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ORGANIC MATERIALS PRIMER FOR BIOGAS

MARCH 2014

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The views expressed in this report are the views of the Biogas Association and do not necessarily reflect those of the governments of Canada and Ontario.

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Executive Summary

Biogas systems actively break down organic material in the absense of oxygen and convert it into useable energy and a soil amendment. Biogas production provides multiple environmental and economic benefits, and helps enable policy makers to consider organic material as a resource instead of a waste material.

A steady supply of organic material or feedstock is required for biogas systems to operate and generate energy. Securing a steady supply of organic material is a challenge in Ontario for a range of reasons outlined in this report. An organics diversion strategy should be established that would keep organic materials out of landfills, creating demand for end users such as biogas systems.

This ***Organic Materials Primer for Biogas*** was developed to help biogas industry stakeholders and decision makers understand the issues related to organic materials and their relationship with the biogas industry. It has five main sections:

- The first section provides a brief historic overview of anaerobic digestion and outlines the anaerobic digestion (AD) process.
- The second section summarizes the challenges faced by AD, and then highlights opportunities related to capitalizing on the food waste opportunity, and creating jobs. A discussion of the value of different organic materials in energy generation is followed by a summary of the environmental benefits of AD.
- The third section addresses regulations that govern the anaerobic digestion sector. Testing and certification requirements are outlined. An overview of draft Ontario legislation is provided as background understanding to current legislative gaps.
- The fourth section examines each pathway that organic material can follow, depending on which type of AD system accepts the material, including regulation references that guide different sources, and relative volumes of material available in each stream.
- The fifth section focuses on what is being done differently in other jurisdictions, including Quebec, Nova Scotia, the US and Europe, where restrictions are in place on how organic material can be treated and disposed.

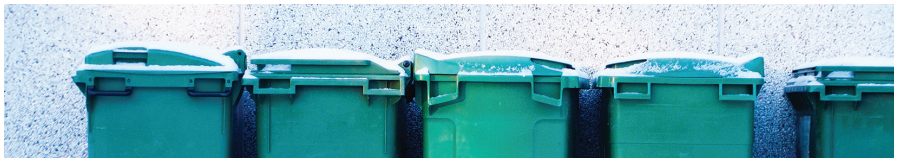
Note that organic material can flow to AD systems, landfills or compost facilities. The *Primer* focuses on anaerobic digestion and does not address matters related to compost or landfill gas.

There are four sources of organic material that supply AD systems, excluding leaf and yard waste that supply dry AD systems:

1 **Farm-based inputs including manure, crop residues and purpose grown crops**

2 **Organic material from the commercial and industrial sectors, including food and beverage processors, restaurants and the grocery sector**

3 **Municipal organic material from residential green bin programs (residential SSO)**



4 **Biosolids from municipal wastewater treatment plants**

In Ontario, the biogas sector is challenged with securing feedstock from these sources. In particular, commercial and municipal organic materials are valuable inputs that require the focus of the biogas sector in sourcing feedstock for AD. A greater diversion of organic materials to AD will result in the capture of energy from these materials to be converted to useable energy, avoiding harmful greenhouse gas emissions and the creation of green jobs. When organics are mixed with manure in an AD system, additional environmental benefits result, including manure treatment of pathogens and odour, and improved manure handling characteristics. Equally important, the nutrients in this organic material will be returned to farmland and enrich our soil for food production.

Introduction

This ***Organic Materials Primer for Biogas*** was created by the Biogas Association to inform members and decision makers of key issues related to organics diversion and provide common understanding of these issues within the industry and government. The ***Primer*** will be used to inform Biogas Association decision making regarding organic materials diversion.

Currently, organic material can be sent to landfill at very low cost in some areas, with no restrictions, except leaf and yard waste which is banned from landfills. This contributes to relatively low levels of available feedstock for anaerobic digestion. When organic material is landfilled, the energy in the material is not captured, unless the landfill gas is captured and converted to useable energy. The organic material decomposes, venting greenhouse gases to the atmosphere, and contributing to climate change. For every tonne of organic residuals diverted from landfills, at least one tonne of greenhouse gas emissions is avoided, and the number may be much higher.

Organic material availability for anaerobic digesters affects the biogas industry profoundly as all existing biogas operations rely upon some form of organic material to produce biogas and make their systems economically viable.

Many municipalities in Ontario have waste diversion policies that include green bin programs for residents, also known as source separated organics (SSO). Industrial food and beverage processors, commercial grocery retailers, restaurants and other large-scale producers of organic material commonly dispose of these materials at the lowest cost to their businesses. In the absence of policies that guide how organic material is disposed of, greenhouse gas emissions will rise further.

Another concern related to disposal of organic material is the declining trend in organic matter in soils. While it is difficult to put a dollar value on the nutrient value and organic matter of the soil, the connection between soil health and nutrient value in food is important.

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A. Organic Materials Processing in Ontario

This section provides a brief historic overview of anaerobic digestion (AD) and outlines the AD process.

Anaerobic Digestion

Historic Overview

Biogas has grown in recent years in Ontario as a result of progressively improving policies related to renewable energy. Starting in 2006, the Ontario Power Authority offered power purchase agreements for biogas systems under the *Renewable Energy Standard Offer Program*. The Ontario government introduced the *Green Energy and Green Economy Act* in 2009, and the Ontario Power Authority transitioned to the *Feed-In Tariff Program* offering long-term power purchase agreements for renewable energy in early 2010.

The first farm-based AD system was installed in 2003 at Fepro Farms, and Ontario currently has approximately 30 operational farm-based biogas systems. The Ontario Government introduced the *Ontario Biogas Systems Financial Assistance* program in 2007 to support biogas sector development through feasibility studies, capital grants, training, and research.

Organic material that is landfilled produces methane as it breaks down as well. In June 2008, new rules came into force under the *Environmental Protection Act* (EPA) that increased the number of Ontario municipal landfills required to have landfill gas collection systems in place. Landfill owners are also required to produce annual reports on landfill gas reductions. Prior to these amendments, only landfills with a capacity in excess of three million cubic metres were required to have such systems. The new rules require gas collection systems for landfills that have a capacity exceeding 1.5 million cubic metres. Most landfills flare the gas collected, rather than convert it to useable energy.

A privately run commercial AD facility opened in Newmarket Ontario in 2001 with an *Independent Power Purchase Agreement* (IPP) with Ontario Hydro and the local utility. Commercial AD facilities have started operation in London in 2013, and in Elmira in 2014.

Toronto is currently the only municipality that digests its residential source separated organics (SSO). While the gas is currently flared, there are plans to use some of the gas for energy production.

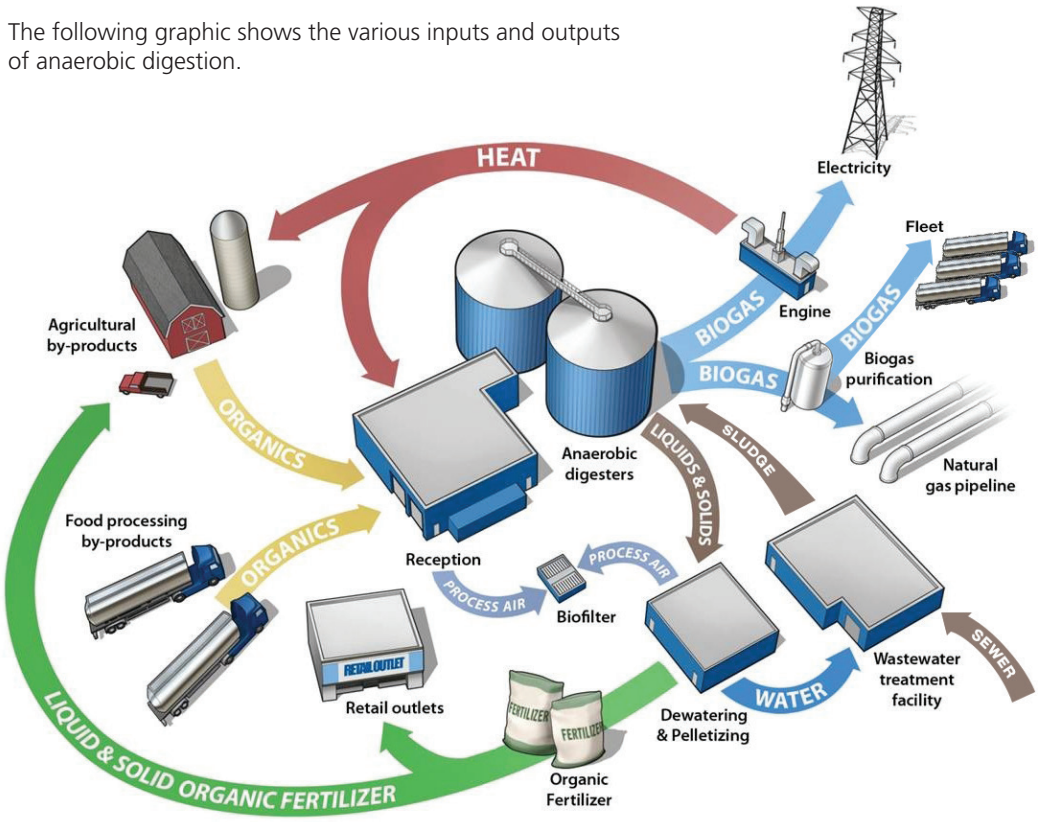
Wastewater treatment plants use AD to digest biosolids, and most facilities in Ontario use the heat generated for internal purposes. Starting in 2012, some municipal facilities, such as Hamilton and Chatsworth/Georgian Bluffs, started generating useable energy which was exported to the electrical grid. Some additional municipal energy projects are under development.

Process Overview

Biogas is created when organic material is broken down in an oxygen-free environment, called anaerobic digestion. Biogas is a mixture of methane (CH_4), carbon dioxide (CO_2) and smaller amounts of other gases, including hydrogen sulfide (H_2S) and ammonia (NH_3). Methane amounts vary from about 45% in landfill gas, about 55% in farm biogas, and about 60% in SSO biogas. Biogas, in its raw form, can be combusted in specially designed engines. Biogas can also be upgraded to pipeline-quality natural gas by removing all of the unwanted gases, particularly carbon dioxide, hydrogen sulphide and water. The purified or upgraded gas is called biomethane or renewable natural gas (RNG).

Digestate is the material remaining after the anaerobic digestion process which is returned to agricultural land, where it provides valuable nutrients. In some cases, the digestate needs an aerobic phase before it can be land applied. Depending on its make-up, it can provide moisture retention and organic content for soils. It is rich in macro- and micro-nutrients, and therefore enhances plant growth. It can also be used to protect soils against erosion. It can be used on farm as animal bedding or fertilizer, or if tested and certified, sold as fertilizer.

The following graphic shows the various inputs and outputs of anaerobic digestion.



B. Challenges and Opportunities Related to Organic Materials

This section summarizes the challenges faced by the AD sector, and then highlights opportunities related to capitalizing on the food waste opportunity, including creating jobs. A discussion of the value of different organic materials in energy generation is followed by a summary of the environmental benefits of AD.

Challenges for Anaerobic Digestion

As we consider how to divert more organic material to the biogas sector, it is important to understand the associated challenges, which include:

- Industrial food processors are able to landfill food waste in areas such as Michigan with low landfill charges. There are no requirements to process organic materials at AD facilities.
- Just as landfill is a cheap and easy option, so too is NASM land application, drawing materials away from biogas systems and missing out the opportunity for energy production.
- Biogas system operators need to use internal resources or hire an external company to source feedstock for them.
- Organic material availability varies by location, and different digester types are designed for different feedstocks. This means that locally available feedstocks may not be suitable for operating digesters in the area, and suitable organic materials may have to be trucked long distances.
- High energy feedstock, such as fats, oils and grease (FOG) are ideal, but not always accessible or readily available.
- As more digesters operate in Ontario, prices may change as competition for that feedstock increases.
- Municipal source separated organics (SSO) cannot be processed at farm-based RMADF systems.
- Biogas systems are typically not close to food processing sources.
- Food processing and food service companies have several barriers that may limit their ability to produce a food waste stream suitable for biogas systems.
- Lack of data about organic materials, including: type of materials, where they are being produced, how much is being produced, availability (i.e., seasonal), current disposal costs, what the materials consist of.

Food Waste: An Opportunity

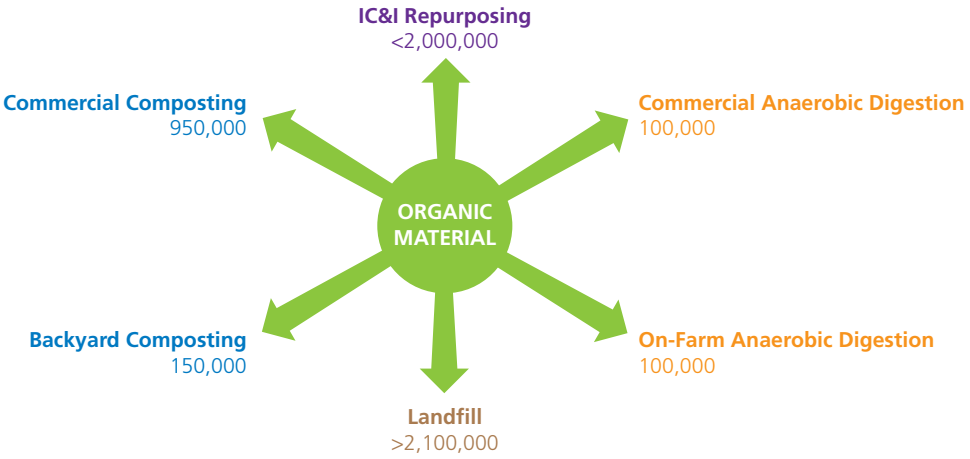
It is clear that food waste is both a challenge and an opportunity. While there is significant organic material in the food industry, and a lack of related data from the sector, there is an opportunity to divert a significant amount of this material to productive use, which will provide a range of benefits. Ontarians will benefit from improved policy if organic material is considered a resource.

The quantifiable difference in value between what is produced on farms in Canada, then processed, distributed and sold every year, compared to what is consumed, exceeds $27 billion (Value Chain Management Centre, 2010). This equates to approximately 40% of all the food we produce and 2% of Canada's GDP (Statistics Canada, 2010; Macdonald, 2009). To put this in perspective, $27 billion is:

- More than Canadians spend on food purchased from restaurants in 2009
- Slightly below the value of all Canadian agricultural and agri-food exports in 2007
- Greater than the value of all Canadian agricultural and agri-food imports in 2007
- Higher than the combined GDP of the 32 poorest countries (World Bank, 2009)

In Ontario, the estimated flow of organic material in 2013 is estimated by 2cg, and graphically displayed below. The term "IC&I Repurposing" is used to describe the material that is used in some manner by the food processing or farm sector, as animal feed, or other application.

ESTIMATED FLOW OF ORGANIC MATERIAL (TONNES/YEAR)



Source: © van der Werf, 2014, used with permission

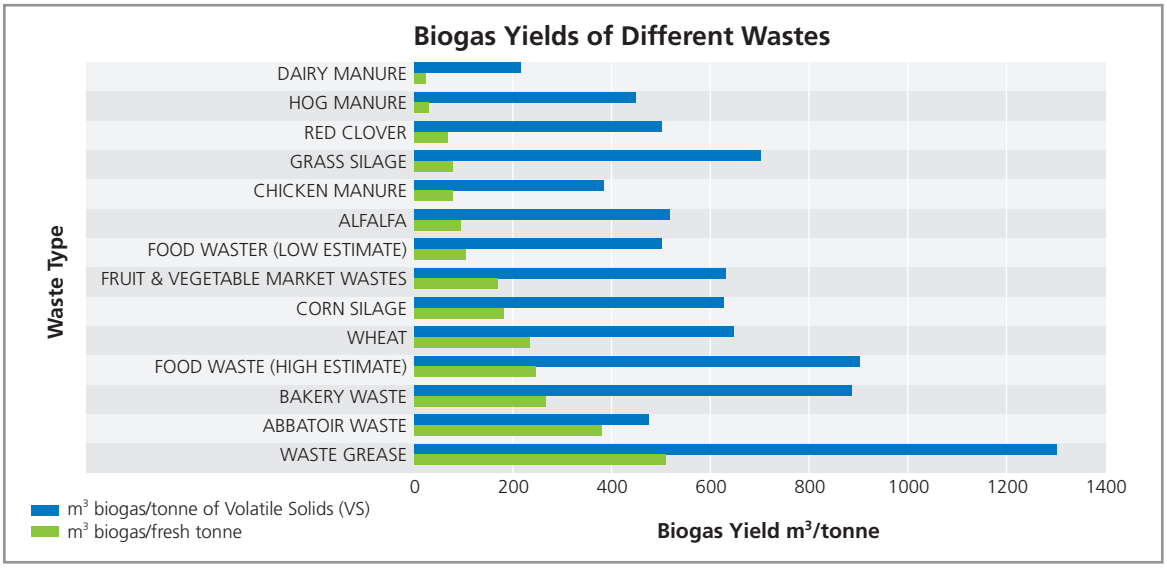
Energy Potential of Organic Material

Different organic materials yield varying amounts of energy through anaerobic digestion systems. It is important for system operators to understand the energy potential of the organic material available to them.

In projecting the biogas yield from a particular feedstock, the components of interest are:

- Organic content – fat and protein constituents, and carbohydrates assessed by measurement of volatile solid content and carbon-to-nitrogen (C:N) ratio
- Inorganic content - also known as minerals or ash, which includes metals, and
- Water

To determine volatile solid (VS), total solid (TS) and water content, a sample of feedstock is first weighed before and after drying. Only biologically degradable organics can be converted into biogas, so volatile solid (VS) content is a key measure of the maximum biogas-generation potential of a substrate. The chart below illustrates the biogas yields of different organic materials.



Source: Regenerate Biogas

There is a comprehensive feedstock section in *Appendix A* of the *Farm to Fuel: Developers' Guide to Biomethane*. It includes a section on biogas yields from different feedstocks and associated advantages and disadvantages, questions to ask your potential feedstock suppliers, and maps of feedstock densities across Canada.

Information on storage tanks for pumpable feedstock, feedstock sorting and separation, sanitation, and mashing and homogenizing can be found in the *Biogas Handbook*.

Jobs Creation from Organic Material Processing

It is always important to consider the job creation value of any new industry or policy, and increasing the amount of available feedstock for AD and compost increases the job related benefits Ontario can enjoy. The ***Ontario Organic Waste Management Report, 2013-2033***, finds that in 2011, 245 operators and managers were employed in organic materials processing facilities. On average, about 0.15 direct labourers/operators were employed per 1,000 tonnes of organic materials processed, generating approximately $11 million in wages. For every 3.5 operators, there was one manager. This does not include secondary employment in organic materials collection and transportation, or sales. (2cg, 2014)

In order to process the 390,000 tonnes of organic material that will be diverted by 2033, new capacity will be needed. Without changes to provincial and/or municipal policy and regulations, direct employment for about 55 facility operators would be created. However, if Ontario were to implement progressive diversion targets with an end goal to divert 100% of its organic waste from disposal, it would create employment for about 680 facility operators. (2cg, 2014)

Environmental Impact of Diverting Organic Material

The biogas industry was created in Ontario in large part because of the range of environmental benefits it provides. As outlined in the Biogas Association's 2013 *Canadian Biogas Study*, the following are environmental benefits of diverting organics to the generation of biogas through AD.

- Recycling of nutrients through re-application of digestate on land;
- Preservation of carbon within the carbon cycle by land applying digestate after digestion;
- Reduced emissions of carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O) thereby reducing GHG emissions and contributions to climate change;
- Reduced odours;
- Pathogen destruction of up to 99% which contributes to cleaner, safer waterways, and
- GHG reductions from biogas projects can help local communities meet sustainability, community energy plan and GHG reduction targets.

In Canada, there is the potential for reduction of 37 megatonnes of eCO_2/year by diverting organics to biogas production. In Ontario alone, almost 15 million megatonnes could be avoided. This is the equivalent of taking 3 million cars off the road.

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C. Ontario Regulations Governing Organic Materials

Photo courtesy of CCI Bioenergy

This section addresses the regulations that govern the anaerobic digestion (AD) sector. An overview of draft Ontario legislation is provided as background understanding to current legislative gaps. Testing and certification requirements are outlined.

The environmental approvals for biogas provided by the Province of Ontario have evolved since the first AD systems were established. Current approvals and compliance requirements governing waste management in Ontario consist of the following regulations and standards:

- Nutrient Management for farm-based AD (O.Reg. 267/03 introduced in 2007)
- Renewable Energy Approval (O.Reg 359/09 introduced in 2009)
- Environmental Compliance Approval (formerly Certificate of Approval for Waste Disposal Sites)

Nutrient Management

The *Nutrient Management Act* (NMA) including the *Nutrient Management Regulation* (O.Reg. 267/03) sets out requirements for design and operations of farm-based AD facilities, also known as regulated mixed anaerobic digestion facilities (RMADF), as well as feedstock ratios and types. Schedules 1, 2 and 3 of O.Reg. 267/03 included in the NMA list specific organic materials allowed and prohibited for processing in a RMADF as well as any treatment requirements. Biogas systems approved under O.Reg. 267/03 can land apply the digestate similar to manure as it is considered an *Agricultural Source Material*. Amendments to O.Reg. 267/03 in 2013 provided more flexibility for farm-based biogas system operators, increasing the allowable proportion of off-farm materials to be digested in AD systems from 25% to 50%.

If AD digestate does not meet the definition of an *Agricultural Source Material*, and is destined for land application, it must meet the *Non-Agricultural Source Material* (NASM) standards. NASM are treated and recycled materials from non-agricultural sources like leaf and yard waste, fruit and vegetable peels, food processing waste, pulp and paper biosolids and sewage biosolids. NASM is classified under one of three categories. Each of the categories can be applied to agricultural land, providing valuable nutrients to soil and crops. The categories determine the requirements for sampling and analysis, and the degree of government oversight. Each of the categories can be applied to agricultural land. The land application standards in the Regulation vary based on the category and quality of NASM being applied.

Renewable Energy Approval

The *Renewable Energy Approval* (REA) sets out requirements for siting, design and operation of renewable electricity sources sold to the grid. A REA separates AD facilities into classes, with varying provincial requirements depending on the facility location (e.g., on a farm), feedstock material (e.g., agricultural wastes), and size (e.g., greater or less than 500 kW). Biogas systems that cannot satisfy the RMADF rules in O.Reg. 267/03 (for instance, being located off farm, mixing >50% off-farm materials, etc.) fall into the category requiring REA approval as set out in the *Technical Guide to Renewable Energy Approvals*.

Environmental Compliance Approval

Environmental Compliance Approvals (ECA) govern a business's emissions, discharges and wastes which are not considered renewable energy developments. Sites wishing to process higher proportions of wastes generated off-site, located off-farm, or wishing to accept materials not included in the RMADF framework (e.g., municipal source separated organics) need to obtain an ECA if they don't produce electricity. For example, any development of *Renewable Natural Gas* (RNG), which is biogas cleaned, refined and injected into the natural gas distribution pipeline or compressed and used as a vehicle fuel, would require an ECA.

Proposed Waste Reduction Act

Ontario currently does not prescribe where organic waste is sent for management, apart from requiring composting of leaf and yard waste generated from municipalities with populations greater than 5,000 (Reg. 101/94).

Bill 91 was the proposed *Waste Reduction Act* and *Waste Reduction Strategy*, which was designed to update waste reduction policies, force waste diversion, and transfer more of the cost of diversion to industry and consumers from government.

Stakeholders have proposed to the government that organic material be included in the proposed *Act*, either in this iteration, or in the future if the current proposed legislation is not passed.

Testing and Certification

The province requires testing of organic material which is diverted to AD according to the particular approval obtained for the AD system (i.e., NMA, REA, ECA). For farm-based AD systems, a sample of off-farm materials must be collected for every 1000 m^3 of materials received. It must be analyzed for metals to ensure threshold levels of metals are not exceeded.

Testing and monitoring requirements for commercial or industrial AD systems approved through REA or ECA have monitoring and testing requirements incorporated into their approval document. These may be adjusted based on site-specific factors.

When digestate is sold as a fertilizer, the Canadian Food Inspection Agency has an N-P-K rating for labeling fertilizer based on the relative content of the chemical elements nitrogen (N), phosphorus (P), and potassium (K) that are commonly used in fertilizers.

D. Organic Material Pathways

This section examines each pathway that organic material can follow, depending on which type of AD system accepts the material.

Overview of Organic Materials Pathways

Food and agricultural materials take(s) different pathways, depending on where it is generated and used. The section below seeks to illustrate the different pathways so that decision makers and those in the organic material processing industries can understand the bigger picture, including regulations that guide different sources, and relative volumes of material available in each stream.

There are four sources of organic material that supply AD systems. These inputs include:

1. agricultural materials including manure, crop residues and purpose grown energy crops;
2. organic material from the commercial, industrial and institutional sectors, including food and beverage processors, restaurants and the grocery sector;
3. municipal organic material from residential green bin programs (residential SSO); and
4. biosolids from municipal wastewater treatment plants.

AD systems process these organic materials as described above and can be designed and integrated with farms, commercial businesses or municipal facilities. Municipalities process human waste in wastewater treatment plants by digesting the material aerobically or anaerobically.

Depending on the type of AD system, the digestate is managed differently. Farm-based AD systems apply the digestate to the land recycling nutrients. In Ontario, Toronto anaerobically digests residential SSO. Material is then composted and sold, or given to residents. Municipal AD systems (i.e., waste water treatment plants) dewater the remaining biosolids and usually land-apply them on farms in Ontario, providing a valuable soil amendment.

The pathways organic materials can take include:

	Organic Material Source	Approval Type	Organic Material Destination
1	**Field and Barn**	Renewable Energy Approval (Class 1)	**Farm AD**
2	**Field, Barn and IC&I SSO**	Nutrient Management (RMADF) or Renewable Energy Approval	**Farm AD**
3	**IC&I SSO**	Renewable Energy Approval or Environmental Compliance Approval	**Commercial AD**
4	**Residential SSO**	Renewable Energy Approval or Environmental Compliance Approval	**Commercial or Municipal AD**
5	**Biosolids**	Renewable Energy Approval or Environmental Compliance Approval	**Municipal and Commercial AD**
6	**Undiverted SSO**	Environmental Compliance Approval	**Landfill**
7	**Field and Barn, SSO**	Environmental Compliance Approval	**Compost**

This ***Primer*** is concerned with the first five pathways. Although anaerobic digestion takes place in landfills, the scope of this ***Primer*** is diversion of organic materials to AD systems; it does not address the opportunities and challenges related to biogas from landfills and compost.

Below, each pathway is described in terms of the regulations that govern it, and where possible, data is provided on organic material volumes that support the pathway.

Pathway One

This pathway relates to organic material that is generated and processed on farms only. The regulation governing farms producing organic materials, such as manure and crop residuals, is the *Renewable Energy Approval* (Class 1).

The potential to generate energy from organic material available from farms is summarized below

	Animal Manure RNG Production Potential (Methane CH_4)	Removable Crop Residues RNG Production Potential (Methane CH_4)	RNG Production Potential (Methane) 100% Utilization	RNG Production Potential (Methane) 50% Utilization	Electricity Production Potential MW
	Mm^3 CH_4/year	Mm^3 CH_4/year	Mm^3 CH_4/year	Mm^3 CH_4/year	
Ontario	382	283	666	333	111.0

These figures are from *The Potential Production of Renewable Natural Gas from Ontario Wastes, Alberta Innovates Technology Futures, May 2011*. See page 29 for a breakdown of crop production and estimates of residues for Ontario. See page 38 for manure volumes and potential methane production.

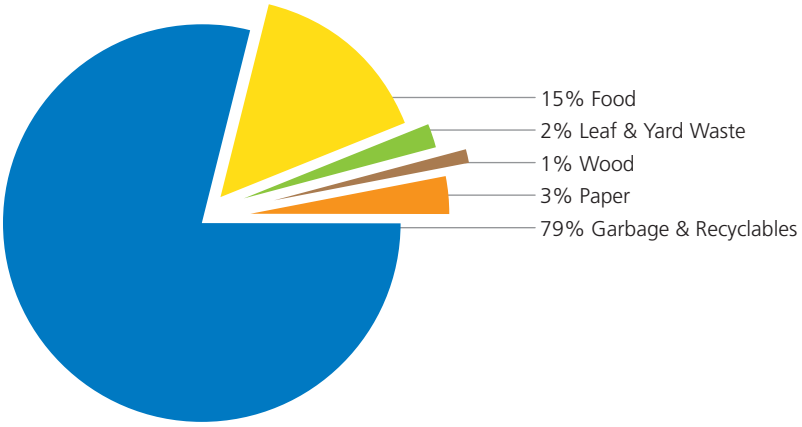
Pathways Two and Three

The second pathway addresses systems that accept IC&I SSO for use at a farm AD. Farms that take off-farm materials to feed their ADs amend their *Nutrient Management* strategy and seek approval as a *Regulated Mixed Anaerobic Digestion Facility* (RMADF) based on the volumes and type of materials they bring to the farm-based AD system. Farms that accept this material may be regulated by O. Reg. 267/03, provided operators comply with the requirements set out for RMADF, including those for acceptable materials listed in Schedules 1 and 2. If it is a material not acceptable under Schedules 1 and 2 or if it is listed in Schedule 3 as a prohibited material, or the facility operation does not comply with regulated design and operational requirements, the developer would need to apply to the MOE for a *Renewable Energy Approval* (REA).

The third pathway addresses systems that accept IC&I SSO for use at a commercial AD. The regulation governing these systems is either an *Environmental Compliance Approval* or *Renewable Energy Approval*.

The chart below shows the estimated relative quantity of organic material in the IC&I waste stream in Ontario, relative to other types of material, and sub-divides the organic material into categories.

ESTIMATED AMOUNT OF ORGANIC MATERIAL IN IC&I WASTE STREAM IN ONTARIO



Source: 2g, 2014

In 2014, 2cg estimated that the amount of IC&I organic material generated ranged between 1.4 and 3.2 million tonnes per year. 2cg noted that developing a comprehensive estimate of IC&I organic material generation and capture was challenging due to a lack of data.

In 2014, 2cg estimated that approximately 200,000 tonnes/year of organic material was diverted to industrial composting or AD and 100,000 tonnes/year to on-farm AD facilities for a capture rate of between 9 and 22% of all estimated IC&I organic material generation.

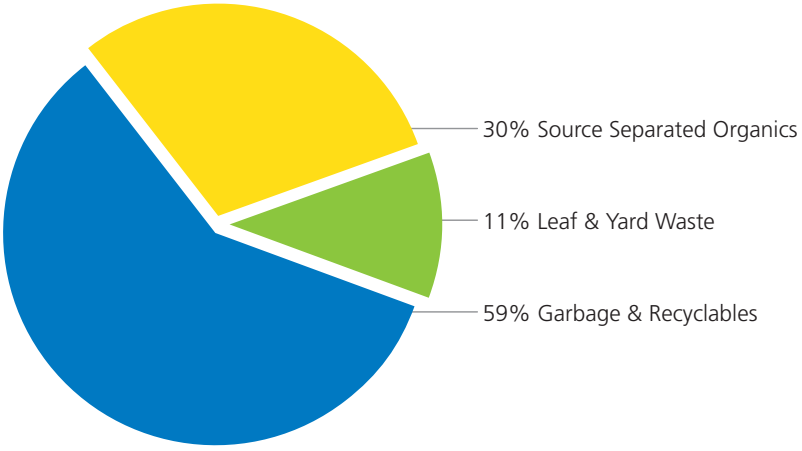
SUMMARY OF IC&I ORGANIC MATERIAL GENERATION AND CAPTURE IN ONTARIO

Organic Material Type	**WDO GAP 2011**	**Statistics Canada 2008**
	tonnes/year	
Captured	200,000	200,000
Captured-On farm AD	100,000	100,000
Total	300,000	300,000
Generated	1,360,000	3,199,000
Capture Rate %	**22**	**9**

Pathway Four

This pathway relates to systems that accept residential SSO, material that has the potential for contamination with plastics and materials with higher pathogen loads than IC&I organic material, and therefore subject to more stringent regulation. At this time, farms are not permitted to take residential SSO organic material unless they obtain a REA. Commercial systems must specify sources when seeking a REA or ECA.

AMOUNT OF ORGANIC WASTE IN ONTARIO RESIDENTIAL WASTE STREAM



Source: 2cg, 2014

In 2014, 2cg estimated the total amount of organic material generated in Ontario in the residential sector at between 2.2 and 2.3 million tonnes/year. An estimate of 250,000 tonnes/year of SSO is generated by multi-residential households (about 25% of Ontario households). It is estimated that fewer than 20% of multi-residential homes receive SSO collection; however, some municipalities are working to increase such collection.

When considering data from both Waste Diversion Ontario and Statistics Canada, the estimates for organic material captured in Ontario ranges from 84-89% for leaf and yard waste and 29-31% for SSO. The following table by 2cg shows the range of total organic material generated based on two sources of data (WDO, 2011, Statistics Canada, 2008) and the calculated capture rate based on the amount of SSO and leaf and yard waste captured in 2011 (WDO, 2012) through curbside programs and backyard composting.

Organic Waste Type	**WDO GAP 2011**	**Statistics Canada 2008**
Leaf and Yard Waste	tonnes/year	
Captured	543,000	543,000
Generated	612,000	643,000
Capture Rate %	**89**	**84**
Source Separated Organics	tonnes/year	
Captured	479,000	479,000
Generated	1,569,000	1,653,000
Capture Rate %	**31**	**29**

Pathway Five

This pathway addresses systems that accept biosolids, including sewage and pulp and paper waste. It is an important source of biogas, and can contain heavy metals, which limits the rate and location at which they can be land-applied. These systems are governed by the *Environmental Compliance Approval* or *Renewable Energy Approval* process with land application of biosolids regulated in the NASM framework of the Nutrient Management Regulation.

CH2M Hill carried out a study of the 50 largest treatment plants in Canada for Environment Canada in 2000. (Burrowes, 2000) Based on a database that Environment Canada developed in 1996, and a survey carried out as part of the study, about 55% of the biosolids produced by the 50 largest plants in Canada are anaerobically digested. There does not appear to be any more recent data available on the topic, which is a considerable data gap. Based on the study results, the following amounts of biosolids are currently digested or available for digestion:

- 55% of 660,000 dry tonnes = 363,000 dry tonnes via AD
- 45%of 660,000 dry tonnes = 297,000 dry tonnes potential AD or other

The digestate from wastewater treatment plant digesters is dewatered to increase its solid content and is generally land applied as a *Class B* material on agricultural land, either as a liquid or a dewatered solid.

Digestate containing biosolids cannot be land applied on food crop acreage. To be applied near growing crops, it would first need aerobic stabilization. If the digestate contains contamination in excess of regulatory requirements, it may be refused for land application.

NASM can be applied to agricultural land which have nutrients and organic matter that benefit crops. Food processors continue to land apply NASM as an inexpensive and easy option. The seasonal nature of their output coincided with farmers' need for fertilizer. Larger food processors with output material year round also did land application. Sampling requirements present a challenge in the short window for seasonal land application.

E. Jurisdictions Outside Ontario

As Ontario continues to consider options for organic material diversion, consideration should be given to what is being done well in other parts of Canada and the world. Some of the more progressive regions include: Nova Scotia, Quebec, British Columbia, several jurisdictions in the United States, and the European Union. A brief summary of relevant policies is provided below.

Nova Scotia

Nova Scotia banned compostable waste from landfill in 1998. It currently has the highest diversion rate in Canada, at 68%, and the lowest per-person waste disposal rate. Most municipalities have curbside organics collection, which is coupled with policies that include mandatory use of clear bags for garbage.

Quebec

Quebec's *Environment Quality Act* spells out the rationale for banning organic material by 2020 as follows:

In 2008, 12% of table scraps and yard waste generated by the municipal sector in Québec was recovered and reclaimed. The remainder was largely landfilled. The same year, 31% of municipal wastewater sludge and 26% of paper mill sludge was landfilled. To ensure that organic materials are managed with greater respect for the environment and in a way that spurs economic activity and helps meet the objectives of the *Climate Change Action Plan* and the *Québec Energy Plan*, the government wants to ban disposal of organic waste.

The government will help fund the necessary infrastructures to foster the recycling of biodegradable organic materials. This financial support will encourage the development of biological treatment technologies that help reduce greenhouse gas emissions. It will take action to ensure that landspreading is permitted when conditions are safe for health and the environment, and it is beneficial agronomically. It will also promote the development of new uses and markets for compost and digester sludge. In addition, the government will ensure that treatment facilities for organic matter are properly managed.

The program, called the *Treatment of Organic Matter by Biomethanisation and Composting* (Phase II), is accepting applications until the end of 2017, and using cost sharing among the federal, provincial and municipal governments, provides $800/tonne to process organic material for AD. Proponents can be municipal or private entities.

British Columbia

While the British Columbia government has not placed restrictions on organic material disposal, some progressive municipalities have moved ahead with policies of their own. For example, Metro Vancouver will have a landfill ban on organics in place by 2015.

United States

City-led initiatives

After a six-month program in which restaurants volunteered to keep commercial food waste out of landfills, New York City is planning to ban food scraps from hotels, hospitals and other

large generators from being landfilled entirely. The city would join Northeastern states Massachusetts, Connecticut and Vermont, as well as West Coast cities Seattle, San Francisco and Portland, all of which have banned landfill disposal of food waste from large commercial food waste generators.

The New York City proposal made by Mayor Michael Bloomberg in November 2013 would affect facilities generating more than one ton of food waste per week. It would require food waste to be collected and sent to a composting facility or to an anaerobic digester for conversion to energy. Bloomberg's office said the bill would affect less than five percent of the city's largest food waste generators. However, it would reportedly cover 30 percent of commercial organic waste, or more than 250,000 tons annually.

State-led initiatives

Connecticut was the first state to ban commercial food waste from landfills. In 2011, it passed a state law requiring generators of two or more tons of food waste per week to recycle the materials rather than sending them to a landfill if located within 20 miles of a suitable recycling facility.

In Vermont, a similar 2012 law also banned food waste from landfills. Like Connecticut, its law limited the ban to large generators located within 20 miles of a recycling facility. The Vermont law, however, gradually expanded coverage in a series of steps. Only commercial generators of two tons of food waste per week or more were required to comply at first. By 2020, however, all food waste will be banned from Vermont landfills.

In June 2013, Connecticut partially adopted Vermont's graduated expansion approach. The state passed a new law that expanded coverage of its landfill food waste ban to facilities generating a ton of food waste per week, starting in 2020.

Massachusetts is the latest state to move to ban commercial food from landfills. In July 2013, the Massachusetts Department of Environmental Protection proposed requiring commercial food waste generators, defined as those producing a ton or more per week, to donate or re-purpose the food instead of sending it to the landfill. Any waste that could not be donated would have to be used for composting, anaerobic digesting or animal feed. That ban takes effect July 1, 2014.

European Union

The European Union's 1999 *Landfill Directive* established a waste hierarchy, which prioritizes waste prevention, followed by re-use, recycling and recovery, and seeks to avoid landfilling wherever feasible.

The rationale was clear: besides concerns about landfill capacity in some countries, policy makers acted to reduce the environmental impact of landfills from methane emissions, to groundwater, surface water and soil pollution. The *Landfill Directive* set targets for progressively reducing the amount of biodegradable municipal waste landfilled in the period up to 2016.

Extensive analysis on the reasons for success behind the directive can be found in *Diverting Waste from Landfill*, by the European Environmental Agency, 2009.

Netherlands, Germany, Switzerland and Austria are leaders in organic waste diversion. One third of the EU's commitment for renewable energy comes from AD.

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