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RENEWABLE NATURAL GAS (RNG) HANDBOOK FOR CANADIAN MUNICIPALITIES

QUEST

CANADIAN GAS ASSOCIATION
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TAF

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About QUEST

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EXECUTIVE SUMMARY

The Renewable Natural Gas (RNG) Handbook was written principally for municipal elected officials and staff who are involved in solid and liquid waste management and working on the environmental file for their municipality. Knowingly or unknowingly, they are currently in a position to assess their options in terms of what to do with the biogas being produced from the natural degradation of organic materials from their existing landfills, waste-water treatment plants (WWTP) and source-separated organics (SSO)-fed anaerobic digesters. Currently, raw biogas may be managed through flaring or consuming in on-site boilers or generators including combined heat and power (CHP). But the question at hand is whether it would be more financially and/or environmentally beneficial to a municipality to upgrade the biogas into biomethane - also known as RNG.

In fact,most municipalities across the country are already in a very strong position to tackle part of their GHG emission challenges by seizing the opportunity provided by the availability of biogas and turning it into useful RNG.

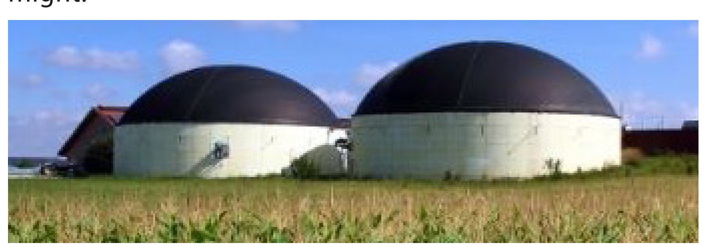
Biogas contains a level of methane (typically 50% - 60%) that can be isolated, or upgraded, from other occurring major constituents such as water and CO_2. The resulting cleaned-up gas, which is often referred to as biomethane or RNG, has a chemical composition that enables it to be suitable for injection into the local gas utility distribution system without any modifications. RNG can be consumed in any existing gas appliance (e.g. furnaces, hot water heaters, boilers, CNG vehicles, etc.). It has value as both a physical commodity (i.e. gas for consumption as in the case of conventional natural gas) and as a conveyor of environmental attributes. As such, the value of RNG is greater than the value of fossil natural gas.

Municipal leaders need to understand if and how it makes sense to invest time and resources into the steps needed to upgrade the biogas that is generated and collected from the various waste streams of their normal operations into more valuable RNG. In other words, would RNG production be more valuable to a municipality than the existing uses of the biogas? It is a significant undertaking that needs champions at both the staff level as well as those sitting on Council who can effectively drive the project. Successfully done, the time period from the concept of upgrading a municipality's biogas production from their existing landfill, WWTP or SSO-fed anaerobic digester (AD) to actual RNG production and injection into the gas utility's distribution system can be as short as three to five years. A municipality would need to make a compelling case to pursue an RNG future over presumably some other excellent initiatives based on a combination of social, environmental and financial reasons.

If the municipality already has an SSO-collection program which feeds an AD-based processing facility, a WWTP with an AD, or a landfill operation which has a gas-collection system, then the municipality is in an ideal position to consider the option to generate RNG. Likewise, if the municipality contracts with outside service providers to manage their waste streams, the opportunity to generate RNG may be a good reason to change courses if it makes sense to do so.

This RNG Handbook summarizes these key questions and issues arising during the early stages of RNG project planning and identifies potential risks and mitigation strategies associated with RNG project implementation.

British Columbia, Quebec and Ontario have existing and emerging provincial RNG policies. It is likely that they will continue to evolve over time as government parties change and the severity of impacts from climate change increases. It is therefore important to keep that in mind when reading these policies described in this document. For municipalities in provinces outside of the three identified, the report also provides a pathway to a business case for RNG projects in their jurisdictions; this is premised on the fortunate fact that connection to a local gas utility's distribution system enables the RNG to be transported and consumed anywhere in North America that is connected to the gas pipe network. This means that RNG produced in jurisdiction-A can be commercially sold to an entity in jurisdiction-B where the former does not have any RNG policy, and the latter might.



This RNG Handbook is an applied resource containing:

- A risk assessment checklist
- Risk mitigation strategies
- A description of RNG costs
- Other practical information that will help municipalities and their partners advance RNG projects

HANDBOOK SCOPE AND AUDIENCE

This Handbook is intended for stakeholders interested in exploring and implementing RNG projects which include municipal staff and elected officials, utilities and RNG technology service providers. It deals specifically with the upgrading of biogas to RNG and not the business case or development of waste collection and processing systems.

APPROACH

The content in this Handbook was informed through desktop research, interviews with subject matter experts and refined through roundtable discussions with representatives from government, utilities, and technology and service providers.

HOW TO USE THIS GUIDE

The implementation of RNG projects is complex and depends on effective collaboration between a wide range of stakeholders. Upgrading raw biogas to RNG and commercializing it requires investment and technical expertise. The process is rarely linear and typically depends on an interrelated set of decisions and partnerships.

This Handbook contains a series of key decisions and issues aimed at guiding municipalities to make the necessary decisions and form the necessary partnerships to implement an RNG project successfully. It is important to note that the key decisions and issues listed in this guide are not listed in any particular order. We advise, however, that all be reviewed in their entirety and addressed as-needed throughout a community's RNG journey.

GLOSSARY OF TERMS

Anaerobic Digester (AD):
A vessel designed for treating organics through the process of anaerobic decomposition (i.e. breaking down organic material in a low-oxygen environment). There are two principle outputs of the process: biogas and digestate. The former, which contains methane and other compounds (e.g. carbon dioxide (CO_2), nitrogen (N_2), hydrogen sulfide (H_2S), water (H_2O), oxygen (O_2)) can be cleaned up or upgraded to remove most of the impurities, resulting in a high concentration of methane that is suitable for injection into gas utilities' distribution networks. The latter, the digestate, can be used as a nutrient source for agricultural applications either directly or subject to further treatment in composting or fertilizer product development.

Biogas:
A combustible gas that is produced by the breakdown of organic matter that takes place in an anaerobic digester (AD) and landfill. The methane content, depending on the feedstock, can range from 50% to 65% with the balance compounds being CO_2, H_2S, N_2, H_2O, O_2, etc.

Clean Fuel Standard (CFS):
A Canadian federal program that is designed to administer the reduction of carbon emissions of liquid fuels. Refiners and distributors over time will be required to reduce the carbon intensity of their fuels. At the time of writing, the program was still being developed.

Compressed Natural Gas (CNG):
Natural gas stored under pressure in robust tanks to power vehicles (cars, trucks, buses) instead of traditional liquid fuels such as gasoline and diesel.

Environmental attribute:
Any emissions and renewable energy credits, energy conservation credits, benefits, offsets and allowances, emissions reduction credits or words of similar import or regulatory effect (including emissions reduction credits or allowances under all applicable emissions trading, compliance or budget programs, or any other federal, provincial or regional emissions, renewable energy or energy conservation trading or budget program) are an environmental attribute. In the context of this report, it is meant to relate to the production of RNG.

Joule (J):
A unit of energy.

Gigajoule (GJ):
A unit of energy equal to 1,000,000,000 Joules.

Injection station:
A small plant that is typically owned and maintained by the local gas utility which is the interface between the biogas upgrading facility and their distribution network. Often located on the same property as the biogas-generating operation, this facility regulates the pressure of the gas (i.e. RNG) being injected into the network, monitors the chemical composition of the RNG to ensure compliance before injection, odourizes the RNG for safety, and meters the volume of RNG for integrity and commercial purposes.

m3:
A unit of volume. A cubic metre used in the report refers to the volume of natural gas or RNG. There is roughly 1 GJ of energy in 26 m3 of RNG.

Megajoule (MJ):
A unit of energy equal to 1,000,000 Joules.

MT CO_2e:
Standing for mega-tonnes of carbon dioxide equivalent, this is a unit of mass of greenhouse gas (GHG) emissions. Carbon dioxide equivalent (CO_2e) is a term used to describe different GHGs in a common unit based on their impact on global warming potential. The main GHGs include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and ozone (O_3).

Renewable Identification Number (RIN):
The credits that the US Environmental Protection Agency (EPA) uses to track and enforce compliance with the renewable fuel mandates set by the Renewable Fuel Standard (RFS) in the US. RINs are essentially records of individual batches of renewable fuel being blended into the US gasoline and diesel pools, namely exclusively the transportation sector. RNG is eligible because vehicles can be fueled by compressed natural gas.

Renewable Natural Gas (RNG):
RNG (ie. biomethane) is upgraded biogas whose energy content is within the range of 36.0 MJ/m3 - 41.3 MJ/m3, and whose other constituents are within the acceptable limits of the natural gas distribution network. Municipalities are encouraged to engage with their local gas utility for the required specifications to inject RNG into their gas network.

Source-separated-organics (SSO):
This is the solid waste that municipalities collect from residences and businesses via green-bin programs. It can also refer generally to any organic-waste stream whose generator separates the organics from the non-organics.

Upgrader:
A facility that is located adjacent to an AD or landfill that either chemically or mechanically upgrades biogas coming from an AD or landfill by removing non-methane compounds such as CO_2, H_2S, N_2, H_2O, O_2, etc. The resulting concentration of methane in the upgraded gas (i.e. RNG) is designed to meet the gas utility's required specifications.

CHAPTER SUMMARY

The following is a summary of the chapters, and Key Decisions/Issues addressed in this guide.

CHAPTER 1: WHAT IS RNG AND ITS BENEFITS

This chapter will describe in greater detail what RNG is and its benefits to a municipality.

Under the premise that municipalities already have an AD and landfills in operation producing biogas, the stage to consider the wider potential societal benefits from RNG is now possible. Since RNG is a product of managing waste, it can indirectly introduce a potential new opportunity for how society can manage its waste. It can also help municipalities contribute toward their "circular economy"[1] objectives and carbon emissions reduction goals by substituting a portion of natural gas with gas derived from local sources of organic waste.

▶ **Decision/Issue #1: Build the case for an RNG project & gain buy-in from municipal staff**

CHAPTER 2: RNG SOURCES & PRODUCTION

This chapter will provide a short review of the processes by which biogas can be generated, focusing on municipal applications including an overview of landfill gas, SSO facilities, and WWTPs.

▶ **Decision/Issue #2: Scoping out the project**
▶ **Decision/Issue #3: Selecting project partners**

CHAPTER 3: PROJECT COSTING

Although there is a price premium for RNG compared to natural gas, the additional costs can often be justified relative to existing applications for the biogas by those wanting to pay more for the environmental attributes that RNG offers.

▶ **Decision/Issue #4: Costing out the project**

CHAPTER 4: GOVERNMENT POLICY & RNG OFF-TAKE AGREEMENTS

Public policies specifically focused on RNG are in place in British Columbia and Quebec, with the federal government rolling out a nation-wide liquids CFS which will incentivize RNG and other low carbon fuel production as part of the allowed CFS 10% cross stream GHG emission reduction compliance pathway for liquids obligated parties (refiners).

▶ **Decision/Issue #5: Assigning value to the RNG**

CHAPTER 5: PROJECT RISKS & MITIGATION STRATEGIES

Municipalities need to understand how to mitigate the risks of pursuing RNG by carefully taking into account a number of key factors, risks and mitigation strategies as they consider proceeding with an RNG project.

▶ **Decision/Issue #6: Getting council approval and public buy-in**
▶ **Decision/Issue #7: Understanding and mitigating risks**

TOOLS & RESOURCES

This section contains a number of resources to help municipalities identify opportunities for RNG production, decide whether an RNG project makes sense, and if needed, better scope out the RNG project.

▶ **Case Studies of RNG production facilities in and around Toronto and across the country**
▶ **A sample project plan which provides municipalities with some milestones and high-level timing on the steps required to complete the upgrading or construction of a biogas upgrading facility**
▶ **Publications and resources for further information on RNG-related issues**

[1] Circular Economy definition: https://files.ontario.ca/finalstrategywastefreeont_eng_aoda1_final-s.pdf

CHAPTER 1: WHAT IS RNG AND ITS BENEFITS

This section first reviews what RNG is and then describes how its production can help meet a wide range of local economic and environmental objectives.

WHAT IS RNG?

RNG is the outcome from cleaning up or upgrading the raw biogas that was generated from the biological breakdown of organic-based waste materials such as AD processing of green-bin waste, WWTPs, and landfills. The upgrading involves various technologies processing the biogas to remove a number of constituents (e.g. CO2, N2, H2S, H20, O2) so that the end result is a gas, now called RNG, that is high in methane. Now chemically similar to natural gas, and when injected and commingled with it, the RNG can be seamlessly consumed in every appliance and process that uses natural gas without any equipment modification or replacement.

DECISION/ISSUE # 1

BUILDING THE CASE FOR AN RNG PROJECT AND GAIN BUY-IN FROM MUNICIPAL STAFF

The decision to upgrade biogas to produce RNG is typically part of a complex overall municipal strategy that involves a number of interdependent disciplines including climate and environmental plans, and waste management. RNG has the potential to reduce GHGs that contribute to climate change, improve local air quality and support the local economy. RNG production is costly, complex and comes with risks, however, most of which can be mitigated by most municipalities who are very familiar with operating AD-based facilities. Those considering advancing an RNG project would be well-advised to develop relationships with other municipalities who have or who are going through a similar process, build out a solid case, and build partnerships among municipal departments that could become allies in moving projects forward. Regardless, municipalities should nonetheless take comfort in knowing that biogas upgrading to pipeline quality RNG is a well-understood practice.

GREENHOUSE GAS REDUCTIONS

RNG projects, which leverage the municipality's existing assets that break down organic waste and capture the biogas, can lead to GHG reductions by displacing all or portions of the use of natural gas in buildings, transportation, industrial processes, power generation (including CHP) and district energy:

- **Capturing methane from organic waste**: Methane is released through the decomposition of organic waste based on various sources (e.g. in landfills or anaerobic digestion of source separated-organics or WWTP).
- **Displacing the use of natural gas and other fuels:** RNG can be blended with fossil natural gas within the gas distribution pipelines. Customers can continue using their existing gas furnaces, boilers, CNG fleets, etc. without having to make any modifications or substitutions, while lowering their GHG emissions. Municipalities are advised to review their municipal climate change plans to help gauge how RNG may rank as an investment in time and resources relative to other initiatives to reduce their carbon emissions.

According to the Canadian Gas Association and the Canadian Biogas Association[2], RNG has the potential to reduce Canada's GHG emissions by 10.5 MTCO2e/yr if 5% of natural gas is replaced by RNG. As an example case, should Toronto and its surrounding municipalities reduce their natural gas demand of approximately 9.7 billion m^3 with the substitution of RNG by approximately 8% , the jurisdiction could reduce their collective CO2e emissions by a significant 13.5 MT over the next 20 years.[3]

Additionally, RNG, when used as a fuel in CNG powered vehicles, is a relatively low carbon transportation fuel, and can reduce GHG emissions by more than 90% compared to diesel powered vehicles.[4]

[2] Source: https://biogasassociation.ca/index.php/news_and_events/update_single/411

[3] An average of 675,000 tonnes of CO2 equivalent per year. This assumes an annual natural gas consumption of 9.7 billion m^3 across the GTHA, source: The Atmospheric Fund (2018). Keeping Track: 2015 Carbon Emissions in the Greater Toronto and Hamilton Area. http://taf.ca/wp-content/uploads/2018/09/TAF_GTHA_Emissions_Inventory_Report_2018-Final.pdf

[4] The switch to compressed natural gas from diesel in and of itself reduces GHGs by 10 – 30 % (weighted average carbon intensity of diesel is just above 90 gCO2e/GJ vs about 65 gCO2e/GJ for natural gas). Switching to RNG from conventional CNG further reduces GHG emissions by approximately 75 % (based on a weighted average carbon intensity of 20 gCO2e/GJ). Source: https://www.cdn.fortisbc.com/libraries/docs/default-source/about-us-documents/regulatory-affairs-documents/gas-utility/200131-fei-response-to-panel-ir1.pdf?sfvrsn=4265e49_4

It should be noted that not all RNG is created equally. RNG produced from different sources are assigned different lifecycle carbon intensity values. [5]

LOCAL AIR QUALITY

RNG, following additional compression to CNG, can be used to fuel medium and heavy-duty transportation fleets as a cleaner alternative to diesel, which would lead to significant improvements to air quality across a municipality.

CNG engines reduce nitrous oxides by up to 90% relative to diesel-fueled engines. When the environmental attributes from RNG are considered, operating vehicles on RNG or a blend of RNG with natural gas provides municipalities a very compelling environmental solution to their transportation emissions challenges.

ECONOMIC BENEFITS

Upgrading biogas to RNG can further a municipality's plan towards achieving a circular economy. RNG contributes to achieving a circular economy by widening the applications and reach of renewable energy. Rather than limiting the use of the biogas to just on-site applications such as boilers or generation, the RNG can be injected into the gas utility's piping system and notionally distributed anywhere for consumption in any gas appliance. Municipalities could, in fact, enhance their circular economy strategies by introducing local targets for the use of RNG in natural gas pipelines, as a source of local electricity, heating, cooking, processing and transportation. In this era of ever-increasing numbers of municipal leaders declaring climate emergencies, upgrading biogas into RNG to be used to displace more natural gas is a very powerful tool.

Locally produced RNG will also help to create and retain jobs locally. This is because money will be retained to produce and consume the RNG locally rather than being spent on gas from outside of the jurisdiction.

In the case where a municipality is flaring the biogas from an AD or landfill, the advantages arising from producing RNG from their biogas and instead putting it to good use (e.g. building heat, transportation) are obvious.

[5] Fuel LCA Model Methodology. Environment and Climate Change Canada. http://publications.gc.ca/collections/collection_2020/eccc/En4-418-2020-eng.pdf

LESSONS LEARNED FOR IMPLEMENTATION

The following key takeaways were shared by municipalities and organizations that have already led the implementation of RNG across Canada:

- Build a consortium of champions across the municipality, in particular within the City or Town Council.
- Identify all municipal departments that may be influenced by an RNG project (e.g. waste management, finance, capital departments, operations, real estate services, CAO, fleet management, etc.). Consider both lower-tier and upper-tier municipalities, if applicable.
- Set up a series of meetings with each department to discuss how an RNG project can contribute towards achieving the city's strategic direction, priorities and targets (e.g. waste diversion targets, carbon emissions reductions, circular economy strategies). Integrate these objectives into the materials that are presented to municipal council.
- It is helpful for municipalities assessing an RNG opportunity to reach out to other jurisdictions that have already completed projects.
- Reach out to the local gas utility early and often in the project. They will be able to assess the capacity and capability to inject RNG into their network. As their staff are working regularly with RNG developers, the gas utility can be an excellent resource for information and advice for municipalities considering an RNG project.

CHAPTER 2: RNG SOURCES AND PRODUCTION

This section provides an overview of RNG. It describes how it is produced, how it can be used (such as injection into the gas grid, fueling transportation fleets and generating electricity), and the role municipalities need to play to enable RNG projects.

DECISION/ISSUE # 2

SCOPING OUT THE PROJECT

Where municipalities have an SSO collection program feeding an AD facility, either owned by the municipality or a merchant operator, a gas-collection system on a landfill, and/or an AD-based WWTP, the biogas is most likely being consumed as-is in the operations' boilers, generators and/or flared. The question becomes whether there is a viable case to be made to invest in upgrading it into RNG, injecting it into the gas distribution system and either self-consuming it on-site or at another location (e.g. municipal offices, community centre), using it as a transportation fuel for municipal fleets (e.g. waste collection trucks, buses), or selling it to a third party altogether.

For a municipality contemplating construction of a new facility that will produce biogas (i.e. from SSO digester, waste-water treatment-plant, landfill), the RNG production and end-use become part of a larger decision-making process that also needs to consider other competing technologies and approaches. This document focuses only on the RNG end-use aspect, however.

In either case, municipalities will need to assemble a strong internal team of individuals who are very familiar with the waste streams of the town's operations as this knowledge will help scope the type and scale of the RNG project. Often a third-party specialist in biogas treatment technologies is engaged to assess the scope of the potential project at hand. One of the critical tasks to complete at the beginning of the project, which should normally be done by a highly qualified engineering firm, is a laboratory sampling of the municipality's biogas. This task should also be done over each of the seasons. This will help to scope one of the complex items of the project, namely the selection of the right upgrading technology.

Important aspects such as existing and projected volumes of biogas, composition of the biogas, availability of on-site space for the upgrading and injection infrastructure, the operation and maintenance of these pieces of equipment, proximity to the gas utility's network and finally, identifying the potential RNG buyers/users, will collectively define the terms of reference for a municipality's RNG project. As always, though, one of the first points of contact for the municipality should be their local gas utility who will complete a capacity assessment of their distribution network to accept the proposed volume of RNG for injection as well as provide a good overview of the major elements of the project.

HOW IS BIOGAS PRODUCED?

The main types of feedstock for generating biogas include the following types of organic waste:

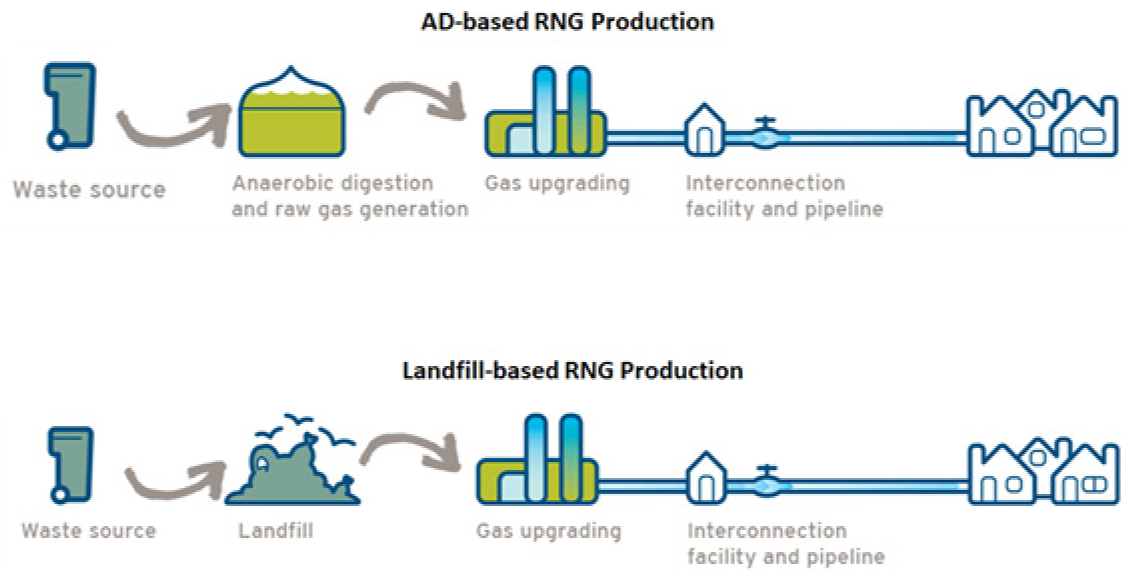
- Organic waste from residential, commercial and institutional uses (e.g. waste from residential and commercial green bin collection, food and beverage manufacturing waste)
- The organic fraction of landfill waste
- Sludge from WWTPs
- Agricultural waste, including livestock manure, bedding and crop residue

The production of RNG consists of two main stages:

- First, organic waste, as per the types of feedstock described above, is fed into a digester tank where naturally occurring bacteria breaks down the organic waste in the absence of oxygen within a narrow temperature band and produces raw biogas as a byproduct.
- Second, the biogas is upgraded by removing the non-methane components such as carbon dioxide, hydrogen sulfide, nitrogen, water and oxygen. The end-product is RNG.

The following two drawings illustrate the major stages that occur between the collection of organic waste to the final use of RNG in our homes and businesses. The first drawing depicts the municipality's SSO and sludge from WWTPs being fed into an AD which generates biogas that is then upgraded to RNG which in turn is injected into the gas utility's distribution network for use by residences and businesses. The second drawing follows mostly the same stages except that the organic waste, which is typically mixed with non-organic waste, is put into a landfill to fulfill the role of an AD.

Image 1 – RNG System Overview[6]



WHAT ROLE DO MUNICIPALITIES HAVE TO PLAY?

With residents and businesses generating steady organic waste streams, municipalities have the opportunity to become both producers and consumers, in some respect taking an active role in creating energy independence and defining the terms of their climate emergency response strategies. They are uniquely positioned to direct an end-point for their organics in a way that makes RNG production the least expensive. As a consumer, blending a small percentage of RNG into their overall demand for energy could make the green gas option more affordable on a per unit basis as compared to other various forms of renewable energy.

DECISION/ISSUE #3

SELECTING PROJECT PARTNERS

RNG projects can be established through a wide range of partnership, ownership and governance structures. Table 1 lists the likely partners that would play a role in the implementation of RNG, and describes their key roles and decision points.[7]

[6] Source: Fortis BC.

[7] Selecting partners to design, permit, finance, build and operate an AD are out of scope for this Handbook.

LESSONS LEARNED FOR IMPLEMENTATION

The following key takeaways were shared by municipalities and organizations that have already led the implementation of RNG across Canada:

- Take stock of existing (ie. already-paid-for), municipal infrastructure, assets and processes that could support an RNG project. Consider existing AD facilities, and whether the municipality has existing SSO and WWTP facilities.
- The infrastructure required to upgrade biogas to RNG includes:
  - A biogas upgrader
  - Piping
  - Utility RNG injection station
- Minimum requirements for their implementation include:
  - Additional space to build on-site infrastructure
  - An RNG injection services agreement between the municipality and the gas utility
  - Council approval and associated budget for a biogas upgrading facility
  - An operating plan for new equipment

Table 1 – RNG Project Roles

Partner	Role(s) & Key Decisions

Natural gas utility	The local gas utility will play a key role in the RNG project. In the cases of BC, Ontario and Quebec, one key aspect is that the RNG injection station is treated as a regulated gas utility asset from a grid safety and integrity perspective and as such, are designed, installed, owned, operated and maintained by the utility on a full-cost-recovery basis.
	
	Side-note:
	FortisBC's Provincial Regulator, the British Columbia Utilities Commission (BCUC), has empowered the utility to also own the biogas upgrader where the supplier is a local government. The total cost of the upgrader ownership and purchase price of the biogas must remain below the Provincial Government's stated regulated maximum price of $30/GJ.
	
	+ They will provide the municipality with detailed requirements for injecting RNG into the natural gas distribution system, such as:
	    + Determining the chemical composition of the biogas (in coordination with an engineering consulting firm, see below)
	    + A network assessment to ensure that the natural gas distribution network has injection capacity for RNG
	    + Interconnection design requirements
	    + Odourization required for gas safety purposes
	    + Technical issues such as space (including appropriate distancing from other sensitive equipment as per codes and standards), proximity to the distribution network and servicing (e.g. electrical power, communications antenna) requirements for the injection station. Injection stations can also have data-collection points that can be used by the municipality as "read-only" signals for their RNG upgrading facility. These signals can assist in operating a more secure and safer plant.
	+ The gas utility can offer advice to the municipality to help them determine how the environmental attributes, volumetric attributes and GHG credit considerations of RNG can be handled.[8]

[8] Shese issues are addressed in Chapter 4 detailing environmental attributes and off-take agreements

Natural gas utility	✚ Depending on the province, the gas utilities will require a municipality that wishes to produce and inject RNG into their network to execute certain contractual agreements. In particular: **In Ontario, Enbridge** requires: ✚ a **backstopping agreement** with the municipality to guarantee their cost recovery; ✚ an **injection services agreement** that covers the injection station and pipe reinforcements for injection, if necessary; ✚ a **distribution service agreement** that will account for the movement of RNG to a destination determined by the municipality; ✚ a **lease agreement** is likely needed to enable the utility's RNG injection-station to be sited on the municipality's property; and ✚ an **easement agreement** to locate the necessary pipe infrastructure to transport the RNG from the injection-station to the distribution network. **In BC, FortisBC** requires the Biogas/Biomethane Purchase Agreement which may include: ✚ Backstopping to guarantee cost recovery for FortisBC assets ✚ Lease/License to enable utility assets to be located on the property including access rights ✚ Biogas/Biomethane quality specifications **In Quebec, Énergir** requires: ✚ a **backstopping agreement** for similar purposes as Enbridge's ✚ an **injection services contract** for similar purposes as Enbridge's; ✚ an **easement agreement** for similar purposes as Enbridge's; and ✚ in the case where the municipality wishes to sell their RNG as a producer to Énergir as a buyer, an **RNG purchase agreement.** ✚ When RNG is injected into the natural gas network, it can be transported to an end-use destination anywhere that is connected to the pipeline system. ✚ It is recommended, however, that municipalities always speak to their gas utility to work out the contractual paths in greater detail.
Engineering consultant, contractor (e.g. EPC - engineering, procurement, construction)	✚ Typically, projects will begin with a study, and then move into a bid process where an engineering consultant will be responsible for overseeing and coordinating the technical components of the project. ✚ They will assess the chemical makeup and volume/flow of the municipality's biogas from their AD, WWTP and landfill facilities and determine the most appropriate biogas upgrading technology for the project. ✚ They will shortlist the most appropriate technology supplier and contractor firm to permit and build the facility. They will prepare the necessary bidding documents to facilitate building the facility. This should be done in coordination with the gas utility to ensure alignment of the volumes, patterns of flow of RNG (hourly, daily, monthly and seasonally) as well as coordinating the real-time monitoring of the gas' composition to ensure it remains within pre-established thresholds. ✚ Depending on their role as set out by the municipality, the engineering consultant may be accountable to ensure that the facility meets all technical requirements and project performance standards. ✚ Operations and maintenance (O&M) agreements need to be thoroughly designed and developed to ensure foreseeable risks associated with the facility's operation, performance and maintenance are properly identified. ✚ Typically, the upgrader technology provider will be contracted by the municipality to operate the facility, at least for a prescribed period of time.

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<td>Investors and finance</td>
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A municipality can finance an RNG project entirely, or it can coordinate to bring debt or equity sources of financing to the project. Grant funding from various levels of government may also be a possibility, provided, for instance, that the GHG reductions can be quantified.
In the case where the RNG-injection station is a regulated asset owned and maintained by the gas utility, the capital requirement is typically recovered through the customer’s distribution rates.

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<td>Approvals branch - Ministry of Environment</td>
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The following should not be considered comprehensive lists. Project managers are advised to consult third party specialists.
In Ontario:

an Environmental Compliance Approval must be obtained from the Ministry of the Environment, Conservation and Parks for RNG production facilities. In some cases, a building permit may also be required.
Summary list of permits and approvals at a minimum:

Building permit
Easement
Site approval plans
Sewer discharge agreement
Technical Standards and Safety Authority (TSSA)
Electrical Safety Authority (ESA)
Environmental Compliance Approval (ECA)
Potential supporting evidence may include geo-technical and environmental studies, and environmental site-assessment

In BC:

BC Oil & Gas Commission
Technical Safety BC
BC Building Code
Ministry of Environment & Climate Change Strategy
Environment and Climate Change Canada
Metro Vancouver Air and Liquids Discharge Permits
BC Agricultural Land Commission approval for non-agricultural activities within the BC Agricultural Land Reserve

In Quebec:

Building permits - specifics are dependent on the zoning and location of the project)
Permitting from the Commission de Protection du Territoire Agricole (for projects that are farm-based)
Certificat d’autorisation from the Ministere de l’environnement et de la lutte les contre les changements climatiques including details on the following files:

Water usage
Soil and land use
Air and noise emissions
Dangerous and non dangerous waste and storage
Further information: http://www.environnement.gouv.qc.ca/Industriel/demande/guide.pdf

Approval from the Regie de l’Energie
All necessary permits and certifications for pipeline interconnection

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Gas trader/broker	If the municipality sells the RNG to a third party, it may be necessary to engage an energy trader/broker to facilitate the purchase and sale of the RNG.
RNG buyer/Off-taker	If the municipality is considering selling their RNG, the offtake transaction should contemplate: ✚ Price for RNG and the environmental attributes which may be based on a dollar per GJ or a commodity reference ✚ Term ✚ Volume parameters (min/max amount) ✚ Flexibility in volume ✚ Credit worthiness of counterparty ✚ As this is a well-known process, there are template agreements available to assist See Decision/Issue #5 for more details on this topic.

LESSONS LEARNED FOR IMPLEMENTATION

The following key takeaways were shared by municipalities and organizations that have already led the implementation of RNG across Canada:

- Projects can be fully owned by the municipality, or can be jointly or wholly owned by a third party. To determine the partnership structure for the project, the municipality should first determine how much ownership/control the municipality wishes to have over the RNG project.
- The municipality may wish to consider a combination of self-consuming their RNG and selling a portion of their production to a third party under contract.

CHAPTER 3: BASIC PROJECT COSTING

This section is intended to give the reader a sense of the costs involved to install a biogas upgrader as well as what is involved with the gas utility to install their equipment, namely an RNG injection station, and as needed, pipe reinforcement.

DECISION/ISSUE # 4

PROJECT COSTING

Estimating project costs is a major step towards assessing the viability of an RNG project. This chapter provides a basic breakdown of the project costs. Actual costs of producing RNG will vary considerably from project to project, based on a number of criteria. Municipalities and other project proponents are encouraged to seek expert technical and financial advice from consultants, utilities and other project partners to help them understand these costs in greater detail.

RNG project costs are broken down into categories, namely:

- ✚ Cost of Biogas (A)
- ✚ Biogas Conditioning/Cleaning Costs (B)
- ✚ Connection/Line Costs (C)
- ✚ Contingency/Additional Costs (D)
- ✚ Supportive Funding/Offsetting (E)

These costs cover both capital and operational expenses. Therefore, one has to make sure that a consistent denominator e.g. $/GJ) is used to add all of these cost categories such that the **Total Cost of RNG = A + B + C + D - E.**

COST OF BIOGAS (A)

Cost of raw biogas from source, e.g. WWTP, landfill, SSO operation **x** $'s per m^3 or GJ produced / day, month or year

E.g.: $8/G

+

BIOGAS UPGRADER CLEANING COSTS (B)

Cost of conditioning / cleaning raw biogas to become RNG (Biomethane) **x** $'s per m^3 or GJ produced / day, month or year

E.g.: $7.5/GJ

+

CONNECTION/LINE COSTS (C)

Cost of connecting upgraded biogas source to NG trans. or dist. system including tie-in, metering & regulation, quality, compression, power, communications, water and discharge water costs **x** $'s per m^3 or GJ

E.g.: $5/GJ

+

CONTINGENCY/ADDITIONAL COSTS (D)

Additional costs not accounted for elsewhere ÷ volume from Source **x** $'s per m^3 or GJ delivered / day, month or year

E.g.: $4/GJ

-

SUPPORTIVE FUNDING/OFF-SETTING (E)

From Utility, Government or Other **x** $'s per m^3 or GJ delivered / day, month or year

E.g.: $2.5/GJ

=

TOTAL COST OF RNG/BIO- METHANE

Cost of RNG delivered in $'s per m^3 or GJ

E.g.: $22/GJ

Notes for estimating project costs

- A consistent common denominator, either metres cubed (m^3), a volumetric measure, or gigajoules (GJ), a measure of energy, is used to engineer the design of the system.
- Capital Expenditures (CapEx): hard and soft costs of building and commissioning the facility, including all equipment, permitting, engineering design, legal, etc. Identify asset class type, expected depreciation term and useful life, as well as capital cost allowance treatment for green energy assets.
- Operating Expenditures, or costs (OpEx): includes the ongoing fixed and variable costs to operate and maintain a facility on an ongoing basis, dollars per day, month or year per energy-unit of RNG produced.

COST OF BIOGAS (A)

(In the context of the handbook, this number is somewhat irrelevant, since the premise for the reader assumes that the municipality already has in place an existing WWTP, SSO-fed AD and/or landfill. The costs associated with their build and operation are therefore sunk. However, to provide the reader some scope as to what the costs could be relative to a biogas upgrader and the final selling price of RNG, a representative sample figure is provided.)

This category encompasses the upfront and ongoing costs of building and operating the municipality's SSO facility, landfill and AD-based WWTP, all of which yield raw biogas.

Detailed costs to include:

- Associated land costs specific to the production of biogas
- CapEx: all upfront costs to build and commission a facility to produce biogas
- OpEx: ongoing cost to operate and maintain a facility that produces biogas
- Biogas-source-material gathering system in the case of landfill's pipeline gathering system

Obtaining cost breakdown:

Entity producing the biogas for commercial purposes speak to specific facility managers (municipal landfill, WWTP, SSO) about costs to capture biogas which today may be being flared, or combusted in on-site boilers for hot water or steam, or a generator to make electricity and possibly heat from the generator as well.

BIOGAS UPGRADING COSTS (B)

This category includes the costs to condition and clean the raw biogas and upgrade it into RNG suitable for utility/transmission pipeline specifications.

Detailed costs to include:

- Full cost of apparatus/system and its operation including energy costs required to condition raw biogas to pipeline specification RNG, real-time chemical composition-monitoring, and more often than not, compression of the conditioned gas.
- The technology and hence cost of the facility, will depend on a variety of details of the project, not the least of which includes the expected chemical makeup, volume (hourly, daily, weekly, monthly, annual) and flow patterns (possible hourly, daily and seasonal variations) of the biogas.
- Waste-water (WW) from the upgrader:
  In many instances, the WW will require pretreatment prior to being sent to the municipal sewer. The pretreated WW will nonetheless require a sewer discharge permit. In some circumstances, a municipality's WWTP may be able to take the upgrader's WW, however; this would need to be verified.
- Rejected biogas/RNG:
  During the period of off-spec RNG (i.e. RNG whose chemical composition falls outside of the permitted specifications of the gas utility for injection into the network) or a maintenance-run, the biogas/RNG will likely be rejected and not be allowed to be injected into the gas utility's distribution network. Instead, the off-spec gas will need to be sent to an on-site flare. During the design of the upgrading facility, the quantity and quality of the rejected biogas/RNG should be considered and whether the existing flare is capable of handling it, or whether a new or additional flare will be required. This, of course, will have an impact on both the CapEx and OpEx of the project.
- It is prudent to maintain a healthy contingency in the project plan's financials to account for any potential unforeseen circumstances.

Obtaining cost breakdown:

Consult the technology provider of the biogas upgrader to lay out the cost components of the facility including up front CapEx and ongoing OpEx.

CONNECTION/LINE COSTS (C)

This category, which is the sole responsibility of the gas utility, includes two main components:

- **The injection station** is the device that regulates the pressure of the RNG into the network, odourizes the gas with mercaptan, meters the flow and lastly, monitors the gas' chemical composition in real-time for injection into the piping network.
- **Pipe reinforcements** are those installations and upgrades to the piping network systems the gas utility deems necessary to safely and reliably accommodate the expected volume of RNG from the generator's facilities being injected. Not all projects will require this step, however. Therefore, the gas utility will determine this on a case-by-case basis.

In both of these facilities, the scale of the project will be key to helping to drive down unit costs ($/GJ). In particular, the length of pipe-runs will be one of the major cost-drivers. [11]

Detailed costs to include:

The CapEx (all soft and hard costs) and OpEx of both the injection station and pipe reinforcement, if required, will be rolled up into a combined all-inclusive monthly service fee with the municipality, depending on the term of the service agreement (e.g. 10 years, 15 years, etc.).

Obtaining cost breakdown:

- Speak to the gas utility. They are typically quite open to a breakdown of the main components of the injection station and any necessary pipe reinforcements, both up-front and on-going.
- Since gas utilities are regulated entities, municipalities also have their provincial energy regulator as a resource to call upon should municipalities experience any issues out of the ordinary.

CONTINGENCY AND ADDITIONAL COSTS (D)

- Examples of additional costs include costs associated with securing a gas marketer to broker the sale of the RNG, transmission and distribution services, transaction services, as well as administrative, legal, and insurance costs.
- Option to put the contingency in a separate line/tab or include a broken-out contingency in each of the individual line items.

SUPPORTIVE FUNDING/OFFSETS (E)

- Examples where government and organization funding may be available, e.g. Federation of Canadian Municipalities (FCM), The Atmospheric Fund (TAF).
- CFS inclusion of RNG as a credit generation pathway to meet up to 10% of liquids obligation (See Chapter 4: Government Policy and RNG Off-take Agreements) below for further details).
- The proposed federal $1.5 billion Low Carbon and Zero Emission Fuel Fund that would support biofuels, RNG and hydrogen.
- GHG credits/offsets.

[11] https://www.mjbradley.com/sites/default/files/RNGEconomics07152019.pdf

CHAPTER 4: GOVERNMENT POLICY AND RNG OFF-TAKE AGREEMENTS

This section will detail policies and programs that are relevant to municipalities, including Ontario, British Columbia, Quebec, and federally in Canada and in American states such as California. These policies and programs are key to project development, because interest in RNG supply is continental and organizations in other jurisdictions are ready to pay a premium for RNG supply. Nonetheless, it is a prudent practice for municipalities to keep abreast of the various governmental programs that become available from time to time which can help to improve the viability of RNG projects.

LOCAL MUNICIPAL POLICY: SELF-USE

Many municipalities should also consider using or purchasing the RNG themselves to offset conventional natural gas purchases. This approach might be pursued as part of a municipal target to reduce the carbon intensity of their operations, or as part of a municipal community energy initiative. During the due diligence process, a cost and benefit analysis of self-consumption versus a sale to a third party for the RNG would have to be completed.

RNG POLICY IN ONTARIO

Since the repeal of the *Green Energy and Green Economy Act, 2009*, there has not been a clear legislative mandate nor any financial incentives in support of RNG projects. However, under the *Food and Organic Waste Framework*, the Ontario government intends to develop and implement a regulation to ban the disposal of food and organic waste under the *Environmental Protection Act, 1990*. This regulation will prohibit disposal of organic waste streams into landfills and incineration facilities. This ban will create new opportunities for resource recovery approaches and drive investments.[12] This Framework explicitly supports RNG markets as a pathway to reducing greenhouse gas emissions.

In Ontario, an Environmental Compliance Approval from the Ministry of the Environment, Conservation and Parks is required for RNG production facilities. However, if the biogas is used to generate electricity that is not fed into the electricity grid, then a renewable energy approval is required for the generation of electricity from the biogas.

Enbridge Gas Inc.'s Voluntary RNG Program submission to the provincial regulator was approved by the Ontario Energy Board in October 2020. The basis of the program would be a modest surcharge on the monthly gas bill of willing customers in return for the gas utility acting as an intermediary to source RNG from project developers and distribute it to those customers.[13] This is a positive step that provides a mechanism to encourage local solutions to curb carbon emissions.

In the fall of 2020, the Ontario Government sought public input on proposed amendments to the Food and Organics Waste Policy Statement to expand the breadth of materials collected within the green bin program. With the ultimate objective to reduce waste and GHG emissions, the theme of the proposed changes included expansion of the types of materials collected along with greater rigor around the design and types of compostable packaging. The public input period for the Environmental Registry closed in mid-November 2020.

The near-term opening of The Niagara Falls Renewable Natural Gas plant was announced in October 2020 by the Ontario Government. The facility will upgrade enough biogas from landfill waste to be processed into RNG to heat the equivalent of some 8,700 homes and thereby reduce GHG emissions by 48,000 tonnes each year.

RNG POLICY IN BRITISH COLUMBIA

Changes to the *Greenhouse Gas Reduction Regulation* have empowered the BC Utility Commission (BCUC) to set out a voluntary program in which gas utilities may choose to include renewable energy in their portfolio with a cap of five per cent RNG out of the total natural gas system.[14] The provincial government's CleanBC Plan also sets out a 15% renewables target by 2030.[15] This is

12 https://files.ontario.ca/food_and_organic_waste_framework.pdf

13 Enbridge's "Renewable Natural Gas Program" submission (EB-2020-0066) can be found at http://www.rds.oeb.ca/HPECMWebDrawer/Record?q=CaseNumber%3DEB-2020-0066&sortBy=recRegisteredOn-&pageSize=400

14 https://www.fortisbc.com/services/sustainable-energy-options/renewable-natural-gas/become-a-renewable-natural-gas-supplier

15 https://cleanbc.gov.bc.ca

anticipated to expand the five per cent portfolio cap in the future. FortisBC has further developed its own target of reducing natural gas customer emissions by 30% by 2030, where renewable gases will play an integral role in achieving this.[16]

Under the voluntary Renewable Gas Program, FortisBC customers can choose to allocate 5, 10, 25, 50 or 100% of their natural gas use as RNG.[17] FortisBC is also permitted to source RNG supply from outside of BC. The utility has been approved by its provincial regulator to procure RNG supplies up to $30/GJ. In 2020, FortisBC secured BCUC-approval for at least three Ontario-based RNG projects, meaning that out-of-province projects can be successful in this marketplace. They had also made it clear that they would vary the price paid for the RNG depending on a variety of factors including the generation-source of the gas and carbon intensity. For instance, the utility may pay a greater premium for farm-based RNG with a lower carbon intensity compared to municipal SSO-derived gas.

Pacific Northern Gas (PNG) issued an expression of interest for RNG or hydrogen supply with a close-date at the end of November 2020. PNG's primary interest in the RNG or hydrogen is to secure the environmental attributes.

RNG POLICY IN QUEBEC

In the 2030 Energy Policy and subsequent 2030 Energy Policy Action Plan, the Quebec Government has set targets to increase renewable energy production by 25%, notably through an increase of bioenergy production by 50%, including RNG, by 2030.[18] *Bill 106, An Act to Implement the 2030 Energy Policy* and amending various legislative provisions, allows the province to implement their Energy Transition Master Plan. The bill amends the Act of the Régie de l'énergie to provide new measures regarding the distribution of RNG through a distribution system. In March 2019, a regulation came into effect, establishing the minimum quantity of RNG that must be delivered by the province's gas utilities. The minimum quantity has been set at five per cent of the total of natural gas distributed within their network by 2025.[19]

Complementary to this, the Ministry of Energy and Natural Resources announced that $18 million would be allocated for bioenergy demonstration projects. In its 2020 Budget, the Quebec Government also announced $70 million in investments in RNG production projects for the next two years.[20]

The province also offers subsidies (up to 66% of the capital costs) for municipal RNG projects through the "Processing Organic Matter Using Biomethanization and Composting (PTMOBC)"[21] in place since 2012, aiming to reduce the landfilling of organic materials and reduce their related GHG emissions.

GOVERNMENT OF CANADA

The Government of Canada has outlined a new 2030 GHG emission reduction plan to exceed 2030 GHG targets set in 2015 in Paris. The new plan includes a decision to remove the gaseous and solid fuels from the regulation and focus exclusively on liquids CFS.[22] As a result, the CFS will now account for 23 MT of GHG emissions compared to the original 30 MT.

RNG is still considered a compliance pathway for liquids. This means a refiner can buy RNG credits from the market to a maximum of 10% of their compliance. The total non-liquids cross stream trading allowance is set at 2.3 MT (10% of 23 MT), creating a significant opportunity for RNG.

Utilities can also generate credits from any of their blended RNG used for heating. It does not have to be used as R-CNG or R-LNG. Any project, regardless of when it commenced, can start earning early action credits as of fall 2021 (when Gazette II is published).

RNG that is blended for heat can earn credits, relative to the lifecycle carbon intensity for natural gas. RNG used as a transportation fuel can earn credits relative to the lifecycle carbon intensity for diesel fuel. To earn credits, parties opting in (ie. utilities, RNG aggregators) will have to undertake significant reporting to Environment and Climate Change Canada, including registration, verification, credit generation reports, credit generation audits, etc.

16 https://www.fortisbc.com/about-us/sustainability

17 https://www.fortisbc.com/services/sustainable-energy-options/renewable-natural-gas

18 https://transitionenergetique.gouv.qc.ca/en/energy-transition-master-plan/roadmaps/details/les-bioenergies

19 https://mern.gouv.qc.ca/quebec-encadre-quantite-gaz-naturel-2019-03-26

20 Government of Quebec. 2020 Budget: http://www.budget.finances.gouv.qc.ca/budget/2020-2021/fr/documents/Budget2021_EconomieVerte.pdf

21 http://www.environnement.gouv.qc.ca/programmes/biomethanisation

22 https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html

The carbon intensity of RNG will be published later in 2021 in a new national LCA tool. However, interim LCA data is available now for RNG and they are considered default values. Any project that can demonstrate they outperform the default CI can apply for a new project-specific CI. ECCC officials will review the new project-specific CI and require 24 months of operating data to do so. The project will be assigned an interim CI based on three months of operating data and that interim CI will be confirmed at the end of 24 months.

The Government has designed the CFS' performance-based framework to incent innovation and adoption of clean technologies in the oil and gas sector, and the development and use of low-carbon fuels throughout the economy. This is how RNG can play a significant role in the program.[23]

Under the federal CFS, a credit price market will incent clean fuels, like RNG, into the market. Obligated parties in the liquids stream can meet up to 10% of their compliance from gaseous credits. The economic contribution of a CFS to the RNG producer/market is expected to be significant. For example, systems similar to the CFS are in place for transportation liquids markets in jurisdictions across North America, including British Columbia and California. In those two markets, credit prices for compliance reached $200-300/tonne in 2018.[24] [25] Should the federal CFS see credit prices of $300/tonne, this would translate into an economic incentive of up to >$15/GJ for RNG depending on the credit price and the carbon intensity of the RNG relative to the lifecycle carbon intensity of natural gas. Therefore, the CFS is a potentially powerful economic tool for the long-term RNG market offering cash flow opportunities for producers. The federal CFS for gaseous fuels is expected to be brought into force in 2023.

FEDERAL US RENEWABLE IDENTIFICATION NUMBER (RIN) MARKET

In the United States, the Environmental Protection Agency (EPA) created the Federal Renewable Fuel Standard (RFS) which amended the Clean Air Act. This standard requires a certain volume of renewable fuel to replace traditional fossil fuels in the transportation sector, and among the accepted renewable fuels is CNG from municipal WWTP digesters. Parties obligated to comply with this program, such as refiners and importers of gasoline, blend renewable fuels into conventional fossil-based transportation fuels, and use RINs as proof. [26]

RINs are generated when a producer makes a gallon of renewable fuel.[27] RINs can also be traded similarly to a cap and trade system, and unused credits can be carried over to the next compliance year. The RINs that have been generated by RNG and used in transportation can be sold to fuel suppliers and refiners to meet their annual obligations, or what is referred to as Renewable Volume Obligations (RVO).

CALIFORNIA'S LOW CARBON FUEL STANDARD (LCFS)

A LCFS is another potential way for a municipality to monetize their RNG.[28] Here's a description of the measure to reduce carbon emissions from the Californian State Government's website:[29] "The LCFS is designed to encourage the use of cleaner low-carbon transportation fuels in California, encourage the production of those fuels, and therefore, reduce GHG emissions and decrease petroleum dependence in the transportation sector. The LCFS standards are expressed in terms of the "carbon intensity" of gasoline and diesel fuel and their respective substitutes. The program is based on the principle that each fuel has "life-cycle" greenhouse gas emissions that include CO2, CH4, N2O, and other GHG contributors. This life-cycle assessment examines the GHG emissions associated with the production, transportation, and use of a given fuel. The life-cycle assessment includes direct emissions associated with producing, transporting, and using the fuels, as well as significant indirect effects on GHG emissions, such as changes in land use for some biofuels. The carbon intensity scores assessed for each fuel are compared to a declining carbon intensity (CI) benchmark for each year. Low carbon fuels below the benchmark generate credits, while fuels above the CI benchmark generate deficits. Credits and deficits are denominated in metric tonnes of GHG emissions.

[23] Government of Canada. Clean Fuel Standard. https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard.html

[24] Government of British Columbia. Low Carbon Fuels Credit Markets. https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels/credits-market

[25] California Air Resources Board. Monthly LCFS Credit Trading. https://ww3.arb.ca.gov/fuels/lcfs/credit/lrtmonthlycreditreports.htm

[26] The formal definition of a RIN is the amount of energy contained in 1 gallon of ethanol (77,000 BTU or 0.077 MMBTU) as sourced in: https://www.biocycle.net/2017/11/13/101-for-rins

[27] https://www.epa.gov/renewable-fuel-standard-program/overview-renewable-fuel-standard

[28] Recent trading prices of a California Low Carbon Fuel Standard (LCFS) credit can be found at: https://www.mjbradley.com/sites/default/files/RNGEconomics07152019.pdf

[29] California Air Resources Board. Low Carbon Fuel Standard. https://ww2.arb.ca.gov/our-work/programs/low-carbon-fuel-standard/about

Providers of transportation fuels must demonstrate that the mix of fuels they supply for use in California meets the LCFS carbon intensity standards, or benchmarks, for each annual compliance period."

In addition to the LCFS, The California Air Resources Board (CARB) approved a Short-Lived Climate Pollutants (SLCP) strategy to reduce GHG emissions across California from compounds such as black carbon (soot), methane (CH4), and fluorinated gases (e.g. hydrofluorocarbons or HFCs). These pollutants have proven to be very impactful on our climate despite the fact that their life-spans are shorter than that of CO2. The SLCPs are estimated to contribute approximately 40% to climate change.[30]

BASIC GHG ACCOUNTING

Estimating the GHG impact of an RNG project is a challenging task, involving many assumptions that largely depend on how the waste material was initially transformed into biogas. Similar to the cost estimates section, this handbook provides an overview of GHG accounting for RNG projects, and how to calculate avoided emissions. Resources are provided for those wishing to delve deeper into life-cycle GHG project accounting.

RNG contributes to GHG reductions through the displacement of all or portions of the use of conventional natural gas as a fuel.

The first part of this calculation depends on the type of facility and source of organic material used to generate the methane. The methodologies and assumptions used to estimate GHG impacts will differ when assessing a landfill gas project, wastewater treatment, SSO facilities, or food and agricultural processing. The detailed estimates will also differ between the specific types and composition of food and agricultural waste streams. The GHG reductions associated with the capture and upgrading of organic waste require an understanding of what the alternatives are in a status quo, or baseline situation. For example, would the landfill already be large enough that it would have to flare any captured landfill gas? Would a farm considering building an anaerobic digester otherwise apply manure to the land as fertilizer, resulting in methane emissions to the atmosphere? Municipalities that already have an existing waste management facility that captures biogas should be able to provide an estimate of an estimate of GHG impacts.

A technical consultant should be engaged to do a detailed, expert analysis to estimate biogas production and GHG reductions. For a "ballpark" estimate, Biogas World has made available an online calculator that allows a user to enter multiple feedstocks (e.g. vegetable waste) as well as the type of operation (e.g. municipal, whether the digester is wet or dry).[31]

The second part of this equation depends on what fuel the RNG is displacing at the end user. For example, if the RNG is compressed as CNG and used to fuel garbage trucks, then it would be displacing the diesel that these trucks would otherwise have used. This would have a bigger impact in terms of GHG reductions than if the RNG was instead displacing conventional natural gas in home heating, simply because diesel has a higher GHG intensity than natural gas.

Canada's Greenhouse Gas Quantification Requirements[32] contain equations governing the use of various fuels under different scenarios, including lookup tables of emission factors that allow for estimates of the impact of substituting RNG for fuels in various applications.

Taking a full life-cycle perspective of the GHG impacts requires more sophisticated modeling.

Environment and Climate Change Canada is currently developing a new Fuel Life-cycle Assessment Modelling Tool to set baseline lifecycle carbon-intensity values for refined petroleum produced fuels used in Canada, and to quantify the life-cycle carbon intensity of low-carbon-intensity fuels used in Canada.[33]

Another Canada-based tool that can accurately calculate the GHG emissions of a project's full life-cycle impact is GHGenius. It has been developed over the last 17 years by (S&T) Squared Consultants Inc. for the federal Department of Natural Resources and other government and industrial clients. GHGenius is capable of estimating life-cycle emissions of primary greenhouse gases and pollutants from combustion. AD and landfill biogas

[30] https://ww3.arb.ca.gov/cc/shortlived/shortlived.htm

[31] Biogas World. Biogas Calculator: https://www.biogasworld.com/biogas-calculations

[32] Environment and Climate Change Canada. Canada's Greenhouse Gas Quantification Requirements, 2019: http://publications.gc.ca/collections/collection_2020/eccc/En81-28-2019-eng.pdf

[33] Environment and Climate Change Canada. https://www.canada.ca/en/environment-climate-change/services/managing-pollution/energy-production/fuel-regulations/clean-fuel-standard/regulatory-approach.html#toc9

sources have been added to the model so that municipalities can use it to determine the environmental impact. The source (type) of organic waste and its location are two key factors that determine the GHG emissions impact of an RNG project. For more information on GHGenius, visit the Canadian Biogas Association's primer on life-cycle assessment models for measuring GHG emissions.[34]

California's Air Resources Board has developed different fuel pathways as part of its lifecycle assessment that uses the GREET Model.[35]

DECISION/ISSUE # 5

WHAT TO DO WITH THE PRODUCED RNG?

For a municipality assessing the investment (financial, social, political, environmental) of an RNG project, there are many tradeoffs that need to be taken into account. The major ones include the following:

- Making RNG to sell to a third party:
  - Level of complexity to execute a buy-sell agreement with a third party - how many internal resources will be required and does the internal skill-set exist?
  - The length of term of an agreement (e.g. short (<5yrs) vs long term (20yrs)) - typically, the longer the better, but it may come at the expense of a low price for a municipality's RNG.
  - Based on the premium price that RNG commands over conventional natural gas, the municipality will need to assess whether it would be more advantageous to sell the RNG to a third party or consume it internally.
  - Strength/calibre/reputation of the buyer - it seems clear that risk-averse municipal governments will want to make sure that the counterparties they deal with are solid and stable.
  - Social and political optics that ask certain soft questions such as "Is it acceptable for a municipality to sell their RNG to a third party outside of jurisdiction?" vs. "Should the municipality's main driver instead be to secure the highest financial return for their RNG?"
  - Municipalities should note, however, that should they choose to sell their RNG to a third party, they may wish to engage a broker/marketer or register with their provincial energy regulator to obtain a license to market gas in the province.[36]
- Making RNG for self-consumption:
  - How does the self-consumption of RNG align with the municipality's plans, be them environmental, social and/or financial?
  - Will there be any investment tradeoffs to pursuing RNG? Would other initiatives become displaced in favour of RNG?

The purpose of Table 2 (see the next page) is to enable a municipal staff member to easily understand the available options of RNG delivery and the key parameters, e.g. duration of contract, flexibility, price, and risk.

[34] Canadian Biogas Association. Primer on Life Cycle Assessment Models. https://biogasassociation.ca/images/uploads/documents/2017/rng/CBA_RNG_Workshop_GHGenius.pdf
[35] California Air Resources Board LCFS Life Cycle Analysis: https://ww2.arb.ca.gov/resources/documents/lcfs-life-cycle-analysis-models-and-documentation
[36] Ontario Energy Board. Gas Marketer License Requirements. https://www.oeb.ca/industry/licensed-companies-and-licensing-information/apply-licence/gas-marketer-licence

Table 2 – RNG Off-take Agreement Options

Municipality's self-consumption of environmental attributes Applicable across the country	Pros: ✚ Maximum flexibility to determine what facility to direct the consumption of the renewable fuel to (e.g. municipality's offices, operations maintenance, etc.). Consult with the gas utility to help facilitate this. ✚ Simpler to administer since brokers/traders will not be involved, there will not be complex legal agreements between seller and purchaser parties. There will be no long-transportation tariffs needed if the RNG is self-consumed within the same jurisdiction of the gas utility, etc. ✚ Could be a holding-pattern strategy until a more lucrative third-party comes along. Cons: ✚ The full value of the RNG will likely not be monetized (e.g. third parties in other jurisdictions (e.g. California) will often be prepared to pay more than what the municipality would otherwise pay to self-consume the RNG).
FortisBC British Columbia, Canada	This will be a long-term contract, with a high price up to $30 per GJ. (Municipalities selling their RNG to FortisBC should note, however, that they won't be able to realize the full potential up to $30/GJ, since marketing fees and similar tariffs will need to be deducted from the final selling price. FortisBC also needs to ensure it is getting a fair price for their rate-payers.) Pros: ✚ FortisBC, a Canadian-based organization, is procuring supplies of RNG from within and outside of BC. They are currently testing markets outside of Canada. This regulated entity is a solid counterparty to base financing for an RNG project in Ontario, for instance. ✚ They will also contract with a municipal RNG producer for a longer term (e.g. 20yrs), allowing municipalities to mitigate risks. ✚ The gas utility is authorized by the BC Utilities Commission to pay a fair price for the RNG. Cons: ✚ A municipality contracting with FortisBC will need to work with a broker/trader to make the transportation arrangements for the fuel to notionally be delivered from regions outside of British Columbia. Transportation and exchange costs will be incurred by the seller (i.e. municipality) (e.g. >$3/GJ). FortisBC has designated Huntingdon as its trading hub in BC. ✚ There is risk in the project from having a policy change in British Columbia as it relates to purchasing RNG from out of province (e.g. British Columbia ratepayers are carrying the cost premium for the Ontario-made RNG being consumed in their province).
Énergir Quebec, Canada	Pros: ✚ Énergir is currently buying RNG from sources inside and outside of Quebec. This regulated entity is a solid counterparty to base financing of an RNG project from another jurisdiction. ✚ They will also contract with a municipal RNG producer for a longer term (e.g. 20 years), allowing municipalities to mitigate risks. Cons: ✚ A municipality contracting with Énergir will need to work with a broker/trader to make the transportation arrangements for the fuel to notionally be delivered from outside of Quebec. Énergir has designated Dawn as its main delivery-point for its gas. This adds extra costs to the project (e.g. >$3/GJ). ✚ There is risk in the project from having Quebec policy changes as it relates to purchasing RNG from out of province (e.g. Quebec ratepayers are carrying the cost premium for the Ontario-made RNG being consumed in their province).

BC Low Carbon Fuel Standard (LCFS) British Columbia, Canada	British Columbia's low carbon fuel standard (BC-LCFS), was introduced to reduce the carbon intensity (CI) of fuels used in the province. ✚ The BC-LCFS sets CI targets that decline each year. ✚ Fuel suppliers generate credits for supplying fuels with a CI below the targets and receive debits for supplying fuels with a CI above the targets. ✚ The debits and credits are proportional to the emissions a fuel generates over its full life cycle. ✚ Credits can be traded between fuel suppliers or banked for future use. ✚ At the end of each compliance period, suppliers must have a balance of zero or more credits to avoid non-compliance penalties. The credit market creates a financial incentive to reward low-carbon fuels in proportion to the amount of real, measurable emissions reductions they yield when substituted for conventional fuels. This generates revenue for low carbon transportation fuel suppliers and supports investment in clean fuels and vehicles.[37]
Federal Clean Fuel Standard (CFS) early action credits Applicable across the country	✚ Liquids stream obligated parties can meet up to 10% of their compliance via gaseous credits including by purchasing RNG from producers, including municipalities. ✚ Participating directly in the CFS market will carry significant reporting obligations with high administrative burdens.
Hybrid Applicable across the country	Opportunity to follow a combined strategy of self-consumption of a portion of the municipality's RNG production and the sale of the remaining amount to a third party. The objectives here are twofold: ✚ Take advantage of the expected higher returns from a riskier agreement (e.g. RIN) for a shorter period of time that might be enough to cover the bulk of the investments made in the project. ✚ Diversify risk across long and short, and safe and riskier buying groups for the municipality's RNG.

LESSONS LEARNED FOR IMPLEMENTATION

The following key takeaways were shared by municipalities and organizations that have already led the implementation of RNG across Canada:

- Since gas molecules are indistinguishable, interchangeable and co-mingled in the pipeline system, purchasers of conventional or renewable natural gas generally do not physically consume the same gas molecules that they purchase. In other words, municipalities can sell their RNG to entities outside of their jurisdiction by injecting the gas into the gas distribution network. Once in the pipes, it can notionally be delivered to any location in North America.
- In the case of a municipality selling their RNG to a third party, arrangements can be and are often made to separate the environmental attributes from the commodity. In fact, a portion of the environmental attributes can still remain with the municipality during a buy-sell transaction.

[37] https://www2.gov.bc.ca/gov/content/industry/electricity-alternative-energy/transportation-energies/renewable-low-carbon-fuels

CHAPTER 5: PROJECT RISKS AND MITIGATION STRATEGIES

As with most complex projects, municipalities will need to engage with their counterparts in other jurisdictions who've already commissioned RNG projects to better understand the risks and strategies to overcome them. In this section, a table has been prepared to run the reader through the most common risks and strategies to mitigate them.

DECISION/ISSUE # 6

GETTING COUNCIL APPROVAL & PUBLIC BUY-IN

LESSONS LEARNED FOR IMPLEMENTATION

The following key takeaways were shared by municipalities and organizations that have already led the implementation of RNG across Canada:

- It is essential for the municipality to identify a political champion that can act as an ambassador for the RNG project as well as senior staff members.
- A communication strategy should be developed for both council and public engagement.
- Consider how the project can be incorporated into the council's objectives such as addressing climate emergency announcements.
- Consider what materials have been prepared for council (e.g. information package, business case). Are the recommendations simple, clear and well-supported?
- What public engagement activities have been planned (e.g. open house, public survey)?
- Engage with the gas utility early and often in the process to stay updated with their assessment of the capacity of the gas piping distribution network to accommodate the injection of the RNG. As well, the utility generally has a great deal of experience with RNG projects in general based on their engagements with numerous project developers which can be very helpful to municipalities.
- Has a go/no-go moment been identified?

DECISION/ISSUE #7

ARE RISKS UNDERSTOOD AND ADEQUATELY MITIGATED

A number of risks can arise throughout the implementation of an RNG project, including:

- Market risks
- Regulatory risks
- Technology risks
- Permitting and associated timelines
- Financing risks
- Planning & management risks
- Site selection risk
- Utility cost risks (e.g. increasing cost of electricity to operate the upgrader)
- Political risks - with each successive government comes a revisiting of all projects in development
- Operational risk
- Public perception risk
- Other risks (e.g. competing for limited funds against against other projects to combat climate change)

Table 3 describes these risks in more detail, the period in which they are most likely to arise, and approaches for mitigating risks.

Table 3 – Risks and Mitigation Strategies Summary Table

Risks	Time of Risk	Risk Mitigation Strategies
1. MARKET RISKS		
Community stakeholder and public perception risk	Pre-Development	Engage the community early in the process. Highlight the benefits of RNG, namely that it represents a useful fuel that is generated from the green bin program that a great deal of society has become accustomed to. Involve the engineering consultants, the technology providers and operators in the community engagements to share their expertise. This adds credibility to the discussions and helps those unfamiliar with the whole concept of making RNG become more comfortable.
Market price differential with natural gas	Pre-Development	✚ Secure long-term gas purchase agreement with utilities or gas marketer. ✚ Tax credit for RNG ratepayers and project developers. ✚ Consider approaching domestic institutional gas users (e.g. universities, government, hospitals) who have corporate social responsibility (CSR) targets and who may be interested in purchasing RNG. ✚ To manage the price premium of RNG over conventional natural gas, a blending strategy may be more viable (e.g. 5% to 25% blend rate with natural gas). As conventional gas prices increase (e.g. due to carbon pricing), the blend ratio can be increased. ✚ Develop other in-house uses for the RNG product such as a fuel for fleets, electricity generation, etc. ✚ Consider co-digestion of SSO within existing municipally-owned WWTP's. With some process modifications and adjustments to the material-handling system, it may be possible for a municipality to leverage their existing assets in their water treatment operations to handle SSO. This would save time, money and space and would likely be more palatable with the public who are often skeptical of new infrastructure builds within their community. There may be increases in the financials from co-digestion that could help to justify the expenditures in RNG. ✚ Although outside of the scope of this document, it is worth noting that the business case of the investment in an RNG project could be improved if in fact it was part of the investment needed to be made into an AD project as well, for instance. Some of the common costs (e.g. engineering, commissioning, permitting, etc.) could be shared.
Lack of consumer knowledge of RNG	Pre-Development	✚ Ongoing public education campaign and part of official sustainability policies. ✚ Direct customers to the gas utilities' websites on RNG. For an example, see Enbridge's site.[38] ✚ Approach the Canadian Biogas Association (CBA) and the Canadian Gas Association (CGA) for helpful general counsel. ✚ Showcase diverse projects. ✚ Developers should get familiar with high-profile projects (e.g. City of Toronto's Dufferin Organics Processing Facility), download online material, request some process and communications support from these leading developers, etc. ✚ As in the case of managing the public's concerns, the municipality is advised to fully seek counsel from the portfolio of RNG stakeholders, namely consultants, and the technology providers and operators.

[38] https://www.enbridgegas.com/Natural-Gas-and-the-Environment/Enbridge-A-Green-Future/Renewable-Natural-Gas

Reaching economies of scale	Design and Operations	✚ Create regional hubs for RNG production, rather than municipalities and developers building small plants. This concept is also referred to as "clustering" and/or forming co-ops. ✚ Collaborate with neighbouring municipalities. ✚ Location of the hubs should consider the proximity to major gas lines in the distribution network to reduce the cost of pipe installation. ✚ Co-digest with waste-water sludges. ✚ Co-locate with a municipal landfill and use one upgrading facility to process the biogas. ✚ Co-locate with solid-waste transfer stations.
Potentially high costs to connect and inject RNG into distribution network	Pre-Development	✚ Engage with the gas utilities early and often about the project. ✚ Locate a project as close to a known major pipe in the network as possible. Areas of the network that maintain high hourly volumes of gas flow throughout the whole year (relative to the volume of hourly RNG injection) stand the best chances to keep potential additional piping costs down for the project. ✚ Ask the gas utility if they have different payment options.
No third-party buyer for RNG	Pre-Development	✚ Be prepared to consume the RNG directly. ✚ Work with a gas marketer to find another end-user for the RNG.
Potential shortfall in the generation supply of RNG at certain times of the year to meet contractual commitments	Pre-Development	✚ Work with gas marketer to mitigate times of supply shortfalls. ✚ There may be times in the year when the RNG volume being injected into the gas distribution system is greater than the system can manage; this situation is most likely to occur during the times of low gas consumption (i.e. warmer months). The advice to the municipality planning for these times is to work closely with the gas utility to determine the best course of action and what could be the expected frequency of these situations.
2. POLICY RISKS		
Absence of mandate and incentives	Pre-Development	✚ Consult regional and provincial governments to give municipalities a clear mandate via legislation or policy for waste diversion and utilization. ✚ Leverage the sustainable energy planning initiatives that most municipalities now do; RNG for government building heating, for instance, would be aligned with these plans, as would applying RNG to their medium and heavy-duty city-owned transportation fleets (e.g. buses).
Absence of utility regulator policy on renewable portfolio allowance and cost sharing	Pre-Development	✚ Engage provincial ministries and their regulators to offer suggestions for certain minimum blends of RNG within the natural gas system (e.g. >5%). ✚ Work with gas utilities to encourage a voluntary RNG program. As a municipality, help to build awareness and excitement in such a program to help drive maximum participation. ✚ Write letters of support or requests to the local gas utility for an RNG program that includes locally-produced RNG.
3. TECHNOLOGY RISKS		
Poor uptime in the production of RNG	Design and Operations	✚ Establish a repair and maintenance schedule and contract(s). ✚ Develop in-house expertise to maintain and break-fix the system. ✚ Procure technology that doesn't contain "black boxes" or proprietary secrets. ✚ Seek uptime guarantees from established providers who will be available in the long term. ✚ The municipality should seek counsel from their technology provider and operator who have had a great deal of experience on this issue on other projects.

Product quality - pipeline grade	Design and Operations	✚ Adopt industry-wide quality standards. ✚ For the potential time-periods when RNG composition does not meet the specifications that the gas utility requires, consider designing in alternative strategies (e.g. on-site electricity generation, dual-fired on-site boilers). ✚ Engage the engineering consultant to prepare contingency plans in the plant's designs and operations to overcome this scenario.
4. FINANCING RISKS		
Limited financing, competition for limited public investment	Pre-Development	✚ Advocate for project demonstration grants and low-rate financing options that are long term. ✚ Seek and secure Grade-A long-term off-take agreements for RNG. ✚ The gas utility may be able to offer regulated and unregulated (affiliate) finance options with flexible contract terms. ✚ Advocate the GHG benefits on top of the economics and link them to the strategic initiatives. ✚ Engage a reputable gas marketer to put together a solid sell-buy strategy for the municipality's RNG.
Competing opportunities for investment funding within the municipality	Pre-Development	✚ Support for renewable gas tax incentives (e.g. exemption from excise or fuel tax in transportation). ✚ Accelerated capital cost allowance for renewable equipment.
5. PLANNING AND MANAGEMENT RISKS		
Lack of in-house technical expertise in municipalities to help guide the RNG development process	Development and Planning	✚ Ongoing engagement with RNG community; education and training. ✚ Maintain service contracts with technology providers and utilities that can operationalize knowledge sharing. ✚ Consider contracting with a reputable engineering firm with expertise in this area to implement an EPC (Engineering, Procurement, and Construction) approach. ✚ Communicate with similar-sized municipalities on challenges they faced. ✚ Leverage the expertise of the engineering consultant and technology provider and operator.
Lack of community support; preference for the status quo	Development and Planning	✚ Develop a strong value proposition before any project proposals; highlight existing RNG operations and demonstration projects. ✚ Education: any RNG proposal is a long-term strategy towards greater energy independence and a carbon neutral economy. ✚ Cite benefits including reduced smell at the landfill and a longer asset life for the landfill. ✚ Educate residents and schools that disposing of organics into green bins minimizes waste to landfills, and fuels the production of fertilizer (i.e. disgestate) and RNG. In effect, this is the story behind closing the loop behind a circular economy. ✚ Support data collection, transparency. ✚ Offer to set up and run a community panel made up of people from the community and the municipality project-team that will meet regularly to discuss the ongoing operations, and raise any issues that may arise, including odour, increased truck traffic, or noise.

6. OTHER RISKS		
Pipeline connection	Development and Planning	✚ Engage with your gas utility early on in the process to have them complete a connection assessment. ✚ Clear gas quality and metering standards, and protocols for sharing data between utilities and producers. ✚ Evaluate factors determining the scale of the project, pipeline extension requirements and costs. ✚ Consult CGA guidelines or other standards.

TOOLS AND RESOURCES

APPENDIX A: RNG CASE STUDIES FROM ACROSS CANADA

Across Canada, there are several operating and planned RNG facilities. The following section provides a list of these facilities and summarizes lessons learned.

City of Hamilton, Ontario

Woodward Avenue Wastewater Treatment Plant
Year implemented: 2011
Project type: Wastewater Treatment Plant
Partners: City of Hamilton, Enbridge/Union Gas, Hamilton Renewable Power Inc. (HRPI - a wholly owned company of the City of Hamilton)
Ownership/governance: Biogas Unit: Fully owned by the City of Hamilton; Combined-heat-and-power (CHP) unit: owned and managed through Hamilton Renewable Power Inc. (HRPI - a wholly owned company of the City of Hamilton also has additional 3.2MW of renewable power generation located at the Glanbrook landfill site).

Since 2006, the Woodward Avenue Wastewater Treatment Plant has used anaerobic digesters to generate biogas for use in a 1.6 MW CHP unit. In 2011, the city invested in a biogas purification unit to capture and upgrade additional biogas into renewable natural gas (RNG). The facility can produce over 200GJ of RNG per day. This RNG is injected into the local gas distribution system operated by Enbridge through a transfer station.

Links:
https://www.uniongas.com/business/communication-centre/success-stories/hamilton-partnership
https://biogasassociation.ca/index.php/featured_member/member/the_city_of_hamilton

Region of Peel

Year adopted by Council: 2017
Project type: Source Separated Organics Facility
Partners: Peel Region, Enbridge Gas Inc.
Ownership/governance: Full ownership by Region of Peel

A primary drivers for RNG in the Region of Peel were that the project supported waste diversion, and the City's Roadmap to a Circular Economy in the Region of Peel. The municipality therefore was able to gain approval through the region's long-term waste management strategy.

The operating cost of the AD facility is expressed as the net impact to the Region's operating budget for waste management and so the cost is net of current organics processing costs, avoided disposal, etc. In calculating the operating cost of the AD facility, the Region valued the RNG as strictly a commodity fuel similar to conventional gas. Thus, the project team considered their RNG would hold no additional value beyond its commodity value to displace fossil natural gas.

Links:
The Rationale for an Anaerobic Digestion Facility, Report to Council, July 3, 2014: http://laszloenergy.com/ns/wp-content/uploads/2020/03/Peel2014CouncilMeeting.pdf
Strategic Terms for the Anaerobic Digestion Facility Project, November 30, 2017 (see item 4.4): http://www.peelregion.ca/council/agendas/2017/2017-11-30-wmsac-agenda.pdf

City of Stratford, Ontario

Stratford Water Pollution Control Plant: Renewable Natural Gas (RNG) Facility

Year: 2020 (proposed)
Project type: Wastewater and organic waste
Partners: Ontario Clean Water Agency, the City of Stratford and General Electric (GE) Water and Power, FortisBC, Suez Group
Ownership/governance: Municipal Services Corporation, with the City of Stratford and the Ontario Clean Water Agency (OCWA) as the partners.

In January 2020, The City of Stratford Council approved a motion to upgrade the City's existing water pollution control plant to produce RNG. The proposal includes the upgrading of the wastewater treatment plant to a facility that can co-process wastewater as well as organic waste. 20,900 tonnes of organic waste will be diverted from landfills to the facility to produce RNG. The facility will produce 2 million m^3 of RNG that will be sold and utilized in the natural gas pipeline network. The facility is expected to reduce GHG emissions by 49,000 tonnes of CO2 annually.

This project is unique due to the partnership formed between the City of Stratford, Ontario Clean Water Agency (OCWA) and Suez. Each of the partners is invested in the project to make it feasible, along with third-party investors. The project will cost $22.7 million. The City of Stratford received a grant from the Province of Ontario for a total of $5M, the City of Stratford would initially fund $1.5 million, and the Ontario Clean Water Agency would fund $1.5 million. Longer-term financing of $15 million will be required by the City of Stratford.

Links:
https://www.stratford.ca/en/inside-city-hall/renewable-natural-gas.aspx
http://www.ocwa.com/sites/default/files/ocwa_2018-20_business_plan_public_version_-_english.pdf

St. Hyacinthe, QC[39]

The City of St. Hyacinthe, Quebec upgraded their wastewater treatment plant from only processing sludge to processing multiple waste streams. The facility began operation in 2017 and is processing 150,000 tonnes of organic waste annually to produce 13 million m^3 of RNG. The RNG produced is sold to Énergir and will be injected into the local pipeline network. Upgrading the facility cost $50 million that was funded by the Federation of Canadian Municipalities' Green Municipal Fund, the provincial government of Quebec and the City of St. Hyacinthe.

City of Surrey, BC

In 2012, the City of Surrey, British Columbia built an organic biofuel processing facility that processes organic waste into RNG. The RNG produced will be used to fuel the waste-collection fleet of the city, and the remainder is injected into FortisBC's natural gas pipeline network. This facility has the capacity to process more than 115,000 tonnes of organic waste to produce 120,000 GJ per year. The cost of the facility is estimated to be $68 million and was developed through a public-private partnership. Since B.C. has a carbon tax, this project is eligible to receive carbon credits from the Climate Action Rebate Incentive Program as it is committed to be carbon neutral.

- See: Details of the Tendering Process: Corporate Report to Council - December 11, 2014: https://www.surrey.ca/bylawsandcouncillibrary/CR_2014-R206.pdf
- Background report and procurement process for the City of Surrey Biofuel Processing Facility Project, City of Surrey, Corporate Report R206, December 15, 2014: This corporate report to Council contains a summary report on the work that was undertaken to develop the successful P3 funding proposal for the City of Surrey Biofuel Processing Facility Project. This includes a list of proponents, their roles and responsibilities, project management budget, costs and schedule. https://www.surrey.ca/bylawsandcouncillibrary/CR_2014-R206.pdf

[39] Canadian Biogas Association. RNG Workshop Case Studies https://biogasassociation.ca/images/uploads/documents/2017/rng/CBA_RNG_Workshop_Case_Studies.pdf

Terrebonne, QC[40]

In 2013, Progressive Water Solutions invested to convert the biogas produced from the Lachenaie landfill, which holds one-third of the waste from greater Montreal, QC to RNG. The facility will process 10,000 ft^3 per minute to produce RNG to fuel 28,000 homes. The investment of $45 million was made solely by Progressive Water Solutions. This facility is expected to reduce GHG emissions by 1.2 million tonnes of CO2 over the period of 10 years.

City of Toronto, Ontario

Dufferin Organics Processing Facility ("Biogas Utilization Project")
Year implemented: 2019
Project type: Source separated organics
Partners: City of Toronto, Enbridge Gas Inc.
Constructor: NPL/W.S. Nicholls Construction Inc.
Ownership/governance: Initially owned by Enbridge Gas Inc. with a sliding-scale of ownership over the term of the contract.

In 2019, the City of Toronto implemented the Dufferin Organics Processing Facility. Working with Enbridge, the City will convert approximately 6 million m^3 of raw biogas produced by the Dufferin Organics Processing Facility into approximately 3.3 million m^3 of RNG beginning in 2021. The project is expected to displace 9,356 tonnes of carbon annually, totaling 140,340 tonnes over the project's lifetime.

Enbridge was responsible for the design, construction and commissioning of an upgrader and an injection station. The RNG will be injected into the natural gas grid, allowing the city to use RNG to fuel its waste collection trucks (enough to fuel 132 garbage trucks).

The total project cost was $16 million. Annual cash flows are expected to be $0.52 million in 2021 and $0.421 million in each year from 2022 to 2033.

In building the case for RNG and strengthening Council and public buy-in, the City of Toronto used a triple bottom-line approach focused on the business case of using CNG vehicles, GHG reduction potential and environmental impacts like truck engine noise, emissions and particulates from diesel.

Links:
Lease Agreement with Enbridge Gas Distribution: http://app.toronto.ca/tmmis/viewAgendaItemHistory.do?item=2018.EX35.24
Project financing and other background files: https://www.toronto.ca/legdocs/mmis/2018/ex/bgrd/backgroundfile-116686.pdf

Disco Road Organics Processing Facility
Year implemented: 2021
Project type: Source separated organics
Partners: City of Toronto, Enbridge Gas Inc. Services Inc.,
Ownership/governance: Initially owned by Enbridge Gas Inc. with a sliding-scale of ownership over the term of the contract.

Disco Road Organics Processing Facility, has a capacity to process about 75,000 tonnes/year of residential SSO and produce 4.6 million cubic meters of RNG annually.

Links:
https://swana.org/Portals/0/awards/2016/winners/CityofToronto_CompostingSystem.pdf

Other Toronto-based projects include: Green Lane Landfill (active) and Keele Valley Landfill (closed) where RNG is being explored as an opportunity to utilize landfill gas.

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[10] Canadian Biogas Association. RNG Workshop Case Studies https://biogasassociation.ca/images/uploads/documents/2017/rng/CBA_RNG_Workshop_Case_Studies.pdf

APPENDIX B: PROJECT PLAN TEMPLATE

	Internal Resources	Partners & Vendors	RNG Product	Business Case	Buy-in	Approvals							
Site selection -it will involve proximity to feedstock and practicality to deliver digestate from facility -speaking with gas utility about RNG injection into the network (i.e. preliminary network assessment) -community acceptance -permits!!!!!!!! what activity is the area zoned for?													
Buy-in						Community Outreach							
Feedstock (potential) investigative meetings; execute MOU's													
Preliminary egangement with gas utility regarding injection capacity; depending on response, this could result in a finding a different site													
Select/hire a designer/engineering firm to create designs of the system and lay out what permit process are required. They should also be able to help quantify and qualify the facility's expected RNG yield													
Investigate permitting requirements; execute a project plan													
Preliminary investigation of equipment and technologies that will be based on site and type & volume of feedstock. I think I would try to get budgetary pricing for major components													
Investigate potential RNG buyers													
Hire a gas marketer/transportor to lay out the contractual and operational details on moving RNG from Point-A to point-B													
Business Case prepared													
Investigate potential financiers, investors													
RFP for Vendors													
Finalizing vendors & signing contracts													
Revised project cost													
Revised business case													
Constructing or Upgrading the facility													
Delivery of materials													
Production of RNG													
Selling of RNG													
Phase of Project	Concept								Installation			O&M	

APPENDIX C: RESOURCES

This section includes an annotated bibliography of publications, projects and other resources.

Closing the Loop Primer, Canadian Biogas Association, June 2015

https://biogasassociation.ca/images/uploads/documents//2015/close_the_loop/RNG_Close_the_Loop_Primer_Web.pdf

A report that introduced compressed natural gas (CNG) and RNG, and outlined how blended RNG can "close the loop" from turning waste into renewable fuel that can power municipal waste management operations. It includes case studies and best practices from Canada and the U.S.

Municipal Guide to Biogas, Canadian Biogas Association, March 2015

https://biogasassociation.ca/resources/municipal_guide_to_biogas

A report that introduced three sources of biogas: source separated organics, wastewater treatment plants, and landfills and presented a technology overview and business case for each source. Several existing biogas facilities are summarized as snapshots. The guide also explained tasks associated with grid connection, as well as approvals, safety and regulations.

RNG Technology Roadmap (2014), CanmetENERGY for Canadian Gas Association, 2014

https://biogasassociation.ca/images/uploads/documents/2017/rng/The_Renewable_Natural_Gas_Technology_Roadmap.pdf

A report that outlined Canada's vision of a fully developed RNG marketplace by 2020. It illustrated the RNG carbon offset potential, explained some of the challenges in the marketplace, and presented a set of recommendations to realize the RNG vision.

RNG for Municipalities, Canadian Biogas Association, 2017

https://biogasassociation.ca/resources/rng_outreach_and_market_development

A series of online resources (checklists, tools, case studies, technology and industry overview) prepared by the Canadian Biogas Association in 2017 identified major issues that municipalities should address in planning for anaerobic digesters and biogas upgrading facilities.

Renewable Natural Gas: The RNG Opportunity for Natural Gas Utilities, M.J. Bradley & Associates, 2017

https://www.mjbradley.com/sites/default/files/MJB%26A_RNG_Final.pdf

This report illustrated the GHG impact of replacing traditional natural gas fueled buses with RNG and other low-carbon fuels.

Technical Guide Note 38, Scottish Environmental Protection Agency, 2015

https://www.sepa.org.uk/media/154194/ppc_technical_guidance_note_38_anaerobic_digestion.pdf

This report offers a technical description of the process in an AD facility, as well as other technical specifications that should be taken into consideration when operating this facility.

Greenhouse Gas emissions Estimations Methodologies for Biogenic Emissions from Selected Source Categories, United States Environmental Protection Agency, 2010

https://www3.epa.gov/ttnchie1/efpac/ghg/GHG_Biogenic_Report_draft_Dec1410.pdf

This report offers a technical calculation to quantify the GHG emissions from landfills with and without a gas collection system. It also offers a technical calculation for GHG emissions from wastewater treatment plants.

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