

Biomethane Report

Market Intelligence

December 2022



biogasworld.com

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About BiogasWorld

BiogasWorld is a business generation network and project support platform, connecting the suppliers of products and services with project developers. We accelerate the biogas and biomethane industry worldwide.

With the experience of working with hundreds of suppliers and collaborating to over 50 biogas and biomethane (RNG) projects in North America, BiogasWorld offers to project developers a wide range of services to help them reduce the cost and duration of their project implementation.

For more details, feel free to contact us at info@biogasworld.com.





Project Leads

Access public and private opportunities for your business; find funding and grant opportunities for your projects.



Market Intelligence

Support your business development efforts and grow your business by getting access to market intelligence and tools.



Online Promotion

Promote your business in biogas and biomethane industry and generate business opportunities through our online platform.

Notice to Readers

Terminology: Biomethane Vs. RNG

There are two terms widely used to describe upgraded biogas: biomethane (used in Europe) and Renewable Natural Gas or RNG (used in North America). To make the reading of the report easier, we opted to use the term "biomethane", however, some direct references to existing legislation and programs in Canada will use "RNG" to make it easier for readers to make additional research.

Energy Conversion

The report uses a number of energy units to present the information due to the fact that different sources of information may use various units of energy. When reading the report, you will find helpful the following table containing approximate energy conversions for biomethane as reference.

Unit of Energy	Conversion							
	1 000 000 GJ							
	0,9478 TBTU							
1 PI	947 817 MMBTU							
113	277 780 TWh							
	26 518 000 m3 Biomethane (RNG)							
	0,9478 Bcf							

Table 1. Energy Conversion

Abbreviations

PJ	Petajoule
GJ	Gigajoule
TBTU	Trillion British Thermal Units
MMBTU	Metric Million British Thermal Unit
TWh	Terra Watt hours
Bcf	Billion cubic feet

Canada

Market Overview

Current Market Overview

There are currently 20 operating facilities upgrading biogas to biomethane (which represents a 20% increase over 2021) and two pilot projects producing biomethane from woody biomass (Alberta & British Columbia). British Columbia is leading the way with 7 plants, followed by Quebec with 6 plants.

From feedstock perspective, all kinds of waste are utilized: agricultural (6 plants), SSO (5 plants), landfill (5 plants), commercial waste (1 plant), WWTP (2 plants) and biomass (1 plant).

As the production of RNG and its injection into the natural gas grid provides a project with stable revenue under RNG purchase agreements, such projects are prioritized over CHP production.

There are at least 26 plants under construction, 39 more in various stages of development (half of them are located in Quebec) and more than 50 in early development stage.

In November of 2022, the Canadian government committed CAD 800 million to clean fuel companies, with the exact funding distribution and requirements still under negotiation. CAD 9 million has been designated for developing RNG and hydrogen refueling infrastructure.

In December 2022, Énergir, the largest gas utility in Quebec, and Nature Energy committed to investing CAD 1 billion for 10 new RNG projects in the province.



Current Market Overview

Projects in Development



Market Size & Potential



RNG in Transportation



There are around 60 plants in development or under construction, and a few dozen more at an earlier stage of concept development. Quebec alone received over 30 projects for evaluation and support subsidies.

Given the successes of 2nd generation RNG projects (from woody biomass), combined with new and continued government supports, it is reasonable to predict that upwards of 60 facilities will become operational in the next 5-10 years.

The <u>CBA estimates</u> that Canada is utilizing only 14% of its biogas potential, translating to approximately 6 PJ of output.

According to the CBA/Torchlight Bioreseources, there is approximately 155 PJ of RNG that is realistically available in Canada. The study further predicts 654 PJ to be available but not commercially viable.

Accounting for other sources of gasification, including woody biomass, it is estimated that Quebec could produce 144.3 PJ in 2030; BC's potential with other gasification sources is estimated at 50 PJ/y in 2030, and as high as 440 PJ/y by 2050.

Research by <u>CUTRIC</u> published June 2022 found enormous potential in decarbonizing public transit and refuse collection vehicles via compressed RNG.

The CGA reports over 1,000 buses in operation in metropolitan areas across Canada, with hundreds more scheduled to begin operation within the next 3 years. Municipalities using NGV transit buses include Vancouver, Victoria, Nanaimo, Kamloops, and Whistler (BC), Calgary, Medicine Hat, and Red Deer (AB), and Hamilton (ON). The city of Hamilton has one bus operating solely on RNG, and the province of BC has identified CNG transport to comply with the provinces LCFS.

Upgrading Snapshot

Providers of upgrading technologies in existing biomethane plants in Canada are as follows:

- AB Energy (membrane) 1 plant
- ARC Technologies (PSA) 1 plant
- DMT (membrane) 2 plants
- ETW Energie (PSA) 1 plant
- Greenlane (water scrubbing, PSA, & membrane) 6 plants
 - One plant in collaboration with Sysadvance (PSA)
- Guild Associates (PSA) 1 plant
- Hitachi (membrane) 1 plant
- Honeywell (membrane separation) 1 plant
- Prodeval (membrane) 2 plants
- Pyro Green-Gas (formerly AirScience) (membrane) 1 plant
- Quadrogen (PSA) 1 plant
- Waga Energy (Cryo) 2 plants
- Xebec (PSA) 6 plants
- Information for three facilities is not yet available



Figure 1. Biogas Upgrading in Canada, Installed Units



Federal - Market Drivers

- <u>The Clean Fuel Standard (CFS</u>) came into force in July of 2022
 - The CFS replaced the RFR system established in 2010+
 - Will apply to liquid transportation, industrial and building fuels
 - Target of 20 million tonnes of annual reductions in GHG by 2030
 - Though the CFS pertains to liquid transportation fuels, it allows biogas, RNG, and hydrogen to generate compliance credits in one of three ways:
 - Credits for using low-carbon intensity hydrogen as a feedstock in the production of fuels
 - Credits for supplying RNG and hydrogen to the transportation sector
 - Credits for supplying biogas, RNG, and hydrogen used as fuel for nontransport purposes
 - Obligated parties include natural gas producers, transmission companies, and utilities
 - GHG reductions are calculated on a lifecycle basis, and establishes lifecycle carbon intensity (CI) for each fuel type
 - Compliance credits must be purchased to lower the CI of a fuel
 - Compliance credits can be generated by producing or importing a low-Cl fuel
 - Full calculations details can be found <u>here</u>
- <u>Bill C-12</u>, The Canadian Net-Zero Emissions Accountability Act calls for government to establish GHG emissions targets and reduction plans for 2030, 2035, 2040 and 2045.

- The 2022 Federal budget included several funding opportunities which could support the development of RNG projects, including;
 - CAD 2.2 billion over 7 years to support Environment and Climate Change Canada (ECCC) expands the Low Carbon Economy Fund
 - CAD 600 million over 7 years to Natural Resources Canada (NRCan) for the Smart Renewables and Electrification Pathways Program
- The Canadian government has announced CAD 1.5 billion for the Clean Fuels Fund, which supports the development of domestically produced clean fuel production and the establishment of sustainable biomass supply chains
- In April 2021, Canada announced it would increase its "30 by 30" carbon reduction commitment to 40–45% (with a floor of 36%) GHG emissions below 2005 levels
- Climate Change Plan (December 2020)
 - Carbon tax to be raised to CAD 65 per tonne in 2023, and to CAD 170 per tonne by 2030
 - CAD 1.5 bln allocated to fund the increase of the production and use of low-carbon fuels like RNG, hydrogen and diesel
 - The 2020 plan targets a yearly output of at least 511 Mt CO2e by 2030, 30% below 2005 levels (730 Mt). With an output of 729 Mt in 2018 (latest date with official numbers), Canada must reduce its emissions by 218 Mt to reach this goal.

Federal - Market Drivers (Continued)

- In October 2021 the Federal government, along with 80 other countries, pledged to reduce global methane emissions by 30% of 2020 levels by 2030
- RNG is exempt from Federal Carbon Charge
- In February 2022, the Federal government announced the creation of the Output-Based Pricing System Proceeds Fund (OBPS Proceeds Fund), which utilizes funds from the OBPS to support industrial activities which reduce GHG emissions and deploy clean technologies through the reinvestment of proceeds from the jurisdiction in which they originate
 - Proceeds can be directly transferred into provincially managed programs such as the Future Electricity Fund (FEF) of the Decarbonization Incentive Program (DIP)
- In 2022, the federal government implemented the Greenhouse Gas Offset system, which allows emitting facilities to generate offset credits tradable in the OBPS through voluntary emission reduction actions that go beyond what's legally required of them
 - Includes the <u>Landfill Methane Recovery</u> <u>and Destruction Protocol</u>
 - Projects which enhance soil organic carbon and are related to livestock feed management can also qualify for credits
- The adoption stream of the <u>Agricultural Clean</u> <u>Technology Program</u> (for provincial and territorial governments) is now closed; however, the R&D stream remains open for new applications

- Biogas systems which contribute to the generation of electricity and heat for industrial processes may be eligible for the Federal Accelerated Capital Cost Allowance (CCA) for Green Energy Generation
- The <u>Green Municipal Fund</u> (GMF), administered through the Federation of Canadian Municipalities (FCM), provides funding for public-private municipal environmental projects, including biogas projects
 - Funding contributes to the development of plans and feasibility studies. The project also offers below-market loans, often in combination with grants
- The Harmonized Sales Taxes (HST) costs associated with the construction and operation of biogas systems may be recovered through Input Tax Credit rebates
- The SD Natural Gas Fund, administered through <u>Sustainable Development Technology</u> <u>Canada</u> (SDTC), supports Natural Gas Projects, including anaerobic digestion, gas upgrading, and some activities related to NG fuelling. Calls for submission are distributed twice per year.
 - Growing Forward 2 (GF2) is a federalprovincial-territorial initiative for agricultural capacity building (development of feasibility and engineering of biogas projects can fit these criteria). Farm producers can be eligible for a 50% cost share, and organizations and collaborations could receive up to 75% cost sharing

Alberta - Market Drivers

- Emissions Reduction Alberta receives funding through NRCan to support the development of biomass and RNG projects
- AER's current strategic plan (2018–2023) is continuing to develop and monitor new regulatory measures to promote renewable energy transition in the province, while updating and revising its current approach to hydrocarbons
- The Strategic Plan (2021–2024) of the Alberta Utilities Commission (AUC) highlights new ministerial cooperation to further decarbonization and technology development within the province
- Emissions Reductions Alberta (ERA) governs the Technology Innovation and Emissions Reductions Regulation (TIER) fund which supports the development of agricultural biogas and RNG

- TIER also regulates the provinces industrial GHG emissions pricing regulation and emissions trading system
 - Registered facilities must lower their emissions to meet benchmarks
 - LFG capture and combustion and biogas production and combustion can generate credits
- <u>Climate Leadership Plan</u> (introduced 2015, last updated 2018)
- <u>Food waste ban</u> (70% for single-family homes, 75% for IC&I sector) in Calgary since 2019
- At the beginning of November 2021, the Government of Alberta released its <u>Hydrogen</u> <u>Roadmap</u>, outlining a policy framework for developing clean hydrogen and competing in the multi-billion-dollar global hydrogen market.

British Columbia - Market Drivers

- June 2022 BC announced a new <u>Low Carbon</u>
 <u>Fuels Act</u>
 - The new LCFS requires fuel suppliers to reduce the CI of transportation fuels by 1.09% annually to reach a CI target of 30% by 2030
 - In conjunction with this target, the Ministry of Energy, Mines, and Low Carbon Innovation (EMLI) proposed a new noncompliance penalty rate of CAD 200/tonne
- Update to the Clean BC Plan (2018): <u>Roadmap</u> to 2030 (2021)
 - Policies aiming to eliminate all industrial methane emissions by 2035
 - New facilities must work with the province to create a plan on how to meet legislated targets
 - Tightened caps on NG utilities (6 Mt of CO2e per year for 2030), with new supports for achieving goals (an emissions reduction of 47%)
 - Reduction of GHG emissions 40% by 2030
 - Reduction of 20% of carbon intensity of diesel and gasoline by 2030
 - 15% renewable content in natural gas by 2030 (approx. 30 PJ)
 - 95% organics diversion (municipal, industrial and agricultural) and CC of 75% LFG by 2030
 - New supports for hydrogen-based innovation, the forest-based bioeconomy, and negative emissions technologies
 - Provincial Carbon Tax set to CAD 45/tonne CO2e, and is set to increase to CAD 50 in 2022, exceeding federal tax levels
- Excess revenue from BC Carbon Tax is directed to the CleanBC Industry Fund

- BC Offset Units can be generated by recognized projects which meet provincial regulations and requirements
 - The Draft BC Methane Management Offset Protocol is one such pathway, with LFG, organics diversion, WWTP, and manure management projects all being eligible.
- Organics ban effective in Metro Vancouver, Capital Region District, Regional District of Nanaimo (commercial food waste only)
 - Organics ban also in-place for single-family dwellings, with fines placed on haulers
- Organic Infrastructure Fund: provides CAD 30 million to improve organic waste management
- FortisBC target 30BY30 aims to reduce GHG by 30% by 2030
 - Voluntary RNG program by FortisBC
 - Renewable Portfolio Allowance for Biomethane by FortisBC—FIT RNG Program (up to CAD 30/GJ) and a supply cap of 5% of the overall load
- <u>Renewable and Low Carbon Fuel Requirements</u>
 <u>Regulation</u>
 - Minimal renewable fuel content of 5% for gasoline and 4% for diesel
 - Supports RNG for pipeline gas and renewable fuel
- Innovative Clean Energy (ICE) Fund
 - Supports the research, development, and implementation of sustainable energy technologies
 - Receives funding from NRCan for the development of biomass and RNG projects

Manitoba - Market Drivers

- Revenues of the Federal Carbon Tax directed toward technology innovation and other GHG mitigation project
- Requires landfills over a certain size to collect LFG and dispose of it, but does not dictate end use
- Established the Made-in-Manitoba and Green Plan in 2018, which included proposals for carbon pricing and reductions in carbon emissions
 - CAD 6 million pledged
 - CAD 1.5 million allocated to the Conservation and Climate Fund

- Biogas identified as a method for producing on-farm energy for agricultural operations
- The Manitoba Public Utilities Board Strategic Plan 2020–2023 does not specifically mention carbon transition
- The city of Winnipeg has laid out its roadmap for net zero which includes utilizing 100% of landfill emissions

Nova Scotia - Market Drivers

- Organics ban in place since 1997, but only 50% of organics are diverted
- Cap and Trade Nova Scotia in effect since 2019
 - Amendments proposed in October 2022 would see the program repealed following its conclusion (December 2023)
- Nova Scotia "Green Fund" utilizes Cap and Trade revenues to fund GHG mitigation and adaptation programs

- Heritage Gas in Nova Scotia is aiming to produce approximately 1.7 PJs of RNG by 2030, or roughly 10% of the 2030 projected demand
- Landfill gas collection and venting required for all landfills but energy recovery not mandatory
- Biogas recovery from wastewater being explored as a method for water conservation in the province

Ontario - Market Drivers

- January 2022 the Ontario government announced an intention to develop a Clean Energy Credit (CEC) registry
 - Credits will represent 1 MWhe
 - Credits will be voluntarily purchased, traded, and retired
 - The registry is planned to be operational by January 2023
- <u>Made in Ontario Environment Plan</u> Continued development. Initiatives include:
 - Improve ICI waste diversion and enforce standards and accountability for industrial emitters
 - Encourage new public-private partnerships to encourage and attract private sector investment
 - GHG reduction 30% by 2030 (4% of which is derived from waste in Ontario)
 - Expansion to Food and Organics Waste policy which includes the phase out food and organic waste sent to landfills by 2030
 - Low-carbon hydrogen plan

- <u>Waste-free Ontario Strategy</u>, Action Plan for the development of the circular economy
- The Community Energy Partnership Program (CEPP) is delivered through the Community Power Fund, and supports the "soft costs" of projects—environmental assessments, legal services, engineering work, and regulatory approvals
- <u>SNAPP Sustainable New Agri-Food Products &</u>
 <u>Productivity Program</u>
 - Regional program
- Enbridge's Voluntary RNG Pilot Program in Ontario began in April of 2021; application for a full RNG program has been done in October 2022

Prince Edward Island - Market Drivers

- Landfill organics ban in place
- Landfill venting required but not energy recovery, new landfills landfill gas potential assessed case-by-case
 - Not considered large enough for wide implementation of landfill gas collection
- Mandatory composting for ICI sector since 1999

Quebec - Market Drivers

- <u>Quebec's 2030 Plan for a Green Economy</u>
 - Commitment to reduce GHG emissions by 37.5% by 2030
 - Use for biomethane for greening the natural gas grid and for heating
- Regulation respecting the quantity of renewable natural gas to be delivered by a distributor (Règlement concernant la quantité de gaz naturel renouvelable devant être livrée par un distributeur)
 - Sets the target of 10% of RNG in natural gas grid in 2030
 - Allocated CAD 213 million for RNG sector
 - <u>TEQ program</u>: the most used program for private projects in Quebec
 - As of April 2021, funding is administered through the Green Economy Plan
 - Expanded to invest in developing Quebec's hydrogen sector
 - As of September 30, 2021, hydrogen was officially <u>redesignated</u> a renewable energy source, from its previous label as a hazardous material, qualifying hydrogen projects for RNG and other renewable subsidies

 <u>The Renewable Natural Gas Production</u> <u>Support Program (PSPGNR)</u>

- Part 1 (Volet 1) Supports for the financing of feasibility studies, subsidizing up to 75% of costs, to a maximum of \$300,000/project
- Part 2 (Volet 2)—financing of initial investment: up to 50% of project expenses or \$15M or to ensure 20% of Internal rate of return
- In effect while the funding is available or until 31 March 2024

- <u>Organic matter recovery strategy</u> funding which contributed to the implementation of this strategy is no longer available
 - Manage organics from ICI by 2025
 - Recycle or recover 70% of organics by 2030
- <u>Starting January 2023</u>, all renewable sources of gas, including RNG and green hydrogen, can be included in the calculation of the proportion of renewable content integrated into the gas system
- Funding of PTMOBC:
 - Contribution of 50% of CAPEX (with the possibility to stack federal contributions for a maximum funding of 73.3%)
 - The program is currently in its fourth phase, with the new deadline for applications being March 2023
 - Admissible projects: installations treating SSO and ICI waste, municipal and industrial sludge and agricultural waste (manure, up to 10% of organic waste volume in the project)
- RNG and biogas can generate offset credits within Quebec's Cap-and-Trade Program
- Organics ban for all municipalities and ICI sector slated to begin 2025.

Quebec - Market Drivers (Continued)

- Hydro-Quebec's Strategic Plan 2022–2026:
 - Development of the green hydrogen market for hard-to-decarbonize sectors
 - Provides financial support for highpotential initiatives including the production of renewable gas via methanation
- Natural gas distributors, Energir and Gazifère, offer voluntary biomethane program for end users.
- The market is currently waiting on the Energy Board to commit to new RNG pricing, which will increase the maximum price from \$22/GJ to \$45/GJ

Saskatchewan - Market Drivers

- Although there is no mandate to recover landfill gas multiple landfills have begun its recovery landfill gas
- The city of Regina is seeking to capture 95% of its wastewater methane by 2025

Gas Utilities and RNG Quality Specifications

Gas Utilities and RNG Quality Specifications

Overall, major developments in Canadian biomethane sector are happening in Quebec, Ontario and British Columbia. The table below presents the information on gas utilities active in the sector and on their biomethane programs.

Enbridge



- Province: Ontario
- RNG is highlighted as a key strategy for reducing Enbridge's GHG emissions
- Enbridge is currently involved in 50 projects in advanced and early stages of development within its distribution range
- Voluntary Renewable Natural Gas Program -Pilot
 - Enbridge launched its Voluntary RNG
 Program named OptUp Program, in 2021.
 cResidential and small business customers
 can 'opt-in' to purchase RNG in their
 natural gas for \$2/month.
 - As of October 2022, 1,496 customers have opted into the program
 - All funds received under OptUp Program are used to acquire RNG. Per 2022 Annual update, Enbridge procured 1000 GJ of RNG

- The proposal to have a Voluntary RNG Program starting 2025 was submitted to OEB on October 31, 2022. Summary is as follows:
 - Proposed procurement of 1 percent of low carbon energy for 2025 (4% in 2028) in its planned gas supply
- Collaborating with <u>Vanguard Renewables</u> to develop RNG projects
- Collaborating with the <u>Ontario Waste</u>
 <u>Management Association</u> to decarbonize waste
 collection vehicles
- Direct link to Program page: Enbridge

Énergir



Province: Quebec

- Voluntary program available to customer with blend choices
- Procures RNG using annual calls for projects and RNG Purchase agreements.
 - This year's <u>request for proposals</u> (November 18, 2022) sets first delivery targets for 2024, aiming to distribute between 70 and 100 Mm3 annually of RNG.
 - Can be in Quebec, or anywhere in North America
- Energir purchases RNG from producers based on production capacity, ranging from CAD 7 to CAD 22 per GJ

- Application to increase RNG procurement price cap was done earlier in 2022 (to have the possibility to offer up to \$45/GJ) and is still under consideration.
- Quality requirements are regulated by BNQ Standard 3672-100 – Biomethane – Quality Specifications for Injection into Natural Gas Distribution and Transmission Systems.
- December 2022, Énergir <u>announced</u> a new partnership with the Danish firm Nature Energy. Énergir announced a total investment of CAD 1 billion (CAD 600 million will be invested by Nature Energy, and the remaining CAD 400 million will be invested by Énergir), Énergir will be responsible for the construction and development of these projects.

FortisBC



Province: British Columbia

- RNG Voluntary Program offered since 2011
- Voluntary product offering for residential customers, since its inception it has grown to serve over 10,000 customers
 - Grown from delivering 0.04PJ in 2011 to 4 PJ in 2022
- Between 2020 and 2021, FortisBC increased its supply of RNG by 184%
 - Fortis expects to triple supply for 2022, totalling 3.9 PJ within its gas system
- BC's GHG Reduction Regulation allows FortisBC to allocate 15% of its portfolio to RNG
- RNG Purchase price is capped at \$31/GJ

- 2 ownership models offered for biomethane suppliers:
 - FortisBC purchases raw biogas and upgrades it at FortisBC owned upgrading facility
 - FortisBC purchases biomethane and injects it at FortisBC owned interconnection facility and pipeline
- January 2022 Fortis announced a 20-year RNG purchase agreement with Archea Energy for 7.6 million MMBtu of RNG
- Direct Link to Program: FortisBC

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Bullfrog Power

- Carbon offset program since 2005, administered through its subsidiary, Less
- Reference project:
 - Dépôt Rive-Nord, landfill located near Montreal, Québec

Gazifère

- Offers Voluntary RNG program with blend choices to end-customer
- Procures the RNG using only short-term RNG Purchase agreements
- Direct link to Program: Gazifère

Pacific Northern Gas LTD.

- Voluntary program has been approved by BCUC in November 2022
- PNG is expecting to use the majority of RNG for its own use

Atco Gas and Pipelines

• Approved for RNG transportation by Alberta Utilities Commission

Critical Parameters - Canadian Specifications

The critical parameters of biomethane quality requirements are presented in the Table below. Please note that in the cases when utility does not have a biomethane specification, the natural gas quality specifications are used. The table below presents the gas quality specifications for TransCanada and other Canadian pipelines for reference.

In Canada, only the province of Quebec has a biomethane quality standard – BNQ 3672-100/2012 that regulates biomethane quality requirements within the province. Other provinces have the standards developed by the gas utilities based on pipeline gas specifications already in place.

RNG / Biomethane Slippage

Methane slippage, the quantity of methane lost in the CO2 stream during the upgrading process, is one of the important characteristics to take into account.

Overall, in Canada there are no federal or state/provincial rules as for the maximum allowed level of biomethane slippage.

The methane emissions in the natural gas sector by <u>OIES</u> in 2017 show that the reported emissions in Canada were equivalent to 0.2% of natural gas production or consumption, whichever is greater. Thus, it will be safe to assume that the same standards will be applicable to biomethane activities of the utilities. As an example, in the industry, BiogasWorld is aware of a landfill in Canada that has over 10% of methane in the flue gas.

A recent report from <u>Envint Consulting and CBER</u> presented the methane slip of upgrading technologies, which ranged from 0.04% to 20%.

Recent studies from <u>FluxLab</u> in Nova Scotia, indicate that a significant amount of current methane emissions go undercounted in Canada. While the study focuses on the oil and gas sector, it corroborates the results of a Danish study conducted by <u>Rambøll</u>, which found methane slippage to be particularly high at biogas production and upgrading facilities. It is worth noting that nearly all rogue emissions could be eliminated through the implementation of best practices.

Contaminant / Property	Unit	FortisBC	Enbridge	Énergir	TCPL Canadian Mainline	TCPL NGTL/ATCO Pipelines	TCPL Foothills (BC) Zone 8	TCPL Foothills (Sask.) Zone 9	TCPL GTN	TCPL North Baja	TCPL ANR	Alliance Canada	Union	Enbridge (Tecumseh Pipeline)	TransGas	West Coast	том
Heating Value	Btu/scf	> 966	966.2-1108.5	≥ 966	966-1109	> 966	> 966	> 966	> 995	990-1150	967-1200	966-1610	966-1079	966-1079	> 939	>966	> 966
Wobbe Index, WN	Btu/scf	-	1267-1371	≥ 1267	-	-	-	-	-	1279-1385	-	-	-	-	1255 -1358	-	-
Diluent gases N2 O2 CO2	% vol	-	-	≤ 4	-	-	-	-	-	-	-	-	-	-	-	-	-
Yellowness index	index	-	-	≥ 0.86	-	-	-	-	-	-	-	-	-	-	-	-	-
Weaver index	Index	-	-	≤ 0.05	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon Dioxide, CO2	% vol	< 2	2	≤ 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2	< 2
02	% vol	< 0.4	0.4	≤ 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.2	< 1	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4	< 0.4
Nitrogen, N2	% vol	-	-	-	-	Max 1.6	-	-	-	< 3 incl. CO2, N2, He, O2	< 3	< 4 incl. CO2, N2, O2	-	-	< 0.0015 each (nitric oxide & total oxides of nitrogen)	-	-
Total Inerts	% vol	< 4	4	-	-	4	-	-	-	-	-	-	-	-	-	-	-
Water (H2O)	lbs/MMcf	< 4	2.2	≤ 2.2	< 4	< 4	< 4	< 4	< 4	< 7	< 7	< 4	< 4	< 5	< 4	< 4	< 4
Hydrogen, H2	% vol	-	0.1	≤ 0.1	-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrogen Sulfide, H2S	grains/Ccf	< 0.26	0.26	≤ 0.306	< 1	< 1	< 1	< 1	< 0.25	< 0.25	< 1 SE & SW area; 0.25 Mainline	< 1	< 0.306	< 0.306	< 0.26	< 0.26	< 1
Total Sulphur, S	grains/Ccf	< 0.92	1	≤ 5	< 5	< 5	< 10	< 10	< 10	< 0.75 , 0.3 mercaptan	< 20	< 5	< 20	< 20	< 1 total, 0.26 mercaptan	< 1	< 5
Ammonia, NH3	grains/Ccf	0.13	0.13	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Siloxanes	grains/Ccf	< 0.043	0.043	≤ 0.043	-	-	-	-	-	-	-	-	-	-	-	-	-
Carbon monoxide, CO	% vol	<2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Halocarbons and OCPs	grains/Ccf	-	0.43	-	-	-	-	-	-	-	-	-	-	-	-	-	-
VOCs	ppmv	-	Site-specific	≤ 3.7	-	-	-	-	-	-	-	-	-	-	-	-	-
Bacteria	-	Impurity filter (0.3 to 5 microns)	Technically free of	Technically free of	-	-	-	-	-	-	-	-	-	-	-	-	-
Particles, dust, etc.	-	Free of	Technically free of		-	-	-	-	-	-	-	-	-	-	-	-	-
Hydrocarbon Dewpoint	°F	< 16 at the delivery pressure	14	-	< 14 at 5500 kPa absolute	< 14 at operating pressure	< 14 at operating pressure	< 14 at operating pressure	< 15 up to 800 psig	< 20 up to 600 psig	< 15	23 at normal opt. conditions	< 18 at operating pressure	< 14 at 5500 kPa	< 14 at opt. Pressure	< 16 at del. pres.	Not specified
Temperature	°F	< 129	<86	-	< 122	< 120	< 109	< 120	< 110	50-105	40-120	41-122	< 109	Not specified	< 122	< 129	< 122

Table 2. Gas Critical Parameters – Canadian Specifications

Selected References

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- 3. Canadian Urban Transit Research and Innovation Consortium (CUTRIC). 2022. "Renewable Natural Gas as a Complementary Solution to Decarbonizing Transit." <u>https://cutric-crituc.org/renewable-natural-gas-a-solution-to-decarbonizing-transit-fleets/</u>.
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- 5. Government of Quebec. 2022. "Renewable Natural Gas." Quebec.Ca. 2022. <u>https://www.quebec.ca/en/agriculture-environment-and-natural-resources/energy/energy-production-supply-distribution/bioenergy/renewable-natural-gas</u>.

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