is heated to a mild temperature (about body temperature) to accelerate biological conversion. The retention time here ranges from 10 to 20 days.

In the second tank, the mixture is allowed to undergo anaerobic digestion. There is no longer active mixing in order to promote separation, and there is no need for heating as the process generates its own heat. This digestion phase takes place in a larger tank and is where the bulk of the biogas is created. It takes an additional 10 days.

In further processes, the settled solids are dewatered and thickened. The goal is to separate as much water as possible to decrease the volume of material. Finally, a phase known as sludge stabilization reduces the level of pathogens in the residual solids, eliminates offensive odours, and reduces the potential for putrefaction.

MUNICIPAL BIOGAS SNAPSHOT

Electricity and Pipeline Quality Gas from Hamilton Wastewater Treatment Facility

The City of Hamilton, Ontario, (population 520,000) has been using anaerobic digesters to process sludge from its Woodward Avenue Wastewater Treatment Plant for a half-century. In 2006, it stopped flaring off most of the biogas and began using it to fuel a combined heat and power (CHP) plant that generates electricity, provides space heating and heats the digesters. More recently, it began purifying the biogas into 98 percent methane — a product known as biomethane or renewable natural gas (RNG), and identical in performance to the conventional fossil fuel — that is injected into the local pipeline system operated by Union Gas Limited.

The City was able to leverage several initiatives, including innovative planning and design as well as a shared municipal, provincial and federal government infrastructure funding.

Hamilton is growing, and a formal master planning process identified the need to increase the treatment plant's daily capacity from 108 million to 132 million gallons/day. The expansion will generate additional sludge, so more digesters and dewatering centrifuges are also planned. These changes are expected to raise biogas production by 215 percent, to a daily average of about 37,000 m^3, within 20 years.

Hamilton plans to outsource the expansion project, and is encouraging proponents to be creative in their approach, including investigating the potential to add solid waste to boost biogas production, and identifying the best use of the methane.

MUNICIPAL BIOGAS SNAPSHOT

Toronto's Wastewater Treatment Facility

The Ashbridges Bay Treatment Plant is the largest of four wastewater treatment plants operated by the City of Toronto. Located in Toronto's east end, the plant has a treatment capacity of 818,000 m^3/day and serves a population of 1,524,000. Treated effluent is discharged to Lake Ontario.

Toronto Water has cogeneration systems at two of its four wastewater treatment plants. Electricity generation potential is approximately 10 MW from Ashbridges Bay Treatment Plant. The City is developing an energy optimization plan, which could include electricity generation or RNG production. The discussions among parties including, City staff, Toronto Hydro, and Enbridge Gas Distribution have been ongoing for many years.

Toronto Hydro indicates that a proposed cogeneration facility could produce 9.8MW (gross) or 9.4 MW (net). The utility has revised its development approach to pursue either a process incentive or a project under the IESO's Large Renewables Procurement (LRP) if eligible, with an anticipated construction-start of late 2016 and an in-service date of 2017. The normal operating mode for the cogeneration facility will utilize biogas to displace hot water and electricity for plant loads in parallel with the grid. The emergency mode for the cogeneration facility will utilize biogas or natural gas to provide hot water and electricity for plant loads isolated from the grid. A site plan approval is being finalized, and a Renewable Energy Approval was issued on April to Toronto Hydro Energy Services Inc. for Ashbridges Bay Biogas Cogeneration Plant. The cogen plant has not yet been constructed.

City of Toronto Water Annual Report includes annual influent data, utility consumption and costs, and outputs, including biogas volumes and biosolids volumes and disposal methods.

Biogas Association

MUNICIPAL BIOGAS SNAPSHOT

ONTARIO WASTEWATER TREATMENT SNAPSHOTS

The use of biogas for energy production at some Ontario municipalities at their wastewater treatment plants is outlined below. See also the more detailed Toronto and Hamilton case studies.

Barrie

In Barrie, the wastewater treatment plant operators fire a 250 kW CHP engine to offset plant power consumption. Currently, the electricity produced from biogas can offset plant power purchased from the local power grid by thirty to forty percent. This translates to nearly $220,000 per year in electricity cost savings. As the plant continues to expand to serve the growing population, the production of biogas will continue to increase offering more energy and cost saving potential.

Peterborough

At Peterborough's wastewater treatment plant

Peterborough Utility Inc. (PUI) has submitted a Renewable Energy Approval (REA) application to the MOECC for a new $1.8 million renewable energy project at the city's wastewater treatment plant. The proposed project includes a 380 kW CHP facility. The project has a Feed-In-Tariff (FIT) contract with the IESO. Currently, most of the biogas from the plant is flared and a portion is used in boilers for heat usage.

The PUI is independent from the City of Peterborough, although wholly owned by the City. It argues that a developer, such as a utility, is ideally positioned to undertake such projects, and take on the risk. It holds a lease and operating agreement with the City. It worked with a biogas developer CCS Biogas to estimate the energy production based on data provided by the City, size the system, and plan how to integrate the CHP into their heat system, existing site and buildings. The Environmental Compliance Approval had to be amended, in addition to applying for the REA.

Peterborough and PUI recognize that the project will convert a waste stream to a revenue stream. Payback waste water treatment plant to CHP projects of this size is generally 4-7 years. PUI does not require external financing for this project.

PUI built a grid-connected facility at Peterborough's landfill, and the conversation evolved among City staff and elected officials to investigate biogas usage at the wastewater plant.

Peel Region

In Peel Region, one of the wastewater treatment facilities uses about $13 million a year in electricity. The region has been advised that it could save $2.8 million by generating electricity from its biogas production. This would not involve a contract with the Independent Electricity System Operator (IESO), but would rather be handled behind the meter, simply offsetting power used by the plant.

MUNICIPAL BIOGAS SNAPSHOT

Chatham-Kent

A 250 kW containerized, digester gas fuelled CHP system was commissioned at the wastewater treatment plant in Chatham-Kent in September 2013. The project includes gas conditioning with cooling and re-heating of the biogas as well as an activated carbon filter to remove H_2S and siloxane from the gas flowing to the engine. The plant also incorporates a flexible biogas storage facility to optimize the revenues generated from the CHP system. Power is being sold under a 20-year FIT contract with the IESO. Heat recovered from the engine is utilized for building heating and to optimize the digester process.

Chatham-Kent's CHP and gas storage dome

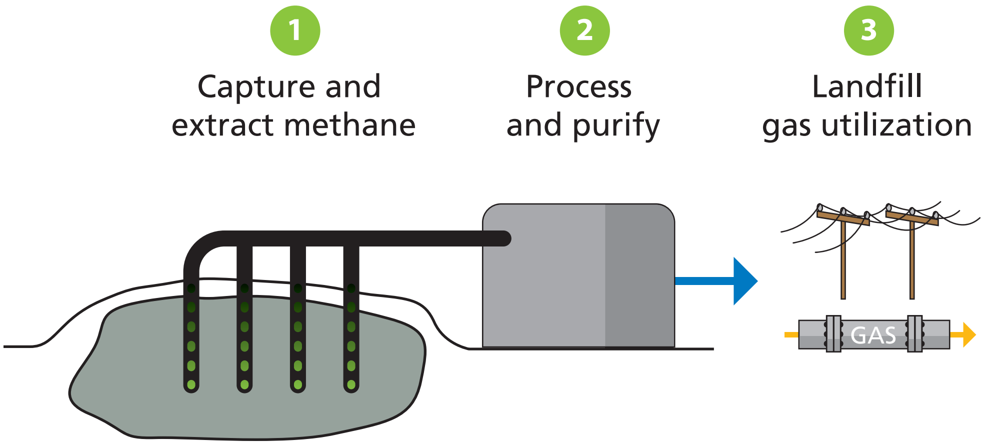
CHATHAM-KENT BY THE NUMBERS

- Sludge Treatment – **250 m^3/day**
- Biogas Production – **1,900 m^3/day**
- Engine Size – **190 kWe**
  - Note that the engine at the Chatham-Kent WWTP is 250 kW to accommodate load growth over time
- Thermal output is **273 kW**
- Plant efficiency is **81.8%**
- Simple Payback – **5-7 years**

Current laws, regulations and practices related to biosolids management have moved from waste management to a focus on beneficial use and maximum resource recovery from these materials. The Canadian Council of Ministers of the Environment (CCME) approved a *Canada-wide Approach for the Management of Wastewater Biosolids* that encourages provinces and territories to beneficially use wastewater biosolids. The CCME Approach recognizes that wastewater biosolids, sludge and treated septage contain valuable nutrients and organic matter that can be recycled or recovered as energy.

4 *Nazaroff & Alvarez-Cohen, Anaerobic Digestion of Wastewater Sludge*

LANDFILL GAS



The decomposition of the organic component of municipal waste in landfills produces landfill gas containing about 50% methane (CH_4) and 50% carbon dioxide (CO_2). Methane is a potent greenhouse gas as it has a global warming potential 21 times that of carbon dioxide. As a result, landfills are considered a significant source of greenhouse gas emissions.

Landfill gas also contains trace amounts of other compounds, such as hydrogen sulphide, mercaptans and non-methane organics. These other compounds may cause odours or affect local air quality.[5]

Ontario has regulations requiring mandatory landfill gas collection and controls for new, expanding and operating landfills larger than 1.5 million cubic metres. Ontario Regulation 232/98 came into effect in 1998 and was amended in 2008.

See *Appendix B* for a summary of Ontario landfill gas to energy projects by IGRS.

5 *Ontario Environmental Registry*

Business Case

Since regulations require many landfills to collect their gas, a feasibility analysis can determine if landfill gas utilization makes business sense. On-site testing can assess the quality and quantity of landfill gas that can be extracted to further determine if landfill gas utilization is viable.

Possible utilization includes direct use at a neighbouring facility, generation of electricity for sale, or generation of RNG for injection into the natural gas pipeline. Aspects to be considered that affect the business case include:

- Size, age and location of the landfill
  - Size, including volume and type of waste material accepted, and age of the waste will affect gas generation and gas recovery over time
  - Location of the facility in relation to electricity grid or gas distribution/transmission interconnection points and proximity to nearby large energy users
- Design and construction of the gas collection system, gas processing system and respective gas compression, power generation or RNG upgrading systems
- Power Purchase Agreements and financing terms
- Environmental attributes associated with the project
- Or the ability to connect to the natural gas grid and find a buyer for the RNG.

Although GHG emissions trading systems have not yet been developed by governments in Ontario or Canada, many companies have participated in GHG emission trading schemes as part of their risk mitigation programs. Emission reduction credit agreements must be negotiated and implemented, including credit verification.[6]

Some landfill sites have already obtained their REA and have a FIT contract, such as Peterborough's Bensfort Road Landfill Site.

6 *Mike Watt, Integrated Gas Recovery Services*

Technology Overview

Landfill gas can be combusted to generate electricity; however, both the volume and concentration of methane must be high enough to make this process work efficiently. The formation of methane depends upon the amount of organic waste in the landfill and the temperature and moisture content of the landfill. Some of Ontario's large municipal solid waste landfills, which are designed to allow a certain amount of rainfall to seep in annually, may generate enough gas with high enough methane concentrations to make energy production economically viable.

The gas is collected through a system of vertical or horizontal plastic perforated pipes drilled into the landfill at regular intervals. The gas is collected by exerting a vacuum in the pipes using a blower or compressor. This device draws the gas from the waste into the well and gathering pipes and brings it to the plant, compressing it to an appropriate level. Prior to injecting it into a boiler, generator or turbine, the gas is cooled to allow moisture to condense. (Gas is not cooled if being flared.) The gas is filtered, reheated, and is flared or used to generate energy.[7]

Any gas not captured by these systems is eventually released to the atmosphere. The need to create higher methane generation rates (in order to make a gas collection and utilization system viable) could result in landfills designed to be wetter, simply because wetter material decomposes more quickly. Depending on the actual capture efficiency, higher fugitive methane emission rates resulting from wetter landfills could reduce, offset or even exceed the potential environmental gains from landfill gas capture and power generation.[8]

The efficiency of a methane capture system depends upon various factors such as the placement of the wells and the permeability of the waste materials in the landfill as well as many other factors including the limits imposed by landfilling operations. Accordingly, the methane capture rate in most gas collection systems ranges from around 50 percent to as high as 80 per cent. Any gas not captured by the system is eventually released to the atmosphere.

7 Mike Watt, Integrated Gas Recovery Services

8 Environmental Commissioner of Ontario, Landfill Gas Collection and Control Regulation

MUNICIPAL BIOGAS SNAPSHOT

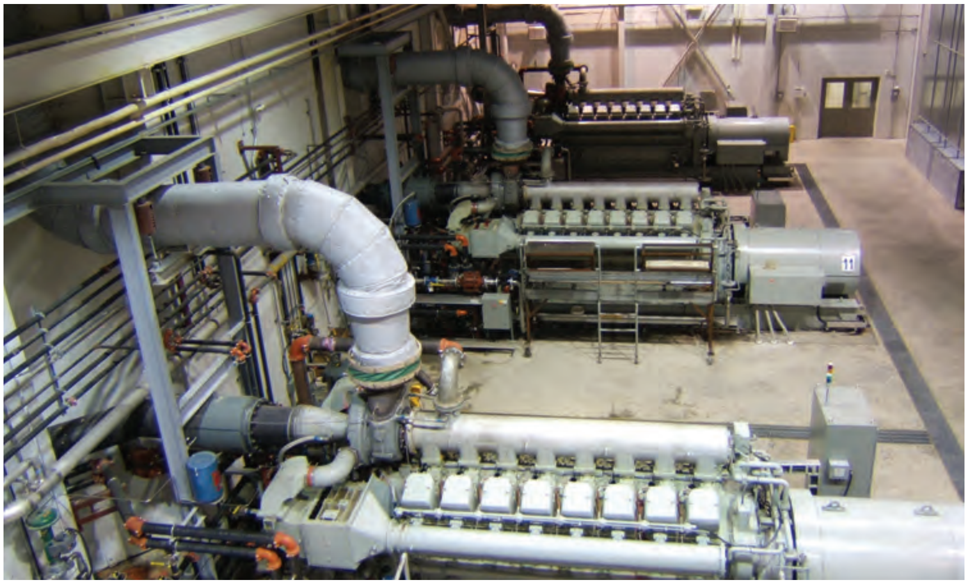
Award Winning Britannia Landfill Gas to Electricity Project

The design-build phase of the project started in 2003 and the facility achieved total performance in 2005. The facility continues to operate and is designed to do so until 2025.

- Total cost of design and construction, $11 million
- Annual revenue approximately $2.5 million

Integrated Gas Recovery Services Inc. (IGRS), a partnership between Walker Environmental Group Inc., and Comcor Environmental Limited, financed, designed, built, owns and operates the Britannia Landfill Gas to Electricity Facility, including the landfill gas collection and processing system. This project takes the landfill gas from the closed Britannia Sanitary Landfill Site to generate up to 5.6MW of renewable electricity.

Using an innovative financing model, IGRS worked closely with the Region of Peel to develop the project. The project was recognized in 2005 by the Canadian Council of Private-Public Partnerships for innovation and excellence in the category of infrastructure development. In addition to providing a long-term, reliable and cost effective source of renewable energy, the City of Mississauga and the Region of Peel redeveloped the closed landfill site into the award winning 27-hole Braeben golf course.



Landfill gas is collected from approximately 55 vertical gas collection wells strategically placed to avoid disruption to the use and function of the golf course. Gas is delivered through an 800-metre dedicated pipeline to an off-site gas processing and electricity generation plant.

Initially structured as a renewable electricity purchase agreement wherein the municipality would purchase the renewable electricity to offset use at municipal wastewater treatment plants, the Region and IGRS worked together to convert to the power purchase agreement to a 20-year Renewable Energy Standard Offer Program contract with the IESO (formerly OPA).

CO-DIGESTION AND CO-LOCATION

Co-digestion of wastewater and SSO can be considered by Ontario municipalities in order to maximize efficiencies and economies of scale, and to take advantage of existing infrastructure and valuable real estate. The Water Environment Research Foundation (WERF) in the US is actively promoting co-digestion as the lowest overall cost option for municipalities, leveraging investment in existing equipment and staffing.

Adding SSO to wastewater treatment facilities is done in several jurisdictions, including Des Moines, Iowa. Experts point to the advantage that micro-nutrients for digesting SSO are present in wastewater sludge, which can maximize biogas production potential. Extensive information on nutrient loading, and co-digestion is available online through WERF's website, including a March 2014 webinar .

Biogas production through anaerobic digestion is limited to conversion of the readily biodegradable portion of the solids. To overcome this limitation, and thus maximize biogas production, pretreatment processes and co-digestion have become rapidly growing practices in recent years at wastewater treatment facilities in the US.[9] Pretreatment processes break open the bacterial cells in the waste activated solids, releasing the cell contents, making them available to the anaerobic bacteria for conversion to biogas. Co-digestion, on the other hand, consists of adding readily biodegradable feedstocks directly into the digester, to co-digest them with the biosolids. Fats, oils and grease, for example, are readily biodegradable by anaerobic bacteria. Other high-strength wastes can also be co-digested to increase biogas production at this later stage, to maximize energy production.

When municipalities consider expanding facilities due to population growth or other factors, it is a good time to consider economies of scale of making investments in facilities that can handle both types of waste.

Understanding long term feedstock supply is the most critical part of the business case development for any biogas system, but is particularly variable when planning a co-digestion facility. For most municipalities, feedstock is from their residents, and volumes are predicated on conservative assumptions related to population projections and waste diversion policies. This helps inform a sound business case for AD. However, in some cases, municipalities enter into joint ventures with private sector entities such as food processors and waste haulers, which changes the material stream being digested.

A municipality could also co-locate SSO treatment at landfill site to minimize transportation costs, and to add efficiencies to grid connection.

9 National Biosolids Partnership, WERF, WEF, Enabling the Future: Advancing Resource Recovery from Biosolids, 2013

MUNICIPAL BIOGAS SNAPSHOT

Rural Communities Handling Mixed Wastes: Georgian Bluffs-Chatsworth Digester Treats Septage, Food Waste, and SSO Leachate

The Georgian Bluffs digester generates revenue from its Feed-in-Tariff (FIT) contract of 100kW. This unique system was installed in 2009 to process septage from Georgian Bluffs, and neighbouring Chatsworth townships in Ontario. In order to boost energy production and the associated revenue from the FIT contract, the system also takes food processing waste and leachate (seepage from organics collection) from SSO treatment plants in other municipalities.

The arrangement with Chatsworth arose out of a desire to meet proposed environmental standards set out by the Ministry of the Environment in 2008, which were to prevent land application of septage. The municipalities worked together to provide capacity to treat septage in Georgian Bluffs, and share landfill space for other material in Chatsworth. While the standards made treatment optional, the municipalities proceeded with the digester, and are able to treat septage to a high environmental standard.

The energy production varies according to how much material is processed through the system. With more anaerobic digesters in the province now than when the system was commissioned in 2009, less food processing waste is being delivered to the digester. However, in winter, when waste haulers cannot directly land apply septage, processing volume is higher. Leachate from municipalities treating SSO is relatively consistent.

The municipalities engaged a consultant to assist with the FIT application to the IESO. There are several issues that staff would not be aware of that are best addressed by third party organizations.

Electricity Procurement

There are several electricity procurement processes in Ontario that municipalities can access to harness the power from biogas systems. These are listed as follows:

Feed-in Tariff (FIT)

The Feed-in Tariff (FIT) Program is a standard offer program for renewable energy projects that are generally less than 500 kW and includes biogas, such as any smaller municipal project noted above, as an eligible fuel type. Details of the FIT Program are updated online, and include information on pricing, program eligibility and rules, procurement windows, and contract documents, materials and standard definitions.

Large Renewable Procurement (LRP)

For municipal biogas projects over 500 kW, biogas developers may be interested in the Large Renewable Procurement (LRP). This competitive process is conducted in two stages, a Request for Qualifications (RFQ) followed by a Request for Proposals (RFP). In the RFQ stage, applicants are qualified to participate in the RFP based on their ability to meet a set of mandatory requirements focused on past development experience and financial capability. In the RFP stage, qualified applicants are invited to submit project-specific proposals that incorporate full details about the project, including location, capacity, connection point and information about meaningful communication engagement (e.g., with municipalities, Aboriginal communities and other groups). Visit the IESO's website on LRP for the most up-to-date information.

Applicants to these procurement processes should be aware that some parts of Ontario's electricity grid are currently constrained and cannot accommodate additional generation at this time. Contracts will not be offered unless capacity is available at the project location. More information is available under FIT and LRP on the IESO website.

Grid Connection

Grid connection and dealing with local distribution companies (LDCs) typically takes place through the services of a consultant or contractor familiar with the processes. Typically, a consultant would liaise with the necessary authorities at both Hydro One and your LDC, develop the system's electrical design, and complete the necessary permits and forms. Here is a summary of the types of tasks to be completed:

- Consult with LDC and Hydro One to ensure there is short-circuit capacity, transformers will not need to be upgraded, and thermal capacity is available on the line to avoid overheating the system.
- The utilities will want to learn about the generation capacity (i.e., kW or MW), that the electricity is being generated by biogas, and that it is a synchronous form of generation.
- Your protection and control plan philosophy will also be discussed, including how the electrical system will be protected by a problem at your project, and how your project will be protected in the event of a problem with the electrical grid.
- Capacity for your project needs to be allocated, based on your proposed commercial operating date.
- The electrical design drawing is submitted as part of the process of getting an Offer to Connect to the grid.
- Forms are completed and submitted, including the Connection Impact Assessment, which includes details including the make and model of the generator. There are fees required to submit these forms.
- The financial impact of grid connection will have to be taken into account, and can be costly. If grid protection is required, it can cost in the $100,000s.

Approvals and Regulations

All municipal biogas facilities that generate electricity, regardless of sale to Ontario's electricity grid, require a Renewable Energy Approval. See the Ontario government's information related to Renewable Energy Approvals (REA). At the website, you will determine what is needed in order to apply for a REA. This includes the description of the project, fees that need to be paid, public consultation requirements, and a series of reports that need to be submitted as part of the application process. Typically, consultants are hired to assist with the REA process, and the process can take well over a year. Some reports, such as odour and noise, need to be conducted by a third party.

In order to complete the REA process, the plant design has to be about two-thirds complete, according to industry representatives familiar with the process. A list of the reports required as part of the process is as follows:

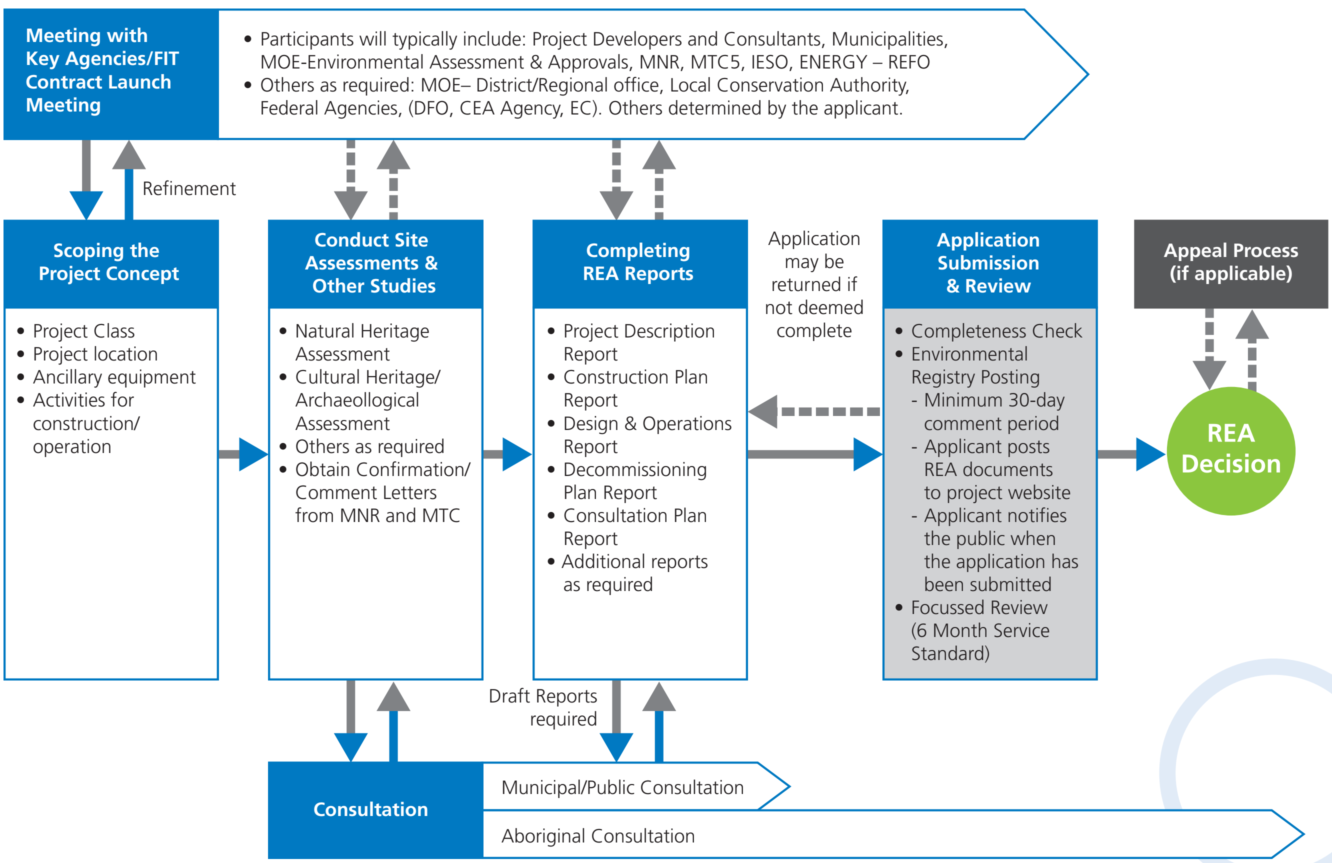


Figure 3: Overview of the principal elements of the REA application process.
Source: Technical Guide to Renewable Energy Approvals, Government of Ontario, 2013

1. Construction Plan Report
2. Consultation Report
3. Decommissioning Plan Report
4. Design and Operations Report
5. Project Description Report
6. Protected Properties, Archeological and Heritage Resources Report
7. Natural Heritage Assessment
8. Water Assessment
9. Effluent Management Plan Report (only for Class 3 AD facilities)
10. Emission Summary and Dispersion Modeling Report
11. Hydrogeological Assessment Report (only for Class 3 AD facilities)
12. Noise Study Report
13. Odour Study Report
14. Surface Water Assessment Report (only for Class 3 AD facilities)

After commissioning, noise and odour audits may be required to be completed and reports submitted to the MOE.

Safety

Technical Standards and Safety Authority (TSSA) requirements are an integral part of the construction process. Complete designs of all gas components must be submitted to TSSA for approval. TSSA approval is required for systems at new operations and facilities or at existing facilities where such facilities have been modified, upgraded or expanded.

The new *TSSA Digester, Landfill & Biogas Approval Code* was published in December 2012. The document is to be used in with the Canadian Standards Association (CSA) B149.6-11 Code for digester gas and landfill gas installations published in 2011; and the SPE-149 Interim Code Requirements for Anaerobic Digesters for Renewable Energy. CSA is planning a revised 2015 version of the CSA-B149.6 code which will include a new section which will include biogas facilities at agricultural farms. When finalized, the revisions will be posted on the TSSA's website .

The TSSA code outlines the requirements for the approval of water pollution control plants, landfill sites and biogas facilities. It covers the safe handling and operation of systems where gas may be captured, stored, transmitted or utilized.

Some examples of requirements include:

- All valves and piping must be approved for biogas application
- Flare must have an alternative fuel for pilot flame including a burner management system
- Flare must have a continuous gas analysis meter and ability to add alternative fuel in case biogas is in the explosive range
- Lightning protection is required for the digester. The lightning protection is for digesters with flexible membranes only, not traditional ones with roofs fabricated from steel, concrete or rigid fiberglass. The proposed 2015 code requires lightning protection unless a risk assessment is done demonstrating it is not required.

Resources

Additional resources for municipal audiences are listed below.

- Government of Canada, Technical Document on Municipal Solid Waste Organics Processing, 2013 (can be obtained by contacting enviroinfo@ec.gc.ca)
- The US EPA's Agstar page related to AD
- Energypedia's Planning Guide for Biogas Plants
- Design Guidelines for Sewage Works

Some additional resources to assist in developing the business case can be found in the following documents:

- Dillon Consulting Study of Options for Organic Waste in the Province of Newfoundland and Labrador, July 2014
- Genivar Consulting generated a "Central Composting Facility Viability Assessment Report", May 2012, for Simcoe County cited in January 2014 staff report titled "Central Composting Facility Update"
- A business case was generated by Golder Associates for Barrie, Ontario in 2012
- Solid Waste as a Resource, Review of Waste Technologies, FCM, 2004

Rather than relying on cost estimates, which may be outdated and not reflect current pricing, it is recommended that municipalities research actual costs from other municipalities. In some instances, municipalities have used cost estimates to prepare budgets for council approval, and these budgets have been too low to result in successful AD projects.

Appendix A: List of Interviewees

The Biogas Association wishes to thank the following individuals for providing their expertise to aid in the development of this Municipal Guide to Biogas:

- Mike Brown, 2G Cenergy
- Alex Chapman, City of Guelph
- Jessie Cheng, City of Toronto
- Tom Chessman, City of Hamilton
- Randy Cluff and Kevin Matthews, CCI Bioenergy
- Wayne Davis, Harvest Power
- Vicki Elliott, PlanET Biogas Solutions
- Marvin Evans, TSSA
- Chris Ferguson, CCS Biogas
- Lauren Fillmore, Water Environment Research Foundation
- Darren Frye and Paul Bulla, IGRS
- Tom Hintz, Seahold
- Matt Lensink, CEM Engineering
- Lisa McFadden, Water Environment Foundation
- Ministry of Agriculture, Food and Rural Affairs staff
- Ministry of Environment and Climate Change staff
- Peter Paquette and Troy Unruh, Georgian Bluffs
- Eric Prevost, Peterborough Utilities Inc.
- Phil Sidhwa, Anaergia
- Jack Simpson, Toronto Hydro
- Jamie Skimming, City of London
- Tim Sunderland, Chatham-Kent
- Brian Van Opstal, Peel Region
- Peter Veiga, Durham Region

Biogas Association

Appendix B: IGRS Landfill Gas to Energy Projects

IGRS Project Name	Project Location	Project Type	Start Date	Installed Capacity	Provincial Program
East Landfill Gas Utilization Facility	Niagara Falls, ON	Direct-Use, Medium BTU Project	March 2002	4,500 scfm of Utilization Capacity 7,500 scfm of Flaring Capacity	None
Britannia Landfill Gas to Energy Project	Mississauga, ON	Electrical Generation	September 2005	5.6 MW of Generation	RESOP
Trail Road Landfill Gas to Energy Facility	Ottawa, ON	Electrical Generation	January 2007	6.4 MW of Generation Capacity	RES-I
East Landfill – GGUI Gas to Energy Facility	Niagara Falls, ON	Electrical Generation	December 2007	1.0 MW of Generation Capacity	RESOP
Essex Regional Landfill Gas Control Facility	Essex, ON	Carbon Reduction Project	January 2009	2,500 scfm Flaring Capacity	None
Eastview Landfill Gas Flaring Project*	Brandon, MB	Carbon Reduction Project	February 2012	700 scfm Flaring Capacity	None
Moose Creek Landfill Gas to Energy Project	Moose Creek, ON	Electrical Generation	January 2013	4.4 MW of Generation Capacity	Feed-in-Tariff
Brady Road Landfill Gas Flaring Project*	Winnipeg, MB	Carbon Reduction Project	August 2013	2,500 scfm Flaring Capacity	None

Biogas Association

275 Slater Street, Suite 900, Ottawa, Ontario K1P 5H9
www.biogasassociation.ca