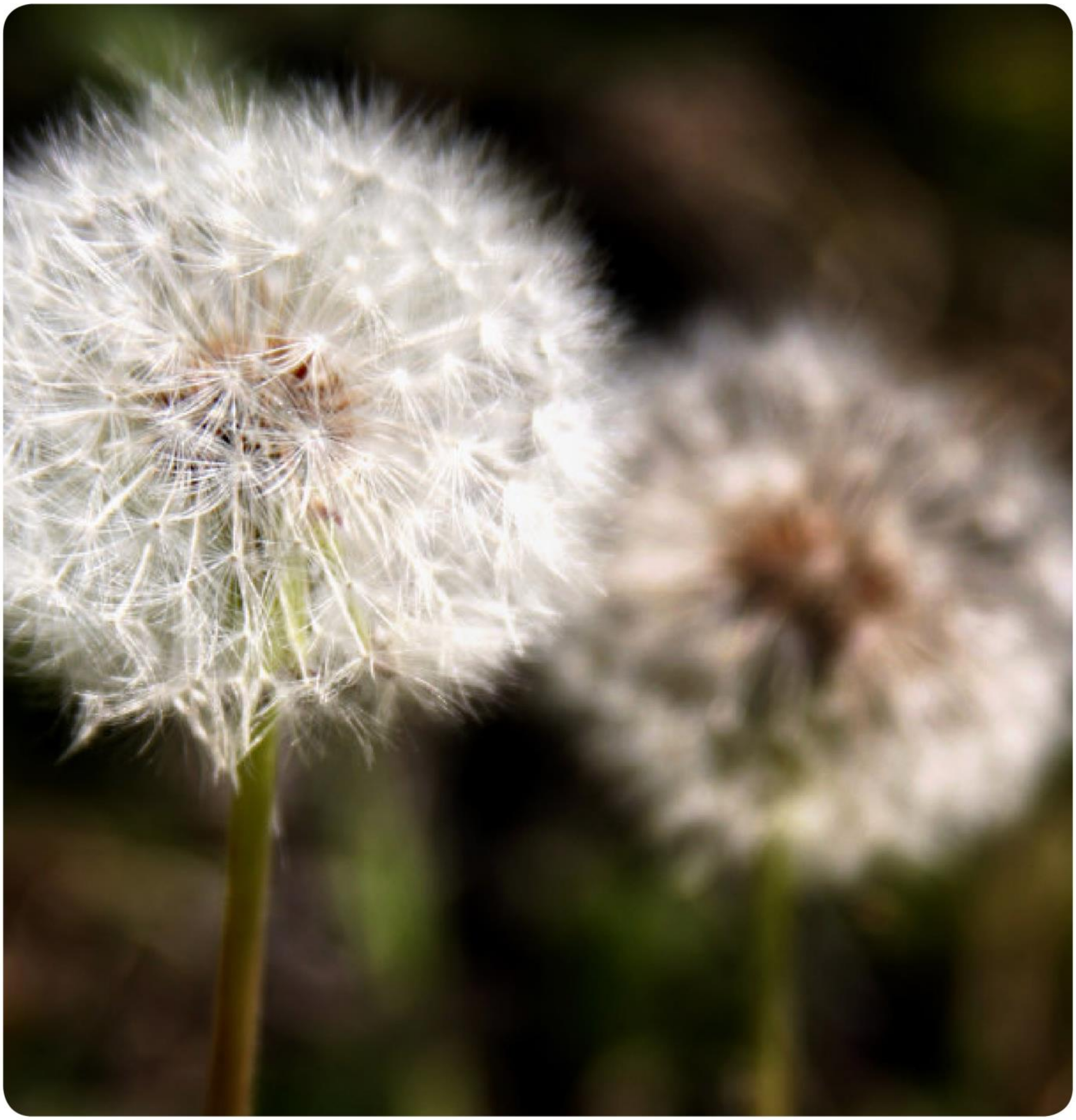

Report Update: Biomethane Greenhouse Gas Emissions Review

FortisBC

March 31st, 2017

OFFSETTERS

Executive Summary

Based on an updated review of British Columbia (BC) Government Policy and best practices, Offsetters considers FortisBC's biomethane product (better known to FortisBC customers as Renewable Natural Gas, or RNG) to be a carbon neutral fuel[1].

More specifically, one gigajoule (GJ) of 100% biomethane will provide savings of 49.58 $kgCO_2e$ when replacing conventional natural gas in BC.

Existing policy shows that the Government of BC considers biomethane from organic waste (including agriculture, landfill, or wastewater sources) to be a carbon neutral fuel source. The following are organizations and documents that refer to the carbon neutrality of biomethane:

1. Provincial Government of British Columbia in the *Natural Gas and Biomethane Sellers: Carbon Tax Act* (June 2014, Revised December 2015)
2. Provincial Government of British Columbia, Ministry of Energy, Mines and Petroleum Resources in the *BC Bioenergy Strategy*
3. Report by Biocap for the BC Ministry of Energy, Mines and Petroleum Resources and the BC Ministry of Forests and Range. Document titled, *An Information Guide on Pursuing Biomass Opportunities and Technologies in British Columbia*
4. Provincial Government of British Columbia in the *BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions* (2016/2017)

With regards to renewable natural gas, carbon neutral status means that both combustion and life cycle emissions do not contribute any net carbon dioxide emissions to the air, only the emissions of N_2O and CH_4 that would also have been emitted in the combustion of regular natural gas. The combustion of biomethane releases biogenic carbon dioxide, which is not additional to the natural carbon cycle. From a life cycle perspective, the emissions savings from displacing conventional natural gas production far outweigh biomethane's production emissions.

Throughout the life cycle of biomethane, expected sources of greenhouse gas (GHG) emissions include:

1. Energy required for processing biomethane, including the electricity and fuel consumed by facilities, equipment, and support vehicles;
2. Methane slip that may occur during processing, transport, and distribution;
3. Energy required for transport and distribution, such as the electricity consumed in distribution facilities and pipeline operations;
4. Methane and nitrous oxide emissions resulting from biomethane combustion at the point of consumer use; and,
5. By-product waste created throughout all life cycle stages, such as wastewater and solid deposits.

Expected GHG sinks in the biomethane life cycle that reduce greenhouse gas emissions include:

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[1] Biomethane is the frequently used term used industry wide, whereas RNG is the specific product name used by FortisBC. For the purposes of this report, which includes a literature review and references to government policies, Offsetters will refer to FortisBC's RNG product as 'biomethane'.

1. Methane capture and destruction from landfill gas, manure management, and wastewater treatment. Under baseline conditions, organic material would typically decompose and release methane directly into the atmosphere;
2. Avoided emissions from the combustion of natural gas, a fossil fuel that emits 49.87 kgCO_2e/GJ in BC. Biomethane emits only 0.29 kgCO_2e/GJ;
3. Avoided life cycle emissions from extracting and processing natural gas; and,
4. Avoided emissions from nitrous oxide released from untreated biomass.

It is important to consider the additional benefit of converting naturally occurring biomethane into carbon dioxide through combustion as a fuel source. The process of biomethane "capture and destruction" reduces global warming impacts considerably. Methane (CH_4) has a global warming potential (GWP) of 25[2] (updated from 21 in the previous report) while CO_2 GWP is 1. This can be simplified to mean that each molecule of CH_4 has 25 times the impact on climate change as one molecule of CO_2. Utilizing biomethane for heating and other purposes converts biomethane to carbon dioxide, preventing it from directly entering the atmosphere and reducing overall greenhouse gas emissions. In addition, CH_4 has been identified as an important short lived GHG[3], leading to CH_4 reductions being of particular focus as policy focuses on short term mitigation opportunities.

According to FortisBC, an average residential renewable natural gas customer uses 90 GJ of natural gas annually and participates in the program at a 10% level. These participants will see a reduction in their carbon footprint by 4.95 kg carbon dioxide equivalent (CO_2e) per GJ, based on 9 GJ of biomethane and accounting for the emissions of N_2O and CH_4 released upon combustion of the renewable fuel.

Even for an average residential customer who consumes 90 GJ of natural gas per year and designates 100% of their natural gas use as biomethane, emissions from N_2O and CH_4 are negligible.

Overall, Offsetters confirms that biomethane can be considered a carbon neutral fuel, though the N_2O and CH_4 emissions generated on combustion should be accounted for, in the same fashion as natural gas.

[2] British Columbia Ministry of Environment. 2016/17 B.C. Best Practices Methodology For Quantifying Greenhouse Gas Emissions. Available at http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/carbon-neutral-government/measure-page/2016-2017_bc_best_practices_methodology/_for_quantifying_ghg_emissions.pdf.

[3] https://www.globalmethane.org/about/methane.aspx

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1 Introduction

1.1 Purpose

This report has been conducted by Offsetters on behalf of FortisBC. The purpose of this report is to:

1. Review the current biomethane *Greenhouse Gas Document* (report dated May 30, 2011), and update the document to reflect current enacted as well as draft policies and protocols.
2. Summarize existing and new policies in British Columbia (BC) that define biomethane as a 'carbon neutral' fuel source.
3. Review the carbon neutral status of biomethane and refresh guidance for the quantification of emissions associated with combustion.

1.2 Disclaimer

All greenhouse gas (GHG) emissions quantified in this report are estimations based on existing data from previous studies conducted, and therefore Offsetters is not responsible for inaccuracies of 3rd party information.

1.3 Life Cycle Assessment (LCA) Background

Drawing from the World Resources Institute's *Product Life Cycle Accounting and Reporting Standard (2011)*, there are two LCA boundaries that we recognize in the preparation of this study:

1.3.1 Cradle-to-Grave

A cradle-to-grave life cycle assessment includes all GHG emissions in the complete life cycle of a product from the beginning of acquiring raw materials through final disposal or post-consumer end-of-life.

In the case of a fuel cycle, the cradle-to-grave emissions are also referred to as well-to-wheels (WTW) emissions. The WTW life cycle includes resource extraction, feedstock production, fuel production, refining, blending, transportation, distribution, consumption, and evaporation.

Figure 1 illustrates the five life cycle stages of a product included in a WTW assessment.

Figure 1: Cradle-to-Grave Emission Stages

1.3.2 Cradle-to-Gate

A cradle-to-gate life cycle assessment does not include end use or end-of-life stages. For fuel, the cradle-to-gate emissions are also referred to as well-to-tank (WTT). The WTT life cycle therefore includes resource extraction, feedstock production, fuel production, refining, blending, transportation, and distribution.

Figure 2 illustrates the three life cycle stages of a product included in a WTT assessment.

Figure 2: Cradle- to- Gate Inventory

It should be noted that a life cycle will have more than one gate depending upon perspective. For example, from the perspective of the biomethane producer, the gate would be the point at which biomethane is transferred to FortisBC's pipeline distribution system. However, from FortisBC's perspective, the gate would be the point at which it delivers biomethane to its residential customers.

For the purposes of marketing carbon neutral biomethane to customers, FortisBC should consider the gate to be the point at which customers receive biomethane in their homes or buildings. However, this report only includes emissions information up to the biomethane producer's gate, where the biomethane is transferred into FortisBC's pipeline distribution network.

2 Review of BC's Biomethane Policies

Offsetters has conducted a review of existing government policy related to biomethane and carbon neutrality in British Columbia on behalf of FortisBC. Tables 1 to 3 (see below) provide excerpts from these documents. They are either Provincial Government documents or are written by third parties on behalf of the Government.

The consensus from these updated documents is that the Government of British Columbia continues to consider biomethane sourced from organic waste (including agricultural, landfill, or wastewater sources) to be a carbon neutral fuel source. The Government's position states that biomethane releases no more carbon into the atmosphere than it absorbs in its lifetime. However, the *BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions* has further clarified the emissions reporting requirements for biomethane. Due to incomplete combustion, entities such as public sector organizations and local governments with biomethane activities are required to include CH_4 and N_2O when calculating and reporting their GHG emissions footprint.

2.1 British Columbia Budget and Fiscal Plan

In British Columbia's latest *Budget and Fiscal Plan*, published on February 18, 2014, biomethane produced from agricultural and other organic waste is no longer referenced.

2.2 British Columbia Natural Gas and Biomethane Sellers: Carbon Tax Act

According to the *Natural Gas and Biomethane Sellers: Carbon Tax Act Bulletin*, the biomethane portion of a fuel blend is to be exempt from the carbon tax as a result of its carbon neutrality. Table 1 provides a summary of this section of the *Bulletin*, with a quote directly from page 4 of the document.

Table 1: Provincial Government – *Natural Gas and Biomethane Sellers Carbon Tax Act (Excerpt)*

Organization
Provincial Government of British Columbia
Document
Natural Gas and Biomethane Sellers: Carbon Tax Act (June 2014, Revised December 2015)
Quote Page 4:
"Biomethane is a carbon-neutral renewable fuel produced from biomass (e.g. agricultural and other organic wastes) that is indistinguishable from natural gas when blended (e.g. in a gas pipeline). Carbon tax does not apply to purchases of 100% biomethane or to the portion of biomethane in a blend of biomethane and another fuel if the actual amount of biomethane in the blend is known. If the actual amount of biomethane in the blend cannot be determined, carbon tax at the rate of tax of the other fuel applies to the blended fuel, unless it qualifies for a biomethane credit."

2.3 BC Ministry of Energy, Mines and Petroleum Resources

The BC Provincial Ministry of Energy, Mines and Petroleum Resources published a report titled, *BC Bioenergy Strategy: Growing Our Natural Energy Advantage*. In this report, biomass refers to organic sources including agricultural waste and manure. The report also states that when used for energy, biomass including organic waste is carbon neutral. Table 2 provides a direct quote from page 4 of this report, which relates to biomass and carbon neutrality.

Table 2: BC Bioenergy Strategy

Organization
Provincial Government of British Columbia, Ministry of Energy, Mines and Petroleum Resources
Document
BC Bioenergy Strategy: Growing Our Natural Energy Advantage
Quote Page 6:
"Bioenergy is energy derived from organic biomass sources – such as trees, agricultural crops, food processing and agricultural wastes and manure. Biomass can be generated from logging, agriculture and aquaculture, vegetation clearing and forest fire hazard areas. When used for energy, biomass such as organic waste, wood residues and agricultural fibre is considered clean or carbon neutral because it releases no more carbon into the atmosphere than it absorbed during its lifetime. When used to replace non-renewable sources of energy, bioenergy reduces the amount of greenhouse gases released into the atmosphere."

2.4 BC Ministry of Energy, Mines and Petroleum Resources and the BC Ministry of Forests and Range

In 2008 the BC Ministry of Energy, Mines and Petroleum Resources and the BC Ministry of Forests and Range published an information guide on biomass energy opportunities in British Columbia titled *An Information Guide on Pursuing Biomass Energy Opportunities and Technologies in British Columbia (February 7th, 2008)*. This report was prepared by Biocap Canada on behalf of the two Ministries. In this report, biomass refers to municipal solid waste, agricultural waste including livestock manure and forestry waste. This report states that biomass as a carbon neutral energy source can play an important role in helping BC achieve its GHG targets. Table 3 provides a summary of the explanations provided in this report related to biomass and carbon neutrality. Of note, page 20 of this report recognizes the potential of methane emissions from biomass contributing to GHGs and how this should be avoided through a biofilter.

Table 3: Information Guide to Biomass in BC

Organization
Report by Biocap for BC Ministry of Energy, Mines and Petroleum Resources and the BC Ministry of Forests and Range
Document
An Information Guide on Pursuing Biomass Energy Opportunities and Technologies in British Columbia (February 7th, 2008)
Quote Page 5:
"The Province of British Columbia has committed itself to maintain a share of at least 90% of its electricity generation from clean and renewable energy sources, and to mandate that all new facilities will have net zero greenhouse gas emissions. Biomass, as a "carbon neutral" renewable resource, can make a major contribution towards this goal. In addition, biomass can also support energy and greenhouse gas emission reduction goals in the fields of heat and transportation fuels. One tonne of dry biomass (bdt) can displace between 1.5 and 3 barrels of oil, depending on the application, technology and process efficiency applied."
Quote from Page 20:
"Note that the carbon contained in biomass is usually considered part of a regeneration cycle and processes using biomass can therefore be considered carbon neutral. However, any methane emissions should be avoided as they would otherwise constitute GHG emissions. Methane emissions can occur during curing of the material, but can be partly eliminated by the biofilter. The anaerobic digestion process will generate GHG credits through avoided emissions in the field or from open lagoons, as well as from the electricity or natural gas displaced when using the digester gas for energy purposes."

2.5 BC Best Practices Methodology For Quantifying Greenhouse Gas Emissions

The BC Provincial Ministry of Environment publishes an annual Best Practices document for quantifying greenhouse gas emissions for public sector organizations. This report includes an extensive list of applicable emission factors and related emission calculation methodologies with jurisdiction within British Columbia.

In order to support the public sector with measuring and reporting GHG emissions, the BC government developed SMARTTool, a web based quantification tool that enables organizations to enter consumption data directly. For entities reporting biomethane activities, SMARTTOOL applies an emission factor for both CH_4 and N_2O per gigajoule (GJ).

Table 4: BC Best Practices for Quantifying GHG Emissions

Organization
Provincial Government of British Columbia, Ministry of Environment
Document
2016/17 B.C. Best Practices Methodology For Quantifying Greenhouse Gas Emissions
Quote Page 11:
"For any given volume of reported FORTIS natural gas where renewable natural gas has been purchased; customers will enter the higher commodity cost portion as renewable natural gas consumption in GJs into SMARTTool, and the remainder will be entered as natural gas consumption in GJs into SMARTTool."

2.6 Considerations

1. Non-Biogenic Emissions Reporting

Biogenic emissions from biomethane combustion refer to carbon dioxide (CO_2) emissions only. The use of biomethane does result in greenhouse gas emissions of uncombusted CH_4 and N_2O which total 0.29 $kgCO_2e/GJ$. This is equivalent to less than 0.6% of the emissions from the use of natural gas. While the BC Government considers these emissions to be negligible, combustion of biomethane results in emissions of both CH_4 and N_2O and for those customers who must accurately report, commonly Public Sector Organizations and industrial customers, the emissions associated with these should be taken into account.

When reporting biomethane activities, entities should be using the most up to date emission factor for biomethane, which can be found in the *BC Best Practices Methodology for Quantifying Greenhouse Gas Emissions* document published by the BC Ministry of Environment.

2. Biomass vs. Woody Biomass

The use of the term "biomass" can sometimes refer to all types of biomass (including organic matter that generates raw biogas from an anaerobic digestion process), or it can refer to the subset of woody biomass only. This distinction is important because the *BC Regulation for the Greenhouse Gas Reporting*[4] (repealed December 17, 2015 and *replaced by the Greenhouse Gas Emissions Reporting Regulation*, effective January 1, 2016), exempts woody biomass from a reporting facility's emissions total. However, facilities are required to report emissions from biomass sources other than those listed in Schedule C of the *Regulation*, including biomethane emissions. This treatment of biomass has remained consistent in the new regulation. It is unclear why biomethane emissions are not exempt.

"Biomass" is defined in Schedule C as:

- "(a) non-fossilized plants or parts of plants, animal waste or any product made of either of these and includes, without limitation, biomass derived fuels, wood and wood products,

[4] http://www2.gov.bc.ca/assets/gov/environment/climate-change/policy-legislation-and-responses/legislation-and-regulations/249_2015.pdf

agricultural residues and wastes, biologically derived organic matter found in municipal and industrial wastes, landfill gas, black liquor, kraft pulp fibres and sludge gas, and

- (b) any fuels in respect of which the entire heat generation capacity is derived entirely from biomass described in paragraph (a);"

"Woody Biomass" is defined as "Type 1 biomass" in Schedule C as follows:

- Wood biomass, or the wood biomass component of mixed fuels, including…
    - (a) wood residue within the meaning of the Forest Act,
    - (b) wood-derived fuel, red liquor and black liquor from pulp and paper production processes, and
    - (c) woody matter from agricultural trimmings, tree thinning and orchard removals
- But not including wood biomass that fails to meet the criteria for carbon neutrality established by the jurisdiction in which it was produced, if any.

3 Life Cycle Emissions from Biomethane

The following examines the life cycle emissions of biomethane and provides insight into the impacts each stage will have on the overall greenhouse gas inventory. Section 3.1 provides a description of expected greenhouse gas emissions sources and sinks, while Section 3.2 is a summary of findings from existing life cycle studies conducted on biomethane.

Figure 3 illustrates the general life cycle stages associated with biomethane. Each of the five life cycle stages are labelled above the corresponding box.

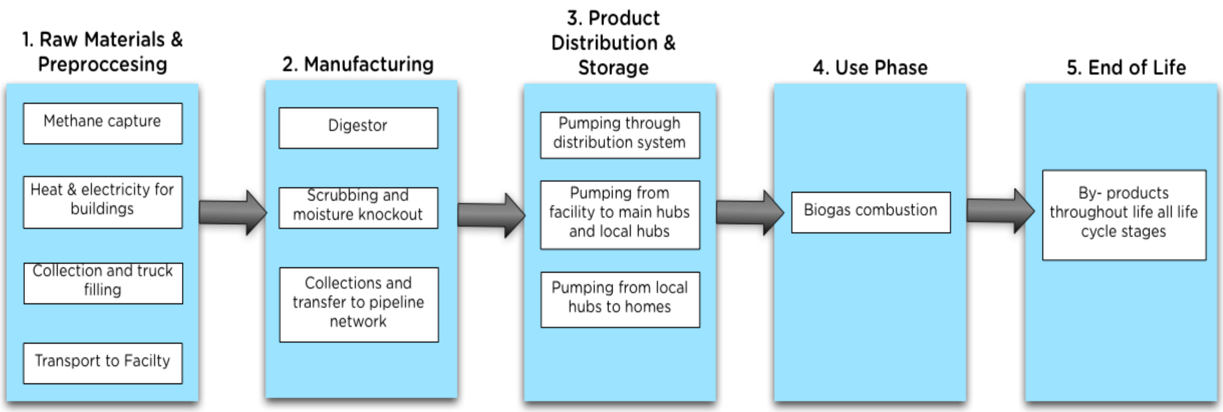

Figure 3: Process Map of Biomethane Life Cycle

3.1 Greenhouse Gas Sources and Reductions Throughout Life Cycle

Throughout the life cycle of biomethane, there are both emissions sources and sinks that balance to create a net reduction in greenhouse gases (GHG) when compared to natural gas as a fossil fuel. Figure 4 illustrates these expected emissions and reductions in the life cycle of biomethane production.

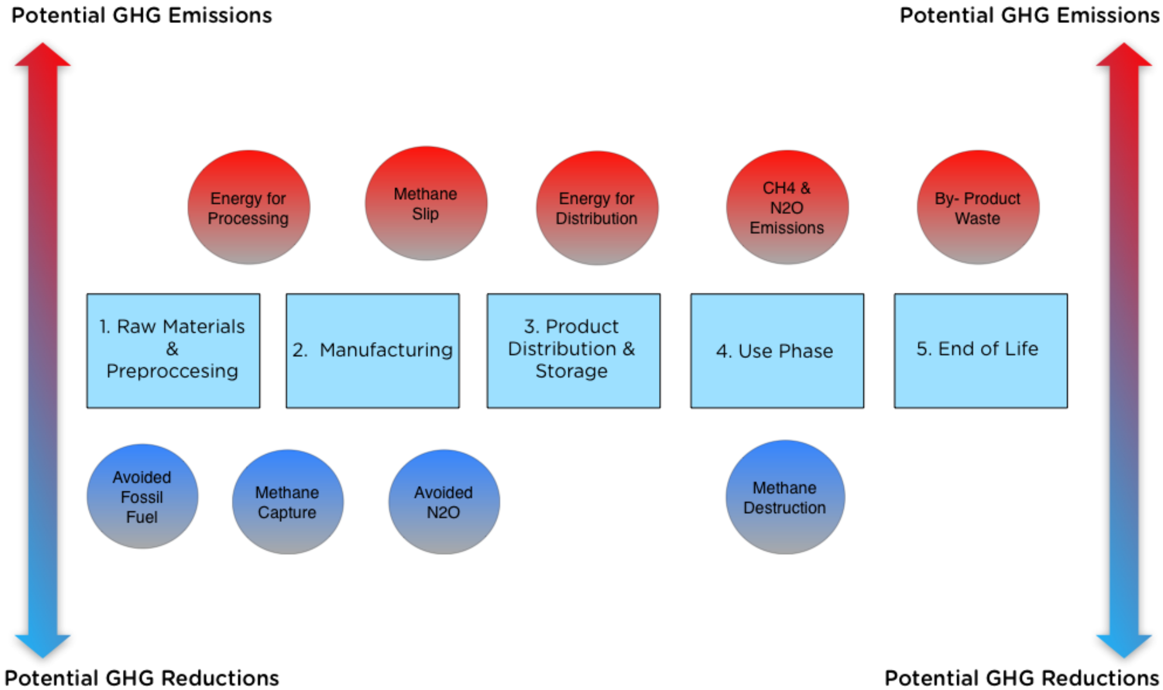

Figure 4: GHG Sources and Reductions from Biomethane Life Cycle

In this figure, the circles in red above the life cycle stages illustrate GHG emission sources, while the blue circles underneath represent GHG sinks. Further explanation of GHG sources and sinks can be found in sections 3.1.1 and 3.1.2 respectively.

3.1.1 Life Cycle GHG Emission Sources from Biomethane

1. Energy Required for Processing

- Electricity, natural gas, diesel fuel, or propane can be used in buildings and other facilities used to process and manufacture biomethane.
- Emissions associated with support equipment and vehicles used to move materials, such as manure or landfill waste within a facility. Support equipment can also include wastewater pumps in the case of a wastewater treatment facility.

2. Methane Slip

- A small percentage of methane is lost in processing, transport, and distribution, which can be referred to as fugitive emissions.
- For example, there may be inefficiencies and venting events that occur that result in leaked emissions from an anaerobic digester, or there may be fugitive emissions from a gas pipeline network.

3. Energy Required for Biomethane Transport Distribution

- Fuel consumed for transportation can include fuel used in natural gas tanker trucks.
- Electricity usage consumed for distribution facilities and gas pipeline network pumps.

4. Methane and Nitrous Oxide Emissions from Combustion

- According to greenhouse gas accounting protocols, such as the *World Resources Institute Greenhouse Gas Protocol*, CH_4 and N_2O emissions are to be accounted for when combusting biomass.
- CH_4 and N_2O are not considered to be biogenic like CO_2. In other words, non-biogenic greenhouse gas emissions are not part of the natural carbon cycle.

5. By-Product Waste

- Waste created throughout the life cycle stages, such as wastewater, solid deposits, and other organic material will result in methane emissions during decomposition that may not be completely captured by the biomethane facility.

3.1.2 Life Cycle GHG Sinks from Biomethane

1. Avoided Fossil Fuel

- Emissions from the combustion of natural gas are avoided when biomethane is used as an alternative fuel source. Because biomethane captures emissions from decomposing organic materials, the CO_2 emitted is considered to be part of the natural carbon cycle and no net increase in greenhouse gas emissions occurs.
- In addition to replacing natural gas combustion emissions which occurs in the use phase, biomethane's cradle-to-gate life cycle also results in far fewer emissions than the life cycle of natural gas. Fossil fuel production includes extraction and processing of natural gas, which is avoided in the use of biomethane.

2. Methane Capture and Destruction

- While avoided fossil fuel emissions result from biomethane displacing natural gas, there are also emissions reductions simply from transforming methane into carbon dioxide. Methane capture and destruction takes advantage of the global warming potential (GWP) difference between the two gases. For example, destroying one tonne of methane is the equivalent of destroying 25 tonnes of carbon dioxide because methane has a greater effect on climate change than carbon dioxide does.
- Under baseline conditions, methane from organic waste would typically decompose anaerobically and release methane into the atmosphere in the natural world. Capturing this methane prevents it from contributing to climate change. There are various technologies that can be implemented depending on the nature of the source of methane. The two most common examples are landfill gas capture, where methane from landfill is captured and destroyed, and anaerobic digesters, where organic waste is collected at a specific facility. Each technology will have a different efficiency of capture. For example landfill gas capture is regulated to be at least 75% efficient, whereas anaerobic digesters will be much closer to 100%. However, in all cases where the baseline is release of methane to the atmosphere, the capture of fugitive methane results in the reduction of emissions.

3. Nitrous Oxide Reduction

- Avoided nitrous oxide emissions from processing of biogas

3.2 Literature Review of Biomethane Life Cycle Assessment

Offsetters has conducted a literature review of existing research conducted on the greenhouse gas emissions associated with biomethane from landfill gas, wastewater treatment, and anaerobic digester facilities. Sections 3.2.1 to 3.2.3 detail the research findings for each biomethane type.

3.2.1 Landfill Gas to Liquefied Natural Gas Life Cycle Assessment

A study conducted by the California Air and Resources Board (CARB) examined three life cycle pathways of North America landfill gas converted into compressed natural gas (CNG), liquefied natural gas (LFG) and liquefied-compressed natural gas (L-CNG). All three can be used as an alternative to natural gas for vehicle fuel. Figure 5 below illustrates these three pathways from landfill gas feedstock recovery to fuel combustion in motor vehicles, also referred to as well- to-wheels (WTW). Table 5 provides a summary of the study and life cycle emissions.

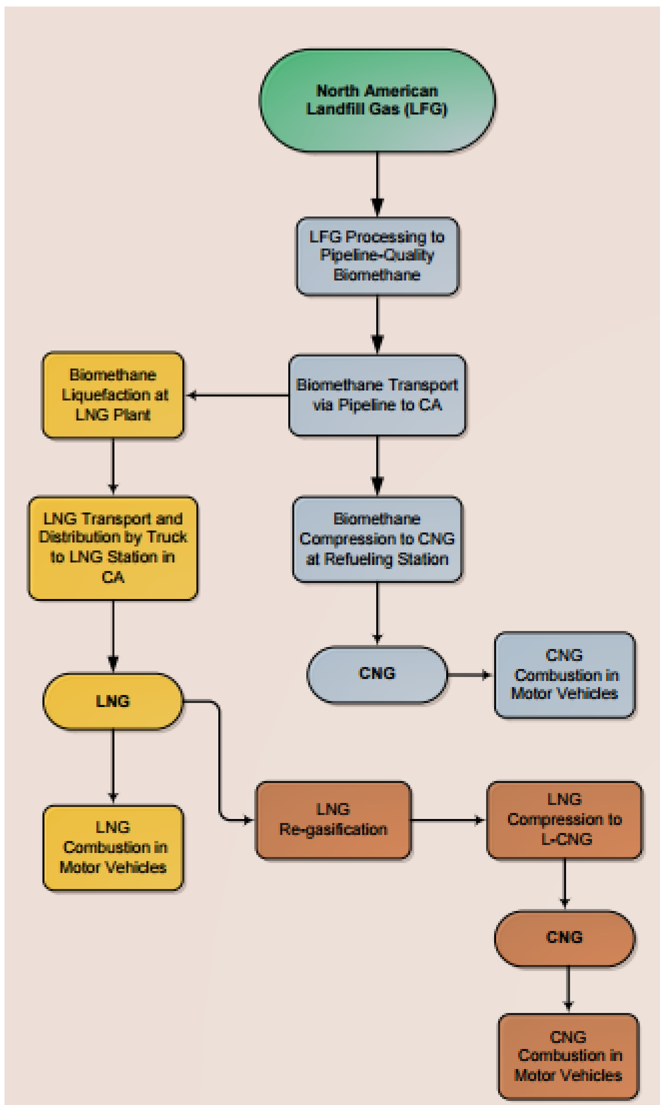

Figure 5: Process Map of Landfill Gas to CNG, LNG, and L-CNG Fuel in North America

Table 5: Summary of CARB Landfill Gas Study

Study
California-Modified GREET Pathways: North American Landfill Gas to Compressed Natural Gas, Liquefied Natural Gas, and Liquefied-Compressed Natural Gas, Version 2.0. November 10, 2014 (Revised May 28, 2015).
Source
https://www.arb.ca.gov/fuels/lcfs/2a2b/internal/nalfg-lng-lcng-rpt-110714.pdf
Summary Points:
• Carbon intensity for every megajoule (MJ) generated during the production and use of LFG in a passenger vehicle (WTW) totalled: ○ 33.02 gCO_2e/MJ for CNG ○ 49.10 gCO_2e/MJ for LNG (80% liquefaction efficiency) ○ 51.30 gCO_2e/MJ for L-CNG (80% liquefaction efficiency) • Landfill gas processing and flaring credits in this study include: ○ -32.49 gCO_2e/MJ for CNG ○ -32.37 gCO_2e/MJ for LNG (80% liquefaction efficiency) ○ -32.37 gCO_2e/MJ for L-CNG (80% liquefaction efficiency)

3.2.2 Dairy Digester to Compressed Natural Gas Life Cycle Assessment

The California Air and Resources Board also conducted a similar study on the life cycle of biogas converted from a dairy digester into compressed natural gas (CNG). The CNG is used as an alternative to natural gas for a vehicle. Figure 6 below illustrates the WTW pathway of CNG from a dairy digester to fuel combustion. Table 6 provides a summary of the study and life cycle emissions.

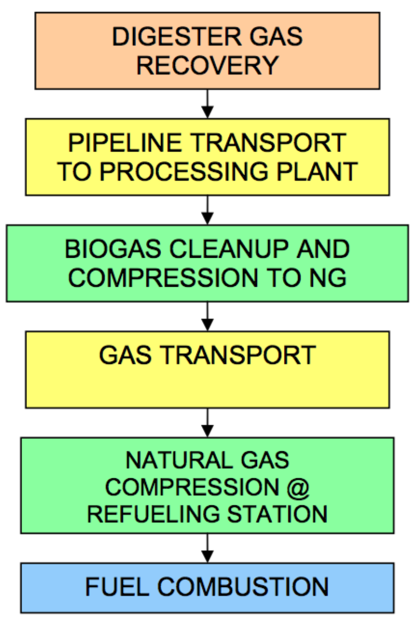

Figure 6: Process Map of Dairy Digester to CNG

Table 6: Summary of CARB Dairy Digester Study

Study
California Environmental Protection Agency: Air Resources Board (CARB). Detailed California-modified GREET pathway for compressed natural gas (CNG) from dairy digester biogas. Version 1.0. July 20, 2009.
Source
http://www.arb.ca.gov/fuels/lcfs/lcfs.htm#lca
Summary Points:
• 13.45 grams CO_2e of GHG emissions are generated for every MJ produced and combusted in a passenger vehicle. • Emission sources in this study include: o Electricity consumption for digester biogas gas recovery, transport and compression and distribution o Tailpipe carbon, methane, and nitrous oxide emissions • Emission credits in this study include: o A biogas GHG credit of -63.05 gCO_2e per MJ has been included based on the carbon content of the emitted biogas

3.2.3 Methane and Nitrous Oxide Emissions from Dairy Cattle Slurry

In this study published in the journal, *Agriculture, Ecosystems and Environment*, methane, nitrous oxide and ammonia emissions were measured during the storage and application of dairy cattle slurry. The study examined the impact of these emissions based on various treatment methods.

Table 7 provides a summary of this article and the emission reductions associated with treating dairy cattle slurry through an anaerobic digester.

Table 7: Summary of Study on Dairy Cattle Slurry

Study
Methane, nitrous oxide and ammonia emissions during storage and after application of dairy cattle slurry and influence of slurry treatment. From *Agriculture, Ecosystems and Environment* 2006. Volume 112 (153-162).
Author
B. Amon et al.
Summary Points:
• Untreated slurry emitted 92.4 kgCO_2e for every cubic metre from storage and field application. For slurry treated through anaerobic digestion, emissions were reduced to 37.9 kgCO_2e for every cubic metre.

3.2.4 Bioenergy vs. Fossil Fuel Emissions

In this study, the life cycle analysis of biomass and fossil fuel energy systems is conducted in order to compare overall greenhouse gas emissions. Emissions throughout the biomass and fossil fuel life cycle are taken into account. Table 8 provides a summary of this article including the GHG reductions from using biogas from manure as an alternative to natural gas.

Table 8: Summary of Study Comparing Fossil Fuel to Bioenergy

Study
Greenhouse gas emissions of bioenergy from agriculture compared to fossil energy for heat and electricity supply. From *Nutrient Cycling in Agroecosystems 2001. Volume 60 (267-273).*
Author
G. Jungmeier & J. Spitzer
Summary Points:
• The life cycle emissions of biogas from cow, pig manure, and co-digestion for combined heat and power plants (CHP) are negative   o The GHG benefits from the use of by-products and from the avoidance of methane from manure storage are incorporated into the measurements • According to this study, using biogas from manure and co-digestion for CHP rather than natural gas will reduce GHGs by between 129% and 286%.

4 Carbon Credits and GHG Accounting

During the life cycle of biomethane, opportunities for emission reductions (illustrated in Figure 4) include the following:

- Avoided emissions from fossil fuel extraction and processing,
- Methane capture,
- Methane destruction,
- Avoided nitrous oxide emissions.

Of these emission reductions, the most relevant opportunities for generating carbon credits are from methane capture and destruction. There is also the potential to generate emission credits from the displacement or avoidance of fossil fuels. The reduction of N_2O emissions is the most unknown and least likely to be quantified for reduction credits at this time.

The following sections provide a summary of the reduction opportunities and protocols available for the generation of carbon credits from wastewater, landfill[5], and anaerobic digesters.

4.1 Methane Capture and Destruction

Methane capture and destruction is the most common opportunity for generating carbon credits from biomethane production. These credits are generated by first installing a biogas control system which captures the methane emitting from organic waste. Then, the methane is destroyed through combustion either by flaring or during its end use application, either on-site or off-site.

The GHG reductions result from avoiding methane emissions associated with the organic material's baseline condition. Without the installation of the biogas control system, organic waste is stored under anaerobic conditions and decomposes to release methane into the atmosphere. By capturing this biogas and combusting it to create carbon dioxide, the methane is transformed into a much less impactful greenhouse gas. Specifically, the global warming potential (GWP) of carbon dioxide is 1, while the GWP of Methane is 25.

4.2 Avoided Fossil Fuel Life Cycle Emissions

Biomethane is a clean alternative to non-renewable fossil fuels, such as natural gas. In the natural gas pipeline network, each cubic meter of biomethane effectively prevents life cycle GHG emissions from being produced for the equivalent amount of natural gas. These life cycle emissions result from the extraction and processing of fossil fuel natural gas, including the production, refinement, and storage of fossil fuels.

[5] As of January 1, 2017, the BC Government has set a jurisdictional target of 75% for landfill gas capture and destruction, significantly reducing the opportunity for generating offset credits.

5 Conclusion

Based on an updated review of British Columbia (BC) Government Policy and best practices, Offsetters considers FortisBC's biomethane product (better known to FortisBC customers as Renewable Natural Gas, or RNG) to be a carbon neutral fuel. The FortisBC renewable natural gas program allows customers to achieve significant greenhouse gas savings and reduce their own carbon footprint. The benefits of using biomethane as a fuel source include:

- Prevention of naturally occurring methane from directly entering the atmosphere;
- Lifecycle GHG emissions savings from the displacement of conventional natural gas;
- No net increase in greenhouse gas emissions from combustion because biomethane is a carbon neutral energy source in British Columbia.

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