



**BIOMETHANE MARKET
INTELLIGENCE REPORT
NORTH AMERICA AND EUROPE**

January 2022



CONNECTING THE BIOGAS INDUSTRY

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A WORD FROM THE BIOGASWORLD TEAM

Dear BiogasWorld members,

For many countries and industries, the year 2021 centered around recovery, developing forward-thinking strategies to assert themselves within the post-pandemic global economy. Many economies have made a 'green' recovery imperative within their economic stimulus packages and have positioned biogas and biomethane alongside hydrogen for green gas development. Indeed, the biomethane industry is uniquely positioned within international methane pledges and holds a vital role within the global waste management sector. Hundreds of new facilities have been commissioned during 2021 with many more entering their later stages of development.

The present document is our fifth edition of Biomethane Market Intelligence Report that became for our members a key reference and an influential part of their decision-making for their marketing and sales activities. We believe that the information included in this report plays an important role for our members' success in the biomethane market and we strive to increase its value to our clients.

What is new in this edition?

- New biomethane projects (more than 1 300 projects in total)
- Updated information on countries in North America and Europe
- Addition of Emerging Markets, this year highlighting the Australian market
- Updated analysis of US and Canadian biomethane (RNG) prices
- Updated lists of major industry stakeholders

In summary, this document and all BiogasWorld actions aim to help the industry connect and grow worldwide. We now have over 170 clients and partners in 30 countries. Join us and take advantage of this professional network or use our continually expanding services to reach your own business goals.

Sincerely,

Your BiogasWorld Team



REPORT INTRODUCTION

The present report provides recent information on the biomethane market. This document will be of value for companies that are planning to enter new markets, to expand in their local market or are interested in general information on the state of this industry. Additionally, the report contains the analysis of the competition in upgrading sector.



WHO WE ARE

BiogasWorld is a business generation network and online marketplace, connecting product and services suppliers with project developers. We accelerate the biogas and biomethane industry worldwide. We specialize in:

- Market knowledge to generate business leads efficiently
- Project support to find solutions
- Reliable network to find partners and build relations
- Market intelligence to support our clients' growth

The present report provides the information on biomethane market developments and major drivers and analyses the competition in this market.

The first two sections of the report focus on main geographical markets where the biomethane developments are the most active. Thus, the Section 1 concentrates on the North American market and includes the information on potential, drivers, major stakeholders and the applicable biomethane quality standards.

Section 2 concentrates mainly on the European market and presents information on biomethane development in nine European countries.

A new Section 3 for the report has been added highlighting emerging global markets, this year presenting a snapshot of the exciting growth opportunity within the Australian market.

Section 4 of the report presents the competition analysis of major upgrading players grouped by upgrading technology.

Appendices contain valuable data on biomethane facilities, industry stakeholders and biomethane pricing mechanisms in North America.

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 US and 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.

Table 1. Energy conversion

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

ABBREVIATIONS

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

SECTION 1.

BIOMETHANE IN CANADA AND THE USA

CANADA

CURRENT MARKET OVERVIEW

There are currently 15 operating facilities upgrading biogas to biomethane (which represents a 36% increase since 2020) and one pilot project producing biomethane from woody biomass (Alberta). British Columbia is leading the way with 7 plants, followed by Ontario and Quebec with 4 plants each.

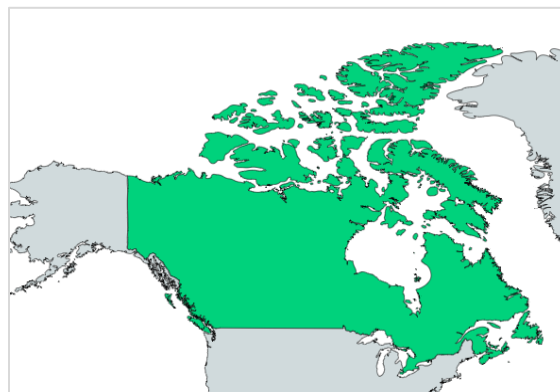
From feedstock perspective, all kinds of waste are utilized: agricultural (4 plants), SSO (3 plants), landfill (6 plants), commercial waste (1 plant), WWTP (1 plant) and biomass (1 plant).

The [CBA estimates](#) that only 27% of projects in Canada are upgrading

the biogas to RNG, however, this share is steadily increasing. As Feed-in-Tariff (FiT) programs for biogas end, new policies have emerged incentivizing upgrading and RNG production.

There are at least 24 plants under construction, 22 more in development (half of them are located in Quebec) and more than 50 in early development stage.

The list of Canadian biomethane facilities can be found in Appendix 1.



IN DEVELOPMENT

There are just under 50 plants in development or under construction, and several dozen more at an earlier stage of concept development. Given the recent success of 2nd generation RNG production (from woody biomass), combined with new government support, it is reasonable to predict that upwards of 30 facilities will become operational in the next 5-10 years.



MARKET SIZE

According to the CBA/Torchlight Bioresources, there is approximately 155 PJ of RNG that is realistically available in Canada. With a current output of 6 PJ, the sector has the opportunity to utilize up to 8x more energy.

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 51.3 PJ/year.



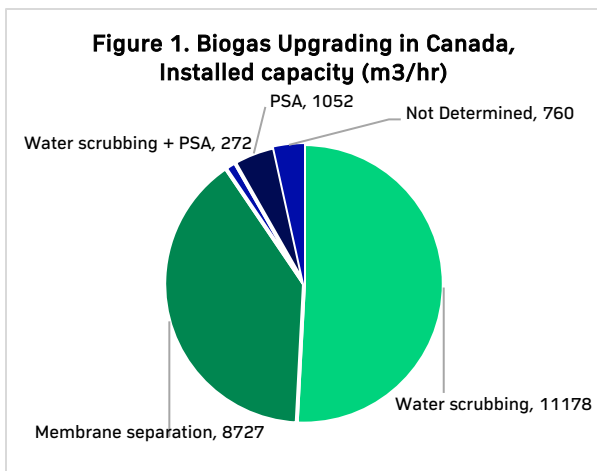
BIOMETHANE TARGETS

In 2020, Quebec government set the target of 5% RNG within the grid by 2025, and 10% RNG in grid by 2030.

BC targets 15% of renewable content in gas grid by 2030.

Ontario's main gas utility, Enbridge, is targeting a 5% blend of RNG within its network by 2025, and 10% by 2030.

Heritage Gas in Nova Scotia is aiming to supply 10% of natural gas demand with RNG by 2030.



UPGRADING SNAPSHOT

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

- Greenlane (water scrubbing) – 6 plants
 - one plant in collaboration with Sysadvance (PSA)
- Honeywell (membrane separation) – 1 plant
- Hitachi (membrane) – 1 plant
- Xebec (PSA) – 2 plants
- ARC Technologies (PSA) – 1 plant
- DMT (membrane) – 1 plant
- AB Energy (membrane) – 1 plant
- Pyro Green-Gas (formerly AirScience) (membrane) – 1 plant
- Information for one facility is not yet available

The most active companies in Canada on the marketing side are Greenlane, Xebec, Hitachi and DMT. New companies entering the market in 2021-2022 are Prodeval, Guild Associates, ETW Energie. Canadian companies Pyro Green-Gas (formerly AirScience) and Qarbonex as well participate in some projects under construction.

CANADIAN MARKET DRIVERS

FEDERAL

- [Bill C-12](#), The Canadian Net-Zero Emissions Accountability Act calls for government to establish GHG emissions targets and reduction plans for 2030, 2035, 2040 and 2045.
- On April 22, 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 50 per tonne in 2022, 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
 - March 2021 the Supreme Court of Canada upheld the law; opposed provinces have since begun developing or publishing their own carbon regulations
 - 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.
 - Official plans for achieving this goal omit radical change to agricultural emission sources, presenting significant opportunity for further emissions reductions
- In October 2021 the Federal government, along with 80 other countries, pledged to [reduce global methane emissions](#) by 30% of 2020 levels by 2030
 - Approximately 30% of total rogue methane emissions in Canada stem from the agricultural sector, presenting a significant [opportunity](#) for growth and development of the RNG sector
- Final regulations under [Clean Fuel Standard](#) for gaseous fuels are scheduled to be published by the end of 2021 and to come into force in December 2022:
 - Will apply to transportation, industrial and building fuels
 - Target of 20 million tonnes of annual reductions in GHG by 2030
 - Will allow producers of low-carbon fuels, which include biogas, RNG, and hydrogen, to generate credits three possible 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 non-transport purposes
 - Obligated parties will include natural gas producers, transmission companies, and utilities
- RNG is exempt from Federal Carbon Charge
- Due to high demand, the [Agricultural Clean Technology Program](#) (for provincial and territorial governments) was extended, continuing to accept applications for funding activities starting as of April 2022
- 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 [Green Municipal Fund](#) (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

FEDERAL (CONTINUED)

- 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 [Sustainable Development Technology Canada](#) (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 federal-provincial-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
- The demonstrated success of woody biomass pilot projects which utilize residual wood waste, have led to an increase in similar projects in British Columbia and Ontario, led by G4 Insights and CHAR Technologies

ALBERTA

- [Climate Leadership Plan](#)
- [Food waste ban](#) (70% for single-family homes, 75% for IC&I sector) in Calgary since 2019
- 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
- At the beginning of November 2021, the Government of Alberta released its [Hydrogen Roadmap](#), outlining a policy framework for developing clean hydrogen and competing in the multi-billion dollar global hydrogen market.

BRITISH COLUMBIA

- Update to the Clean BC Plan (2018): [Roadmap 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
 - 95% organics diversion (municipal, industrial and agricultural)
 - New supports for hydrogen-based innovation, the forest-based bioeconomy, and negative emissions technologies
- Excess revenue from BC Carbon Tax is directed to the CleanBC Industry Fund
- 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, rather than families/business for violations
- FortisBC target 30BY30 aims to reduce GHG by 30% by 2030
 - Voluntary RNG (biomethane) program by FortiBC
 - 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
- [Renewable and Low Carbon Fuel Requirements Regulation](#)
 - Minimal renewable fuel content of 5% for gasoline and 4% for diesel
- [Innovative Clean Energy \(ICE\) Fund](#)
 - Supports the research, development, and implementation of sustainable energy technologies

ONTARIO

- Voluntary RNG Program in Ontario began in April of 2021. No official numbers relating to the program have yet been released
- [Made in Ontario Environment Plan](#) – continued development. Initiatives include:
 - Standards and accountability for industrial emitters
 - Reserve auction to 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](#)
- [Waste-free Ontario Strategy](#), Action Plan for the development of the circular economy
- [Regulation Cleaner Transportation Fuels: Renewable Content in Gasoline and Diesel Fuels](#) (November 2020)
 - Renewable content in gasoline to increase from 10 to 15% by 2030 (11% by 2025, 13% by 2028 and 15% by 2030)
- The Northern Business Opportunity Program can fund up to 50% of a program (to a maximum of \$1 million CAD). Excludes electricity generation projects, however, projects for heating or vehicle fuel will be revisited on case-by-case basis
- 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
- [SNAPP Sustainable New Agri-Food Products & Productivity Program](#)
 - Regional program

QUEBEC

- [Quebec’s 2030 Plan for a Green Economy](#)
 - Commitment to reduce GHG emissions by 37.5% by 2030
 - Requires 10% RNG share in natural gas network and 50% increase in bioenergy production by 2030
 - Allocated CAD 213 million for RNG sector
 - At the beginning of 2021, the government of Quebec announced the allocation of funds to support the development of green hydrogen, aiming to become a recognized global leader in green hydrogen
 - As of September 30, 2021, hydrogen was officially [redesignated](#) a renewable energy source, from its previous label as a hazardous material, qualifying hydrogen projects for RNG and other renewable subsidies
- The Renewable Natural Gas Production Support Program (PSPGMR) received changes in the fall of 2021, funded in part by the 2030 Plan for a Green Economy, the changes include:
 - Supports for the financing of feasibility studies, subsidizing up to 75% of costs, to a maximum of \$300,000/project
 - The ceiling of available financial assistance increased from \$8 million CAD to \$12 million CAD
 - New eligibility for RNG production technologies
 - Possibility for applicants to submit a preliminary draft in order to verify their eligibility for the PSPGMR
 - Continuous evaluation of submitted projects
- [Organic matter recovery strategy-](#) 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

QUEBEC (CONTINUED)

- Provincial Biomethane Regulation set the minimum quantity of biomethane 1 % in 2020 and 5% in 2025 of the total quantity of natural gas distributed (286 000 000 m³/biomethane per year)
- [Funding of PTMOBC:](#)
 - Up to 73.3% of CAPEX
 - Deadline for applications has been extended until March 2022
 - Private biogas projects will have access to the same number of subsidies as municipal project
- Biomethane price of up to CAD 22/GJ for a 20-year contract offered by Quebec gas utility Energir
- In December 2021 Energir issued a call for proposals for RNG projects to achieve the province's goal of 280 million m³ by 2025. Projects can be located in Quebec, Canada, or the US, and should be operational in January 2023
- Cap-and-Trade Program
- Organics ban for all municipalities by 2022
- [TEQ program:](#) 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

NOVA SCOTIA

- Organics ban in place since 1997, but only 50% of organics are diverted
- Cap and Trade Nova Scotia in effect since 2019
- 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

MANITOBA

- Revenues of the Federal Carbon Tax directed toward technology innovation and other GHG mitigation projects
- Established the *Made-in-Manitoba and Green Plan* in 2018, which included proposals for carbon pricing and reductions in carbon emissions
 - Included a new agency, Efficiency Manitoba, which implemented an initiative to reduce the annual provincial consumption of natural gas by 0.75%
 - The *Strategic Plan* published in March of 2021 by the public utilities board does not specifically mention carbon transition

CANADA: GAS UTILITIES AND BIOMETHANE 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.

CANADIAN GAS UTILITIES ACTIVE IN RNG INDUSTRY

ENBRIDGE

- Province: Ontario
- RNG is highlighted as a key strategy for reducing Enbridge's GHG emissions
- Enbridge currently has over 60 projects in advanced stages and early development within its distribution range, with 8 more planned outside of its range
- RNG Enabling Program
 - On April 6, 2021, Enbridge launched its *Voluntary RNG Program*, customers gained the ability to 'opt-in' for \$2/month on their bills. Official numbers for the program will not be released until the end of Q1 2022.
 - During first three years Enbridge expects 25,000 customers and 35,000 GJ of RNG
 - Revenues generated from the program are directed towards the development of RNG projects within the province
- Direct link to Program page: [Enbridge](#)

ENERGIR

- Province: Quebec
- The [new request for proposals](#) (November 18, 2021) sets targets for 2023, aiming to distribute nearly 50 mln m³ of RNG. By 2025, the amount of biomethane is targeted to increase to 280 mln m³
 - After 2023, two new RFPs will be released for meeting 2025 target
 - Can be located in Quebec, or anywhere in North America
 - Focus on the commitment for first deliveries on, or before, October 2023
 - RNG feedstock must be organic materials (farming, landfills, municipalities, industrials, others)
- Quality requirements are regulated by BNQ Standard 3672-100 – Biomethane – Quality Specifications for Injection into Natural Gas Distribution and Transmission Systems.

FORTIS BC

- Province: British Columbia
- RNG Program offered since 2011
- Voluntary product offering for residential customers, since its inception it has grown to serve over 10,000 customers
- 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
- 2nd generation RNG Reference projects:
 - Fruitvale- REN Energy International Corporation is currently constructing a first-of-its-kind facility converting wood waste to RNG
- Direct Link to Program: [FortisBC](#)

BULLFROG POWER

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

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.

Table 2. Gas critical parameters – Canadian specifications

Utility or Pipeline	Heating Value, Btu/scf	Carbon Dioxide, CO ₂ % vol	Oxygen, O ₂ % vol	Nitrogen, N ₂ % vol	Total Inerts % vol
FortisBC	> 966	< 2	< 0.4	-	< 4
Enbridge	966.2-1108.5	2	0.4	-	4
Energir	≥ 966	≤ 2	≤ 0.4	-	-
TCPL Canadian Mainline	966-1109	< 2	< 0.4	-	-
ATCO Pipelines	> 980	2	0.4	MAX. 1.6	4
TCPL Foothills (BC) Zone 8	> 966	< 2	< 0.4	-	-
TCPL Foothills (Sask.) Zone 9	> 966	< 2	< 0.4	-	-
TCPL GTN	> 995	< 2	< 0.4	-	-
TCPL North Baja	990-1150	< 2	< 0.2	< 3 incl. CO ₂ , N ₂ , He, O ₂	-
TCPL ANR	967-1200	< 2	< 1	< 3	-
Alliance Canada	966-1610	< 2	< 0.4	< 4 incl. CO ₂ , N ₂ , O ₂	-
Union	966-1079	< 2	< 0.4	-	-
Enbridge (Tecumseh Pipeline)	966-1079	< 2	< 0.4	-	-
TransGas	>939	< 2	< 0.4	0.0015 each (nitric oxide & total oxides of nitrogen)	-
West Coast	>966	< 2	< 0.4	-	-
TQM	>966	< 2	< 0.4	-	-

If you would like additional information on specifications, please contact us at natalia@biogasworld.com.

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 [OIES](#) 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.

Recent studies from [FluxLab](#) 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 [Rambøll](#), which found methane slippage to be particularly high at biogas production and upgrading facilities.

USA

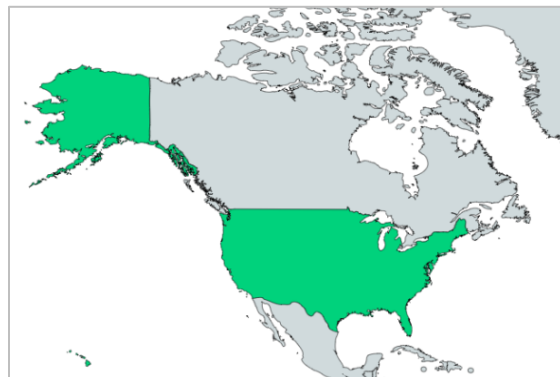
CURRENT MARKET OVERVIEW

There are 163 operating biomethane facilities¹ in the US with the majority of facilities injecting the upgraded biomethane into the gas grid with the purpose of being used as vehicle fuel. The overall increase of operating facilities is 23% as compared with 2020 statistics.

The biggest growth in 2021 occurred in agricultural sector, where the number of operational plants increased by 50%, to 53, as compared to the end of 2020. The majority of RNG facilities are still landfills (72 plants), followed by the agricultural sector (53 plants). The states with the most biomethane production are

Wisconsin, Texas, Pennsylvania, Ohio and California. According to BiogasWorld's database, there is currently 101 RNG facilities under construction and another hundred at various stages of development, scheduled to be online within the next 2-3 years.

Per Energy Vision, the most of US RNG generated since 2015 have gone to the on-road heavy-duty transportation market for the generation of RINs. At the end of November 2021, the EPA reported nearly 1.7 billion RINs were generated for the RFS in October, up from 1.56 billion last year. Of the total, nearly 45.7 million D3 cellulosic biofuels were domestically generated in October (about 386.13 million D3 RINs were produced in the first 10 months of 2021).



IN DEVELOPMENT

There are over 100 RNG facilities under construction, 100 at substantial development or planning stage with majority planning to inject the biomethane into the grid to use as vehicle fuel.

It is estimated that just in California, there will be approximately 80 NGV fuelling stations and close to 4 billion ft³ of gas within its territory within the next 15 years. Estimates further project the Pacific region to produce between 193-371 billion ft³ or RNG per year (representing 66-126% of SoCalGas' projected 2035 consumption).



OPPORTUNITIES

Per [AGA](#), there are activities in 34 US states to promote the use of RNG (legislations, regulations or utility-led activities).

Short term RNG opportunities have shifted from primarily dairy biogas projects in 2019-2020 to both dairy and swine biogas projects in 2020-2021. While the RIN price is slowly recovering from its decline in 2019, the industry's shift to dairy and swine projects continues. For more details, see Appendix 3.



RNG POTENTIAL

The [American Gas Foundation](#) estimates that the total US potential of RNG could displace 100% of the current NG used in transportation.

The National Renewable Energy Laboratory estimates that RNG has the potential to scale up to 1.15 ft³ per day, equivalent to 1.25% of the US NG supply.

NREL estimates that biomethane potential is 516.5 PJ (Only 5% was used in 2018). There are potentially 475 landfills and 250+ agricultural biomethane projects.

Over 503 million gallons of RNG was produced during 2020 for transportation purposes, nearly one hundred million more than the previous year.

¹ It is important to note that operating units in clusters are not counted separately; cluster is considered as one project.

Out of 163 operating RNG projects, the information on used upgrading technology is available for 149 units. The results are presented in the Figures below. Figure 2 presents the available information based on the number of installations, whereas Figure 3 presents the data based on the installed capacity.

Note that the category "Other" includes the information combined for two plants: one using the mix of water scrubbing and PSA, another one, membrane and PSA. For more details, please see Appendix 2.

Figure 2. Operational RNG upgrading plants in the US, number of plants

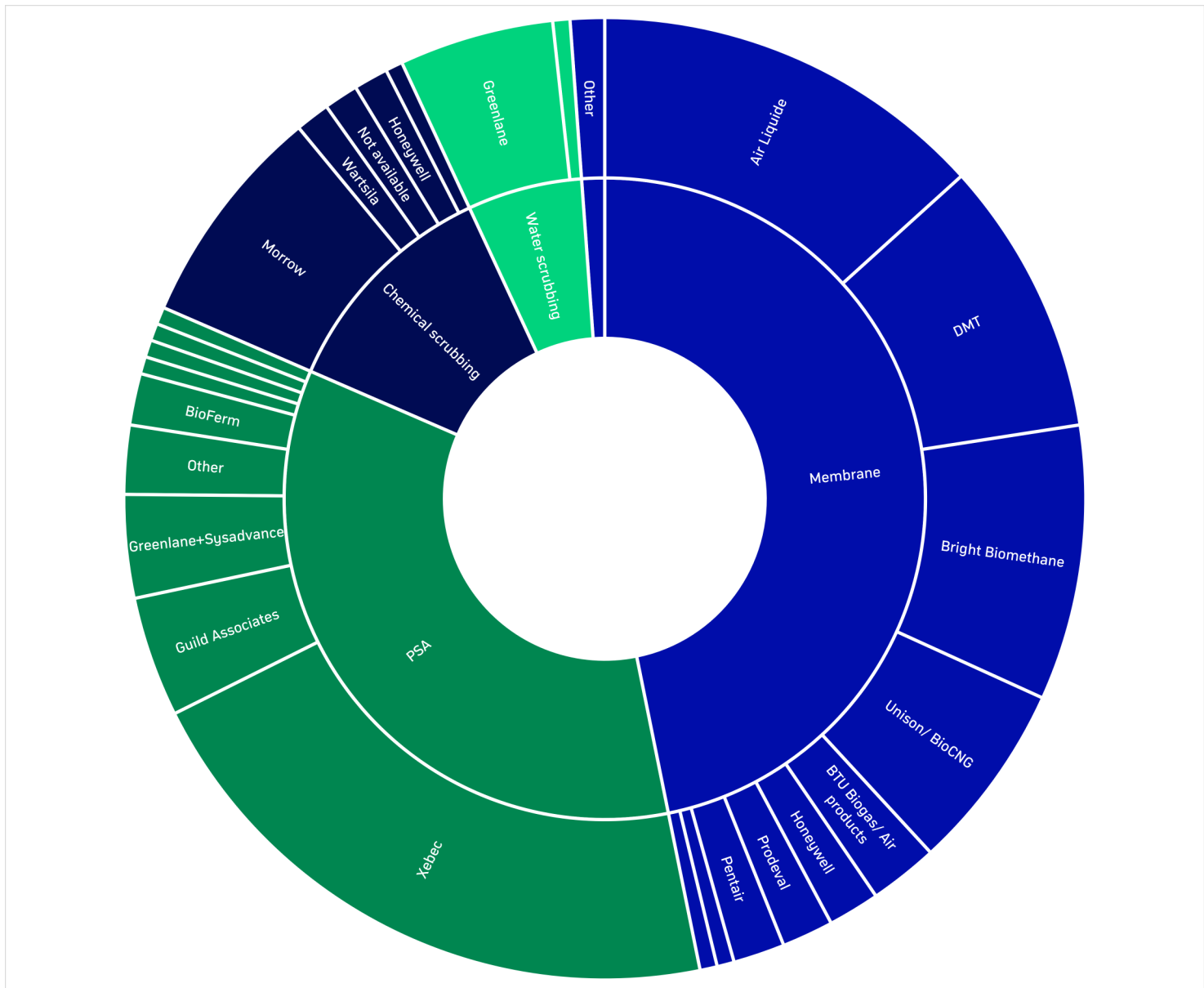
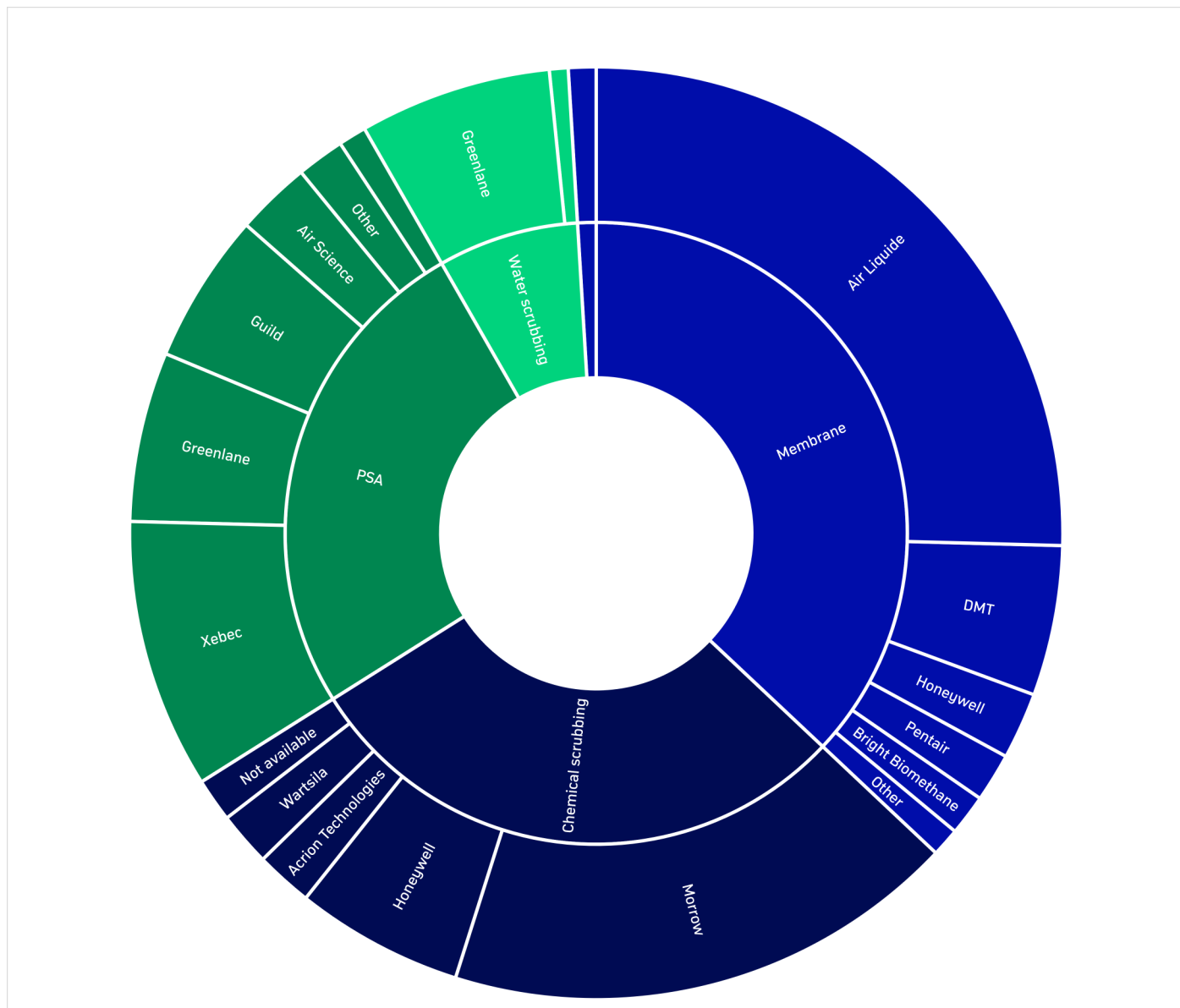


Figure 3. Operational RNG upgrading plants in the US, capacity, m3/hr



US MARKET DRIVERS

FEDERAL AND MULTI-STATE

- [Renewable Fuel Standard \(RFS\)](#) requires minimum volume of renewable fuel in transportation fuel (36 bln gallons of renewable fuel by 2022).
 - EPA tracks compliance through the Renewable Identification Number (RIN) system. Biogas is now qualified as valuable cellulosic RINs (D3 or D5).
 - Analysis of RIN pricing is available in Appendix 3.
 - The current US administration has announced an update of Standards post-2022 will be released before the end of 2021.
- [Renewable Portfolio Standard \(RPS\)](#) requires retail electricity suppliers to generate/procure a min % of electricity from eligible renewable energy sources. 62% of States currently have renewable standards in place, and another 14% have renewable goals.
- The [Build Back Better \(BBB\) Act](#) was approved by the House and is currently being revised by the Senate. The Bill includes a number of biogas-related tax incentives:
 - ITC for non-electricity biogas
 - Extension of the biogas-electricity production tax credit (PTC)
 - Extension of the biogas-electricity ITC
 - Alternative Fuel Excise Tax Credit
 - Extension of the Alternative Fuel Vehicle Refueling Property Credit
 - ITC for Energy Storage Technology
 - Extension of the Combined Heat and Power ITC
 - Extension of the Fuel Cell ITC
- [Regional Greenhouse Gas Initiative \(RGGI\)](#) to cap and reduce CO₂ emissions from the power sector. This initiative allows the avoided methane emissions to generate offsets that can be sold for compliance. This initiative is applicable for Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont. The initiative provides funding to energy projects which reduce the regions dependence on fossil fuels
- [Landfill Methane Outreach Program \(LMOP\)](#): voluntary program encouraging the recovery and beneficial use of MSW biogas
- In November 2021, the *U.S. Methane Emissions Reduction Action Plan* was released, outlining targets for reducing methane emissions within the US. The plan includes:
 - A federally enforceable 'backstop' limit on landfill emissions, aiming to reduce landfill methane by 70%
 - Several new programs to address agricultural emissions including sequestration, improving markets for low-carbon products, and capturing agricultural methane emissions for the purpose of renewable energy
- [HR 5899](#): the *Biomass and Biogas for Electric Vehicles Act* (Nov. 2021), allows biomass facilities which generate electricity to participate in and generate credits for the federal RFS program- former requirements demanded 100% traceability for transportation fuels, while the changes allow for the extrapolation of total electricity in the grid used to charge vehicles
- The [Growing Renewable Energy and Efficiency Now \(GREEN\) Act](#) was introduced to the House in February 2021. If passed, it will allow certain types of renewable sources (including biomass and municipal waste) to be claimed as energy property for the purpose of claiming energy tax credits. The Bill also includes the extension of a number of tax credits not encompassed within the BBB, and further expands tax credits which benefit the development of energy storage technologies.

FEDERAL (CONTINUED)

- The [Alternative Fuel Tax Credit \(AFTC\)](#) was enacted in December of 2020 and extends through 2021
- Rural Energy for America Program (REAP) (OneRD Guarantee Loan Initiative)
 - \$304 million USD has been designated for anaerobic digesters and other underutilized renewable energy technologies

CALIFORNIA

- State renewable energy goal: 50% by 2026, 60% by 2030, 100% by 2045
- [SB1383](#): California target of organic waste reduction - 75% by 2025
- [Low Carbon Fuel Standard \(LCFS\)](#): 20% reduction in transportation fuel carbon intensity by 2030
- [Short-lived Climate Pollutants \(SLCP\) strategy](#): Aims to reduce GHG emissions across California from compounds such as black carbon (soot), methane (CH₄), and fluorinated gases (e.g., hydrofluorocarbons or HFCs).
- AB1826: Organic Waste Ban: commercial generators (should either compost or digest anaerobically):
 - [Short Lived Climate Pollutants organic waste and food collection regulation](#): becomes enforceable January 1, 2022
- [Cap-and-trade program](#): extended until 2030, with changes being presented late 2022 for ratcheting-up of regulations
- [SB1352](#): Mandatory RPS for gas utilities
 - Requires utilities to establish a biomethane procurement program and supply 5% of total volume in RNG by 2022 and 20% of total volume by 2030
- AB2313: [Biomethane Interconnector Monetary Incentive Program](#) covering up to 50% of the interconnection costs with a cap of USD 3 million per project.
 - Program is available until December 31, 2026, or until program has exhausted USD 40 million cap.
 - It is funded by California utility customers and administered by Southern California Gas Company.
- AB118: [Alternative and Renewable Fuel and Vehicle Technology Program](#) – annual budget of USD 100 million to support applicable projects- project is extended through to 2024
- Construction grants by CDFA, [California Department of Food and Agriculture](#) (nearly USD 200 mln in last 5 years), includes research and demonstration projects
- AB3163: adds noncombustion thermal conversion of organic wastes as method to generate biomethane as of 2022
- October of 2021, a number of new “Green” bills were passed into law aimed at reducing waste and improving recycling efforts, the laws include:
 - AB 1201: Truth in labeling for compostables. More stringent regulations have been put in place for products to label their packaging as ‘compostable’
 - AB 881: Exporting Waste. Limits the ability for companies to export recyclable materials to states where they would otherwise go unrecycled

COLORADO

- Sales tax exemption for anaerobic digestion equipment ([HB14-1159](#))
- [SB 21-161](#): establishes rules for utility voluntary reduction programs and establishes 2019s GHG emissions as the baseline: targets 5% of RNG by 2025, 10% by 2030 and 15% in 2035. RNG must also account for at least 35% of a utility’s emissions reduction
- [SB 21-264](#): gas utilities must file a clean heat plan with the Public Utility Commission, targeting 4% reduction below 2015 GHG levels by 2025 and 22% by 2030. RNG may only account for 1% of the 2025 target and 5% of the 2030 target

CONNECTICUT

- Connecticut [Dept. of Energy and Environmental Protection \(DEEP\)](#) targeting 100% zero-carbon energy by 2040
- Organic waste ban: commercial and industrial sector food waste limited to 52 tons/year

CONNECTICUT (CONTINUED)	<ul style="list-style-type: none"> • HB 5250: introduced in 2020 aims to increase the use of RNG, reintroduced February 2021 as CT HB 6409 • CT SB 60: introduced January 2021, streamlines the permitting and siting processes of anaerobic digesters • Adopted interconnection standards for biogas derived from organic materials in June of 2021
FLORIDA	<ul style="list-style-type: none"> • SB 896: In April 2021, biogas and renewable natural gas were added to the existing definitions of renewable energies under state law. Additionally, cost recovery measures for utilities were put in place to levelized the cost between RNG and NG within a 'reasonable and prudent' range
HAWAII	<ul style="list-style-type: none"> • HB 1242: gas RPS is required according to renewable portfolio requirements of 25% of sales by 2025, 40% of sales by 2030, 70% by 2040 and 100% by 2050 • HB 1242 reintroduced in January of 2021 as SB 289
ILLINOIS	<ul style="list-style-type: none"> • HB 3115: introduced February 2021, and would allow NG utilities to seek authorization from ICC for RNG infrastructure investments and supply contracts, and would allow consumers to purchase RNG directly from their utilities • HB 3315 also includes portfolio goals of 2% RNG supply by 2030 and at least 3% by 2035 for utilities
IOWA	<ul style="list-style-type: none"> • HF 522: enacted May of 2021, alters regulations to allow manure to be stored and processed via anaerobic digestion for the production of biogas as an alternative to current requirements
MASSACHUSETTS	<ul style="list-style-type: none"> • Renewable Portfolio Standard requires 35% of energy by 2030 to be sourced from renewables • Organic waste ban: any waste generator producing more than 1 ton a week, unlike other bans, there are no exceptions based on proximity to processing facilities • February 2021, H 3887 was filed to study the opportunities RNG provided for a source of low emissions heating. June 2021 State legislature referred it to the Joint Committee on Telecommunications, Utilities and Energy
MICHIGAN	<ul style="list-style-type: none"> • State renewable energy standard voluntary goal: 15% by 2021, 35% by 2025 • HB 6036: introduced in 2020, aims to extend PACE financing program to include anaerobic digestion • SB 138: introduced February of 2021, would require the PSC to develop and keep updated an inventory of biogas and RNG resources available in the state
MINNESOTA	<ul style="list-style-type: none"> • HF 239 / SF 421 (reintroduced as HF 6 and passed in June of 2021) allows gas utilities to propose innovative resource plans, defined to include biogas, RNG, and power-to-hydrogen. Up to 7.5% of revenue requirements can be invested for RNG and it may also apply for an additional green tariff.
MISSOURI	<ul style="list-style-type: none"> • HB 734: passed in May 2021, requires utilities to develop and implement a voluntary RNG program for customers
NEVADA	<ul style="list-style-type: none"> • SB 154: requirement for Public Utilities Commission of Nevada to adopt regulations authorizing LDCs to engage in RNG activities, with a target of 1% of biomethane of total amount of gas sold by 2025, 2% by 2030 and 3% by 2035
NEW HAMPSHIRE	<ul style="list-style-type: none"> • SB 577: allows biologically derived thermal energy to generate credits under the states RPS carve-out
NEW JERSEY	<ul style="list-style-type: none"> • A3726: classifies landfills with gas capture technology as recycling facilities, and classifies methane captured from landfills, biomass, or anaerobic/aerobic facilities as a "Class 1 renewable energy" • NJ S3526/ A5655: introduced March of 2021 and if signed would encourage the procurement and investment of RNG by gas utilities. It sets portfolio targets at 5% by 2024, increasing by 5% every five years to 30% by 2050.

NEW YORK

- [Clean Energy Standard 2.0](#) approved in October 2020
- In February 2019, legislation has been introduced that will require New York State to adopt a Low Carbon Fuel Standard aiming at reducing the overall carbon intensity of State's transportation fuel supply 20% by 2030. This bill has been stalled in environmental committees since March 2020
- [Food scraps recycling requirement](#) passed in April 2019, it will take effect on January 1, 2022, requiring designated generators to donate surplus food and to divert the remaining for organics processing.
- Currently, NY [Climate Leadership and Community Protection Act](#) excludes biogas and RNG from renewable energy due to the current differentials in potential supply and desired demand

NORTH CAROLINA

- Renewable Energy Portfolio Standard includes a specific requirement for a portion of renewable energy from swine and poultry farming wastes
- [SB 605](#): Passed in June of 2021 streamlines permitting processes for turning hog waste into RNG, and creates 'general permits' for livestock farm owners to construct and operate manure digesters

OKLAHOMA

- [HB 1815](#): requires the OCC to issue a report, including recommendations, to the legislature on the ability of utilities to offer RNG to customers by December 1, 2021. The report must include associated costs of transport infrastructure

OREGON

- State renewable portfolio standard outlines that by 2025 at least 8% of aggregate electrical capacity must be derived from small-scale community renewable energy projects at a capacity of 20MW or less
- Clean Fuels Program (CFP, 2016): 10% reduction in transportation fuel carbon intensity in 10 years.
- SB 98: legislates RNG targets of 15% by 2030, 20% by 2035, and 30% by 2050
- SB 314: allows gas utilities to recover some of the costs of establishing infrastructure which supports alternative fuels for transportation vehicles
- Any business that "cooks, assembles, processes, serves, or sells food" must source-separate its food waste and send it to an authorized facility for processing

PENNSYLVANIA

- [Alternative and Clean Energy Program](#)

RHODE ISLAND

- State renewable energy standard voluntary goal: 38.5% in 2035
- [Organic waste ban](#): industrial, commercial, and institutional sectors

VERMONT

- State renewable energy standard voluntary goal: 75% by 2032
- Organic waste ban: all generators of organic waste, including residents
- Voluntary RNG program by Vermont Gas
- [Standard Offer RFP](#)

VIRGINIA

- [HB 461](#): introduced in 2020 aims to establish the tax credit for renewable energy property

WASHINGTON

- Low Carbon Fuel Standard (2021) aims to reduce GHG emissions from transportation fuels 10% below 2017 levels by 2028 and 20% by 2035
- [HB 1070](#): introduced in 2020 aims to provide tax exemption for sales of RNG when used as transport fuel

WISCONSIN

- Focus on Energy: utilities program for renewable energy
- [Renewable Energy Competitive Incentive Program \(RECIP\)](#)
- [Energy Innovation Grant Program](#): the 2021 EIGP round is due January 14, 2022

USA: GAS UTILITIES AND BIOMETHANE QUALITY SPECIFICATIONS

The gas utilities with RNG (biomethane) programs are presented in this section of the report.

CHESAPEAKE UTILITIES CORPORATION

- State: Delaware
- Interstate RNG gas quality tariff has been approved
- In 2020, announced the partnership with Bioenergy DevCo and CleanBay Renewables to develop anaerobic digestion facilities and distribute RNG to its customers

CENTERPOINT ENERGY

- States: Arkansas, Louisiana, Minnesota, Mississippi, Oklahoma, and Texas
- The RNG Program ([RNG Interconnection Tariff](#)) has been approved in January 2021 with slight [alterations](#) by Minnesota Public Utilities Commission
- May of 2021 Centerpoint filed a petition to establish a carbon intensity framework for RNG and a threshold carbon intensity requirement for RNG interconnection producers
- Gas specification is based on CA Rules 21 and 30, but has the right to make amendments to the requirements

CON EDISON

- State: New York
- In fall 2018, Con Edison announced it is planning the construction of up to three renewable gas facilities that would turn food waste, sludge, yard and other waste into natural gas. These projects would reduce the need for conventional natural gas by up to 7,100 dekatherms on a peak winter day.
 - These projects have not yet started, and are pending PSC approval for cost recovery
- In January 2020, it is approved to purchase RNG and was granted a recovery benefit for RNG interconnection costs

DOMINION ENERGY CAROLINA GAS

- State: North Carolina & South Carolina
- Partnered with Smithfield Foods to create Align Renewable Natural Gas to convert biogas to RNG. The joint venture to operation in North Carolina, Virginia, Utah, Arizona and California.
- Requested approval to offer consumers a voluntary green gas program in April of 2021, making available one or more half-decatherm blocks or RNG attributes

DTE ENERGY

- State: Michigan
- Direct link to the Program: [BioGreenGas Program](#)
- Main program objective is to capture landfill biogas and turn it into RNG
- Voluntary program approved October of 2021: allows customer the ability to offset up to 100% of their emissions
- January 2021 the Clean Vision Natural Gas Balance program went into effect, allowing consumers to mix up to 95% offsets and 5% RNG for an additional monthly fee

DUKE ENERGY

(and its subsidiary Piedmont Natural Gas)

- State: North Carolina
- Announced farm-based RNG project to be operational in 2021
- The project to use pipeline network to supply RNG to local customers, as blocks offered in \$3 increments
- Gas quality standard and alternative gas requirement tariff was approved for a 3 year pilot program in 2018. In 2021 the program was extended for an additional 3 years.
- Swine manure and wastewater approved as acceptable feedstocks and no longer fall under the pilot program

HAWAII GAS

- State: Hawaii
- Issued RFP to receive proposals for RNG supply in 2018
 - 4 'best and final' offers are currently being reviewed and awards are pending announcements

INTERMOUNTAIN GAS

LIBERTY UTILITIES

- State: Idaho
- Provides RNG transportation only
- State: Georgia, Illinois, Iowa, Kansas, Massachusetts, Missouri, New Hampshire
- Currently filing a petition for the New Hampshire PUC to approve an RNG supply and transportation contract. Liberty currently has commitments to sell 65% of the RNG and is exploring a voluntary tariff.

NATIONAL GRID

- State: New York, Rhode Island and Massachusetts
- In April 2019, National Grid proposed a [Green Gas Tariff](#) to enable voluntary purchase of RNG for its downstate customers: includes 4 tiers to select amounts of RNG.
- Partnered with the NYC Dept. of Environmental Protection for the [Newton Creek Renewable Gas Demonstration Project](#), turning biogas from its WWTP to RNG

NICOR GAS

- State: Illinois
- In July of 2021, its RNG interconnection pilot project was approved, and USD 20M in capital was invested for RNG and its interconnection within its jurisdiction, up to USD 4M/project
- January 2021 Nicor began seeking approval for its *TotalGreen* pilot project to offset consumption with 5-20% RNG

NORTHEAST GAS ASSOCIATION

- NGA represents natural gas distribution companies, transmission companies, liquefied natural gas importers, and associate member companies. These companies provide natural gas to over 12 million customers in nine states (Connecticut, Maine, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island and Vermont)
- [Interconnect Guide](#) issued in August 2019

NW NATURAL

- State: Oregon
 - Smart Energy program allows businesses and residents to pay an additional tariff which contributes to the development of biogas projects
 - Announced partnership with BioCarbN to convert methane produced at Tyson Foods facilities into RNG, investing in several projects
 - Issued RFP July 2021, seeking RNG resources, environmental attributes of various feedstocks, and/or resources on renewable hydrogen
 - Signed agreements with various RNG producers to purchase approximately 2% of Oregon's annual sales in RNG
-

ONE GAS

- In April of 2021 ONE Gas announced its partnership with Vanguard Renewables, developing and expanding farm-based RNG projects across Kansas, Oklahoma, and Texas
- Currently exploring offtake options for RNG for large industrial and commercial emitters

PACIFIC GAS AND ELECTRIC COMPANY - PG&E

- State: California
- PG&G bioenergy portfolio includes biomass, digester gas, landfill gas, and municipal solid waste projects.
- Additionally, the utility promotes the use of dairy biomethane
- Direct link to the program: [PG&E](#)
- PG&E's gas quality requirements are specified in its tariff [Gas Rule 21](#) and are summarized in the document
- PG&E filed for bankruptcy early in 2019, however, following filing under Chapter 11, they have restructured and continue operations
- Partnered with SoCal Gas in June of 2020 to further advance new electrochemical technology that converts carbon dioxide content in raw biogas to pipeline quality RNG

PUGET SOUND ENERGY

- State: Washington
- RNG tariff revisions are in their final stages, and will take effect before the end of 2021
- Contract with Klickitat PUD to procure RNG (announced in 2020) (potentially up to 2.5 million dekatherms)

SOCALGAS

- State: California
- Direct link to the program: [SoCalGas Renewable Gas Program](#)
- [Biomethane Monetary Incentive Program](#) assists with Biomethane Interconnectors, and is available until either the end of 2026, or its 40 million USD is exhausted
- SoCalGas gas quality requirements are specified in its tariff [Rule 30](#)
- In December of 2020, SoCalGas got the approval to offer RNG to residential customers

SOUTH JERSEY INDUSTRIES

- February 2021 SJI acquired a minority interest in REV LNG, LLC, and began looking to expand its portfolio of anaerobic digesters/RNG upgrading at a number of dairy farms
- May 2021, SJI announced plans to spend 280 million USD over five years on up to 25 dairy RNG facilities. 8 are expected to be online by 2022.

SOUTHWEST GAS CORP

- State: Arizona, Nevada
- Offers RNG services, including biogas collection and upgrading, RNG interconnection and transport
- In Nevada, the utility entered into partnership with the City of Las Vegas WWTP to procure biogas and offer RNG to customers
- May 2021 it began the process of developing new RNG facilities and ensuring existing ones become connected to the grid

SUMMIT UTILITIES

- State: Maine
 - New tariff has been approved to establish a voluntary RNG Program for customers that will be able to choose RNG annual usage
-

SAN DIEGO GAS & ELECTRIC COMPANY

- In January 2018, SDG&E has issued a draft solicitation for dairy biomethane pilot projects, jointly with SoCalGas, PG&E and SouthWest Gas
- Submitted its application to offer a voluntary RNG program alongside SoCalGas, anticipated to start by the end of 2021
- Biomethane quality requirements have been included into the utility Tariff ([Rule 30 - Transportation of Customer-Owned Gas](#))

TECO PEOPLES GAS

- State: Florida
- [RNG program](#) began in 2018 and is offered to RNG producers and offers biogas gathering, cleaning and conditioning, RNG transportation and interconnection
- Will begin developing, building, owning, and operating its own RNG facility in partnership with Alliance Dairies

UGI

- State: Ohio, Kentucky, & Pennsylvania
- August of 2021, UGI announced a commercial food waste digester near Cincinnati, expected to be operational early in 2023, which will produce approximately 250,000 MMBTUs of RNG each year

VERMONT GAS

- State: Vermont
- [VGS Renewable Natural Gas Program](#)
- Voluntary customer participation through agreement with ability to choose % of RNG in their natural gas supply (10%, 25%, 50% or 100%)
- Vermont Gas and NG Advantage rolled out new initiative to deliver RNG to business and institutional customers (pipeline and virtual pipeline)
- Direct link to RNG Manual page: [VGS RNG Manual](#)

XCEL

- State: Colorado
 - Issued an RFI in May 2020 to initiate the work on the program to deliver RNG across several states.
 - In Colorado, Xcel is exploring a voluntary RNG offering
-

BIOMETHANE SPECIFICATIONS

As in Canada, biomethane quality standards are not federally regulated. In majority of cases, each biomethane project negotiates the acceptance standards with gas utility on a project-by-project basis.

Overall, the lack of standardization is considered as one of the concerns for biomethane industry developments and several standards have been proposed over the past years.

Critical parameters of biomethane quality in US specifications are summarized in the table below. Please note that the table contains the specifications of utilities that have standards adopted for biomethane, as well as general specifications of TransCanada and other US pipelines for reference.

Table 3. Gas critical parameters – US specifications*

Utility or pipeline	Heating Value, Btu/scf	Carbon Dioxide, CO ₂ , % vol	Oxygen, O ₂ , % vol	Nitrogen, N ₂ , % vol	Total Inerts % vol
Vermont Gas	>805	≤ 2	≤ 1.6	-	-
PG&E	Project-by-project	≤ 1	≤ 0.1	-	-
SoCalGas	990-1150 on a dry basis	≤ 3%	≤ 0.2%	-	≤ 4% (incl CO ₂ , N ₂ , O ₂ , inerts)
SDGE	990-1150(gross) on a dry basis	3	0.2%	-	≤ 4% (incl CO ₂ , N ₂ , O ₂ , inerts)
DTE Energy	950-1100	≤ 2	≤ 0.0005	-	-
National Grid	-	≤ 2	≤ 0.2	-	-
NWNatural	985-1115	2	0.2	< 2.75	2.7
Northeast Gas Association	970-1110	2	0.1-0.4	2	-
Alliance USA	>962	< 2	< 0.4	2	-
Empire	950-1200	< 2	< 1	-	-
GLGT	967-1069	< 2	< 1	< 3	-
Iroquois	967-1110	< 2	< 0.2	< 2.75% N ₂ + O ₂ 4% N ₂ + CO ₂	-
Northern Border	>967	< 2	< 0.4	-	-
NWP	>985	< 2	< 0.2	< 3 incl. O ₂ , CO ₂	-
PNGST	967-1100	< 3	< 0.2	< 4 incl. CO ₂	-
SOCAIL	990-1150	< 3	< 0.2	< 4 incl. O ₂ , CO ₂ and inerts	-
Tennessee GP	967-1110	< 3	< 0.2	< 4 incl. CO ₂ , O ₂ <2.75% N ₂ + CO ₂	-
Viking	967-1110	< 3	< 0.2	< 4 incl. CO ₂	-

*For more information on specifications, please contact us at natalia@biogasworld.com.

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.

There are no federal or state/provincial rules as for the maximum allowed level of biomethane slippage in the USA. The majority of related activities focus on the reporting of GHG emissions (for example, [USEPA GHG Reporting](#)). As for state reporting, California, for example, requires a facility to report to CA Air Resources Board if it exceeds 10,000 metric tons of carbon dioxide equivalent (MMT CO₂e) of methane (1 kg methane is approximately equal to 25 kg CO₂e) (for more details, please visit [Regulation for the Mandatory Reporting of Greenhouse Gas Emissions](#)).

The methane emissions in natural gas sector by [OIES](#) in 2017 show USA reported 0.5% of methane emissions. Thus, it will be safe to assume that the same standards will be applicable to RNG/biomethane activities of the utilities.

An interview with a California utility confirmed that no guidelines or standards are used for biomethane slippage, but the utilities will always try to minimize such emissions as much as possible.

A Danish study conducted by [Rambøll](#) found methane slippage to be quite high at biogas facilities, with many rogue emissions going unreported. As party to the 2021 Methane Pledge, it is likely that the EPA will tighten regulations surrounding acceptable levels of methane slippage.

SECTION 2.

BIOMETHANE IN EUROPE

EUROPE

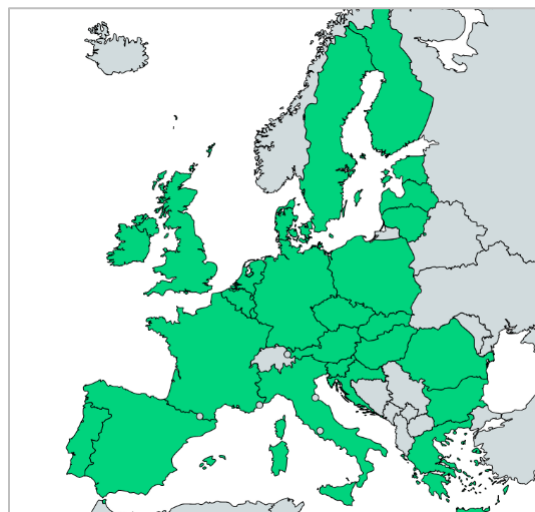
CURRENT MARKET OVERVIEW

The reliability of renewables was thrown into question during the third and fourth quarters of 2021, when weather related factors increased the demand for heating and lowered the availability of solar and wind supplies in Europe. In this optic the biomethane carries an important role in insuring energy security within the EU and managing fluctuations in the availability of other sources.

In December of 2021, following COP26, the EU [announced](#) plans to capture 5 million tonnes CO₂ each year by 2030, through the use of existing and developing Carbon Capture and Storage (CCS) technologies. In addition, the EU has also announced an upcoming certificate system, measuring and verifying CCS. These changes appear to be final, with the EU announcing no further changes will be made to its 2030 targets during 2022.

In December 2021, the Renewable Gas Trade Centre (REGATRACE), launched a pan-European trade network to digitally track the exchange of renewable gas certificates. This will allow biomethane producers in Europe to sell their certificates in any EU state.

According to the EBA, as of August 2021, there are 992 operating upgrading facilities, an increase of 13%. France has now surpassed Germany in its number of biomethane upgrading facilities (306 facilities now in France vs 242 in Germany). Other notable European markets are the UK (92 plants), Sweden (71 plants) and the Netherlands (61 plants). Gas Naturally estimates that Europe's current 12,000 heavy transport NGVs in 2020 will grow to more than 280,000 by 2030.



IN DEVELOPMENT

There are at approximately 150 biomethane plants scheduled to start in 2022-2023, with many more in the pipeline.

The major markets in development are France, UK and Italy.



INTERNATIONAL TRADE

The inter-country biomethane trade has traditionally grown from Swiss market demand that is met by certificates from Denmark, the UK and Germany. However, as biomethane requirements within NG networks continues to ratchet up, demand is likely to increase from countries such as Italy and France.

With the new Guarantee of Origin system established under REDII, GOs are traded across borders more readily, however, due to regulatory inconsistencies, prices fluctuate between countries making certain markets more lucrative for export.



BIOMETHANE POTENTIAL

The EBA has positioned itself with more than a dozen other European companies in asserting a strong role for the biogas sector (biogas + biomethane) within the EU's "Fit for 55" plan. In a [press release](#) from the coalition, it is stated that 350TWh, or 33 billion cubic meters by 2030 is achievable for the continent (a GHG reduction of 110 Mt CO₂e). It is further stated that with the right policy/regulatory environment, the biomethane industry could produce as much as 930TWh by 2050.

It is estimated that by 2030, 40% of biomethane will be able to power the entire NGV fleet.

MAJOR DRIVERS - EUROPE

- **Renewable Energy Directive (RED II)**
 - Utilizes the updated EU Taxonomy, outlining what is and is not considered environmentally sustainable economic activities
 - The Taxonomy will greatly influence activities in the 2021-2027 period removing incineration supports and adding biogas from bio-waste supports
 - Increases strictness of rules on collection, separation and management of waste, raising recycling targets to 65% by 2035
 - Critical to the new Waste Management strategy is that the municipalities which generate the waste carry the responsibility to manage the disposal of it, therefore landfill gas collection and new commercial AD recycling facilities are expected to attract significant public funding during the decade
 - Member states can request detailed Guarantees of Origin on any waste
 - Member states will need to reach 38-40% of RES on final energy consumption by 2030 (instead of previous 32%) per the recommendation of the *Climate Target Plan*
 - Members must also submit to the European Commission by the end of 2019 a 10-year integrated national energy and climate plan (NECP), which went into effect at the beginning of 2021
 - Target to raise the share of RES supplied for heating and cooling by 1.1% annually
 - In transport sector, fuel suppliers should target 14% share of final fuel consumption
 - Support schemes included within REDII:
 - States can grant exemptions from competitive bidding and direct marketing on small-scale projects
 - Waste mitigation and recycling takes priority action over increasing supply of biomass to meet AD demand
 - Facilitating of cross-border supports for renewable development without interfering in national support schemes
 - Major issues with RED II:
 - The tailpipe approach to measuring carbon fails to recognize biomethane's carbon neutrality as a fuel source
 - The potential within the maritime sector goes unrecognized
 - Stricter regulations are implemented for RNGs use as heating
- The Fit for 55 package has been recently approved by the European Commission and aims to reduce EU emissions by 55% by 2030 compared to 1990 levels
- Feed-in tariffs supporting biogas facility development have been phased-out across much of the continent, and few new subsidy/grant systems have been implemented within EU member states to fill the void
 - Further, the EU Parliament announced on [September 28, 2021](#), that it is phasing out all natural gas projects, which will no longer qualify for funding opportunities
 - It was also proposed that existing projects be converted to hydrogen transport or storage
- [Methane Strategy](#) (October 2020)
 - Aims 400% increase in biogas production

AUSTRIA

CURRENT MARKET OVERVIEW

Over the past decade, biogas facility development in Austria has begun to stagnate and even decline due to the expiration of national subsidy schemes implemented in the early 2000s. Expanding upon the former FIT's, the Renewables Expansion Act was passed in the spring of 2021, following extensive review and revision, and has made significant improvements for the continued development of biogas of the industry. Most notable is the cap on energy crop use, tightened annually, which has the goal of alleviating existing negative public opinions derived from crop diversion towards energy production.

Austria has the capability to produce approximately 11.7 Mtoe of energy, 51% of which would be derived from bioenergy and waste. To realize this potential, the Austrian government has set targets to inject 5 TWh of biomethane into the grid by 2030. [Recent studies](#) have estimated that the Austrian agricultural industry has an overall injection potential of 7.4 TWh, increasing further if energy crops deemed unsuited for human or animal consumption are added (i.e., diseased or drought damaged).

Per latest EBA information, there were 423 biogas facilities in operation, producing approximately 1,487 GWh. There are also 15 biomethane upgrading facilities in Austria. Overall, the biomethane upgrading capacity is around 3,000 m³/hour. Municipal waste and sewage sludge are the main feedstock used to produce biogas in these facilities, however, there exists significant potential within the agricultural industry, utilizing energy crops and agricultural waste.



BIOMETHANE INJECTION

Biomethane producers use AGCS Biomethane Register Austria to connect to the grid.

As of August 2021, the total of 12,698.64 MWh of biomethane has been injected into the grid.

Roughly 3% of Austria's total gas supply is derived from biogas.



MARKET TARGETS

Austria has updated its long-term vision, targeting a 100% carbon-free energy sector from 2030 forward, with zero additional outstanding carbon emissions by 2040.

By 2030, Austria plans to increase the share of nationally produced RNG to 5 TWh.

"Greening the Gas Initiative" ambitiously seeks to convert CHP stations to upgrading and grid injection stations



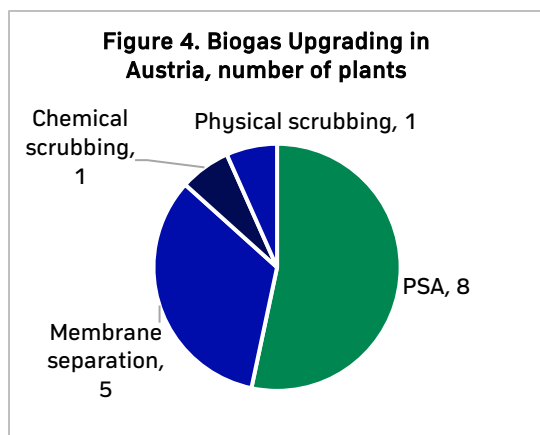
MARKET INCENTIVES

The Renewables Expansion Act signed in 2021 adds supports for new and existing biogas facilities.

The Ministry for Climate Action has suggested biogas-specific legislation is under development.

"klimaaktiv mobil" scheme includes incentives for the development and implementation of biomethane in transport fuel, including tax credits.

Federal grants (30% of investment cost) are under Environmental Assistance



UPGRADING SNAPSHOT

Per available information, the most used upgrading technology in operating biomethane facilities (based on the unit count) is PSA, followed by membrane separation.

Companies that have their systems installed in Austria are Air Liquide, Axiom, Carbotech, Malmberg and Xebec.

While no new facilities have been announced since last year, biogas upgrading in Austria is likely to experience a significant jump following the government's new 'Greening the Gas Initiative'.

MARKET DRIVERS - AUSTRIA

- The Renewables Expansion Act was implemented in the spring of 2021 and adds several new supports for biogas projects
 - Includes an investment subsidy for converting electricity to gas feed-in
 - Investment schemes for new facilities that inject biomethane into the grid
 - A capped upper limit on the use of energy crops, tightened on year-by-year basis
 - Follow up premiums for a period of 24 months for existing facilities which relied on the previous FiT
 - Only for facilities with a capacity of 250 kWel and >10km from a grid injection station
 - All other facilities will continue to receive subsidies up until their 30th year of operation
 - Investment grants for conversion of electricity into hydrogen or synthetic gas
 - Article 19 of REDII enacted into law, providing Guarantees of Origin on gas, in addition to 'Green Gas Certificates' and the 'Green Gas Seal'
- The Austrian Ministry for Climate Action has alluded to the development of new legislation, the Renewable Gas Act (EGG, Erneuerbares Gas Gesetz), which will provide support mechanisms for the renewable gas industry and implement RNG quotas for gas utilities
- #mission2030's Flagship Project 7- "Greening the Gas Initiative", Austria aims to replace a significant share of current natural gas use with biomethane and hydrogen, converting current biogas CHP units to upgrading and grid injection facilities
- Under the updated Natural Gas Tax Act, favorable treatment is awarded to biogas and hydrogen, including tax exemption for biogases and hydrogen upon meeting certain sustainability criteria.
- The Austrian Gas Grid Management authority (AGGM) is developing a map of current biogas facility locations, and where potential exists for the development of new facilities which facilitates their connection to the gas grid
 - The AGGM is also collaborating with the Austrian Power Grid AG to develop a 'Power to Gas' (P2G) map which facilitates the development of Austria's new National Hydrogen Strategy
- Facilities required to recompress gas for reaching higher levels of biomethane in the gas network are currently constructed at the expense of the biomethane producer, however, if the facility becomes considered part of the network infrastructure in maintenance duties, costs for recompression can also be borne by network operators, writing off expenses over the long-term
- Impediments to industry development persist through preexisting regulations which restrict hydrogen injection to a maximum of 4% and prevent biomethane from being injected into underground storage facilities

DENMARK

CURRENT MARKET OVERVIEW

At the end of 2020, there were approximately [186 biogas facilities](#) in Denmark producing 20 PJ of energy. 55 of these facilities are registered with Energinet, upgrading and injecting biomethane into the national grid onsite. Approximately 8 – 10 more are in development.

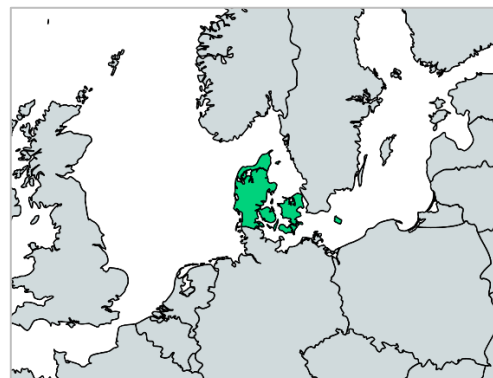
Per Energinet, approximately 30% of biogas produced in Denmark is upgraded to biomethane. As of October 2021 biogas represented 23.6% of annual gas consumption.

The introduction of REDII across the EU had insignificant effect on the Danish biogas industry, as similar regulatory measures have already been implemented. The new tender-based subsidy from 2020, implemented to prevent increases in subsidy costs and decrease the cost of biogas in general, is reportedly on track to produce 10 PJ more biogas in 2030 than previously projected.

The IEA's 2021 [Q4 Gas Report](#) indicates the daily cumulative variability of biomethane production was >5% in 2020, signalling that biogas production still has significant room for growth before it can assume a greater share of the energy burden in Denmark.

Several biogas plants are shifting from electricity production to biogas upgrading to produce biomethane; all new facilities will be upgrading biogas to biomethane.

Biomethane is playing only a marginal role in the transport sector, however, interest in the maritime and heavy transport sectors is likely to grow following the completion of Nordic Liquefaction's LBG facility in Frederikshavn. Demand in the personal and public transport sectors is unlikely to grow as a result of new policies increasing taxation on bio-CNG vehicles and forbidding the launch of bio-CNG shuttle buses past 2025.



MARKET PLAYERS

Dominant players of biomethane market: Orsted, Nature Energy, E.ON, Eniig. First 3 companies produce and trade biomethane, Eniig trades only.

Plants registered in Energinet Register can sell their origin guarantees in Germany and Austria or have them converted for sale on the EU Emissions Trading System.

Nordic Liquefaction (NORDLIQ) is scheduled to open their first liquid biogas facility mid-2023. Denmark's first LBG facility will increase reliability and availability of LBG for the shipping industry, connecting to the gas grid and offering LNG to the ships in Frederikshavn Harbour.



MARKET POTENTIAL

The Danish Bio-energy Cluster estimates that based on raw material availability, biogas production could be increased to 94 PJ (equivalent to over 26,000 GWh) in 2040.

Danish Energy Agency expects that all the Danish gas consumption can be supplied solely from biogas and other green gases in 2040 (estimation of 12,000 GWh), this means Denmark could potentially become an exporter of RNG.

Denmark is aiming as well to convert heavy transport to biomethane. Biomethane applications have otherwise been directed away from the transportation sector and towards the industrial sector.



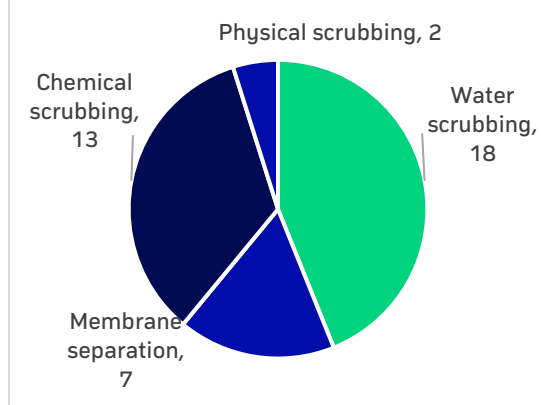
MARKET TARGETS

Denmark has set targets to supply the existing gas grid with 100% renewable gas by 2040. The date was moved back 5 years due to the uncertainty period for new support schemes. Denmark plans to reach 70% reduction in overall carbon emissions by 2030.

So far, the Danish Energy Agency expects output to reach 22 PJ in 2023 and 42 PJ by 2030.

New Energy Agreement signed in June 2018, sets the target of 55% of all energy consumption to be covered by renewable energy sources by 2030, however, [latest estimates](#) predict the possibility of 100% renewable consumption by 2028.

Figure 5. Biogas Upgrading in Denmark, number of plants



UPGRADING SNAPSHOT

The majority of new biogas plants use amine or water scrubbing for upgrading.

Out of 55 plants in 2021, upgrading system information can be found for 39 installations.

Actively working in Danish market are Ammongas, DMT, Envitec, Greenlane, Malmberg, Pentair and Wärtsilä.

2 additional amine scrubbing facilities have been announced by Wärtsilä and are scheduled to open in 2022, they have been included in Figure 5.

MARKET DRIVERS - DENMARK

- The Feed-in-Premium support scheme ended in 2020 and is to be replaced by an auction-based system.
 - Since the beginning of 2020, governmental supports on new biogas facilities producing fuels for transport, industrial processes and heating are no longer awarded
- Support scheme for biogas and other green gases include:
 - Auction-based system
 - The auction-based system has been predicted to slow the overall rate of growth of the biogas industry in Denmark
 - Support for upgrading, transport and industry use
 - Annual subsidy pool 240 mln DKK (app. 32 mln Euro)
 - No aid for biogas used for heating
- Biomethane has a certificate value from the sustainability certificates (mostly REDcert and ISCC). These schemes are primarily utilized in the transportation sector
 - Certificates equal 1 MWh of green gas in the grid
 - Certificates are cancelled on Energinet when used in Denmark, sold through Sweden or Germany, or transferred to the German certificate system, to ensure sale only occurs once
 - As of September 2021, almost 4.5 million certificates were issued by Energinet
- From 2020, a fixed share of fuel used in the transportation sector must originate from waste (5.75-10%) and biogas is the least expensive way to meet these requirements.
- A national initiative between three gas distribution companies HMN Naturgas, Dansk Gas Distribution and NGF Nature Energy to assist in transition for the green gas with an investment of over 7 billion Euro on the gas network.
- Results from [Rambøll](#) for the voluntary scheme measuring methane leakages at biogas production plants was released in August of 2021. The report found methane leakage to be extremely high at production facilities and recommends additional regulation be enacted. The results show an average methane loss of approximately 2.5%. The report points to inefficient pressure/vacuum valves, in addition to uncovered storage tanks/sludge storage.
 - Biogas production facilities had the lowest averages at around 1.9%
 - Treatment plants had the highest methane loss at around 7.7%
- Tax regulation mechanism: Renewable energy sources are exempt from the taxes that are levied on the production, processing, possession, receipt and dispatch of fossil fuels for heating purposes, for example the energy tax on mineral oil products, taxes on coal, lignite and coke or the carbon dioxide tax on certain energy products.

- The existing limit of 12% energy crops per biogas facility has been extended to the summer of 2022
 - In addition, maize as an energy crop is planning on being phased out by 2025/26
- New Climate and Energy Agreement includes a new [Power to X \(PtX\) tender](#)
 - Denmark contributing 750 million DKK to produce 100 MW of electrolyser capacity at two offshore islands, 5x more than the largest facilities in the world currently operating
 - The first planned island off the coast of Jutland, is estimated to cost approximately 217 billion DKK (34 billion USD)
 - Hydrogen produced through electrolysis can potentially replace heavy transport fuels for aviation or transoceanic shipping

FINLAND

CURRENT MARKET OVERVIEW

Per 2021 data, there are 24 installations that upgrade biogas to biomethane, mostly using municipal waste and WWTP sludge as feedstock.

Overall, 25% of all biogas units in Finland upgrade the biogas, with biomethane accounting for a growing percentage of vehicle fuel (40.6% increase over 2020). This is a result of support schemes which promote its uptake in the transportation sector through subsidies and fuel tax exemptions.

Finland’s revised NECP, underscores the need to develop its biomethane industry to meet its sustainability goals. Finland has set targets to utilize 50% of all manure in biogas applications by 2025; only 6% was processed in 2019.



TRANSPORT APPLICATION

With a range of up to 1,600 km, LNG is promoted for the heavy transport sector in Finland.

Biomethane currently accounts for over 59% of NG used in transportation, however, NG vehicles account for only 0.2% of vehicles.

Biofuels quotas target 20% in 2020 and 40% in 2030.

National goal of 50,000 private NGV by 2030.



MARKET POTENTIAL

It is estimated that Finland has an output potential between 6.6 and 10 TWh/year.

Gasum predicts it will produce 4 TWh of biogas across the Nordics by 2024.

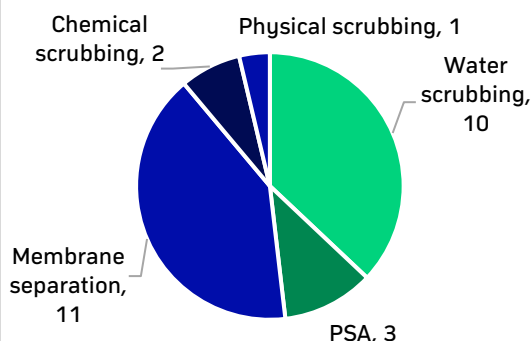


MARKET PARTICULARITIES

The natural gas network is available only in the southern part of Finland, where the population is concentrated. Thus, the production of off-grid biogas is crucial.

Per [CNG Europe](#), there are 41 biomethane filling stations.

Figure 6. Biogas upgrading in Finland, number of units



UPGRADING SNAPSHOT

Out of 24 biomethane plants with available upgrading information, most use membrane separation or water scrubbing. A small number of facilities use PSA, chemical scrubbing, and physical scrubbing.

Upgrading companies that are present in the Finnish market are Ammongas, Bright Biomethane, Greenlane, Malmberg and Wärtsilä.

MARKET DRIVERS - FINLAND

- 2021 introduces the third phase of the liquid biofuel mandate (which includes natural gas), eliminating double-counting mechanisms and raising targets above REDII mandate levels
- Two separate subsidy schemes exist for biogas facility development:
 - Agricultural: administered through the Ministry of Agriculture and Forestry and is subdivided further into two types of farm AD:
 - Farm-scale digesters which use the electricity they produce and do not sell excess gas to the utility company are eligible to receive up to 40% of investment costs
 - Large-scale digesters which sell electricity or biomethane to either the utility or transport fuel company is eligible to receive up to 30% of investment costs. In addition, a separate company must be contracted to conduct this work
 - Industrial: administered through the Ministry of Employment and Economy:
 - A maximum subsidy of up to 30% of investment costs
- To promote the development and upgrading of biogas, and encourage its use as transport fuel, biomethane as traffic fuel has been exempted from fuel taxes
- Investment aid for filling stations and converting passenger cars to gas
- Subsidy scheme for biomethane projects is under investigation
- National biogas action plan (published in January 2020)
 - Defines the measures for the sector until 2024
 - Target for the number of gas vehicles: 50 000 passenger cars by 2030
- Renewable fuel for transport
 - Biofuel quota
 - Quota obligation of 20% in 2020 and 40% by 2030
 - When biofuel is produced from waste, its energy content is counted as double (in calculations of the final amount of biofuels)
 - Excise duty on liquid fuel
 - Excise duty on liquid fuels is collected on all types of fuels, including biofuels.

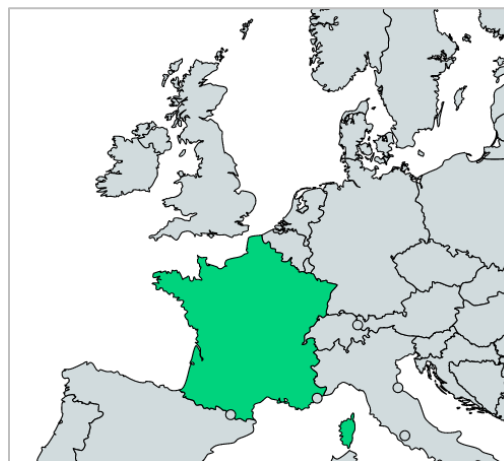
FRANCE

CURRENT MARKET OVERVIEW

In 2021, France overtook Germany based on the number of biomethane plants. During the period between 2011 and November 2021 the production capacity in GWh has increased by nearly 3000%. The French government has made clear the role of biomass and biogas to achieving their net-zero by 2050 ambitions.

As of October 2021, there are 306 biogas upgrading facilities injecting biomethane (4,476 GWh/year) to the gas grid. There are an additional 43 transport stations supplying 1,281 GWh of fuel for NGVs.

French biomethane production is mainly concentrated in the North and east of France, with around 30% of national production coming from Hauts-de-France and Grand Est regions. Other regions active in biomethane production include Brittany, Nouvelle-Aquitaine, Pays de la Loire and Normandie.



IN DEVELOPMENT

As of October 2021 there were around 1000 biomethane projects queuing to be potentially operational within 2-5 years. There is approximately 26 TWh of projects at various development stages in France.

1 new biomethane plant is commissioned each week in France.



MARKET TARGETS

2020 PPE (Multi-year Energy Program) targets biomethane consumption at 10% of total gas consumed in 2030.

By 2028, France plans to have a capacity of between 14 and 22 TWh.

ADEME has set the target to reach nearly 100% renewable gas utilization by 2050 by using the mix of RNG/biomethane, hydrogen, pyro-gasification and power-to-gas, the French Gas Association (AFG) is confident this goal will be met.

France is aiming to have 60 reverse flow facilities available for the transportation network by 2028.



BIOMETHANE POTENTIAL

TIGF, GRDF, GRTgaz and SPEGNN released a [forecast](#) showing that RNG in France could reach between 30 and 40 TWh/yr in 2030, increasing to close to 250TWh/yr by 2050.

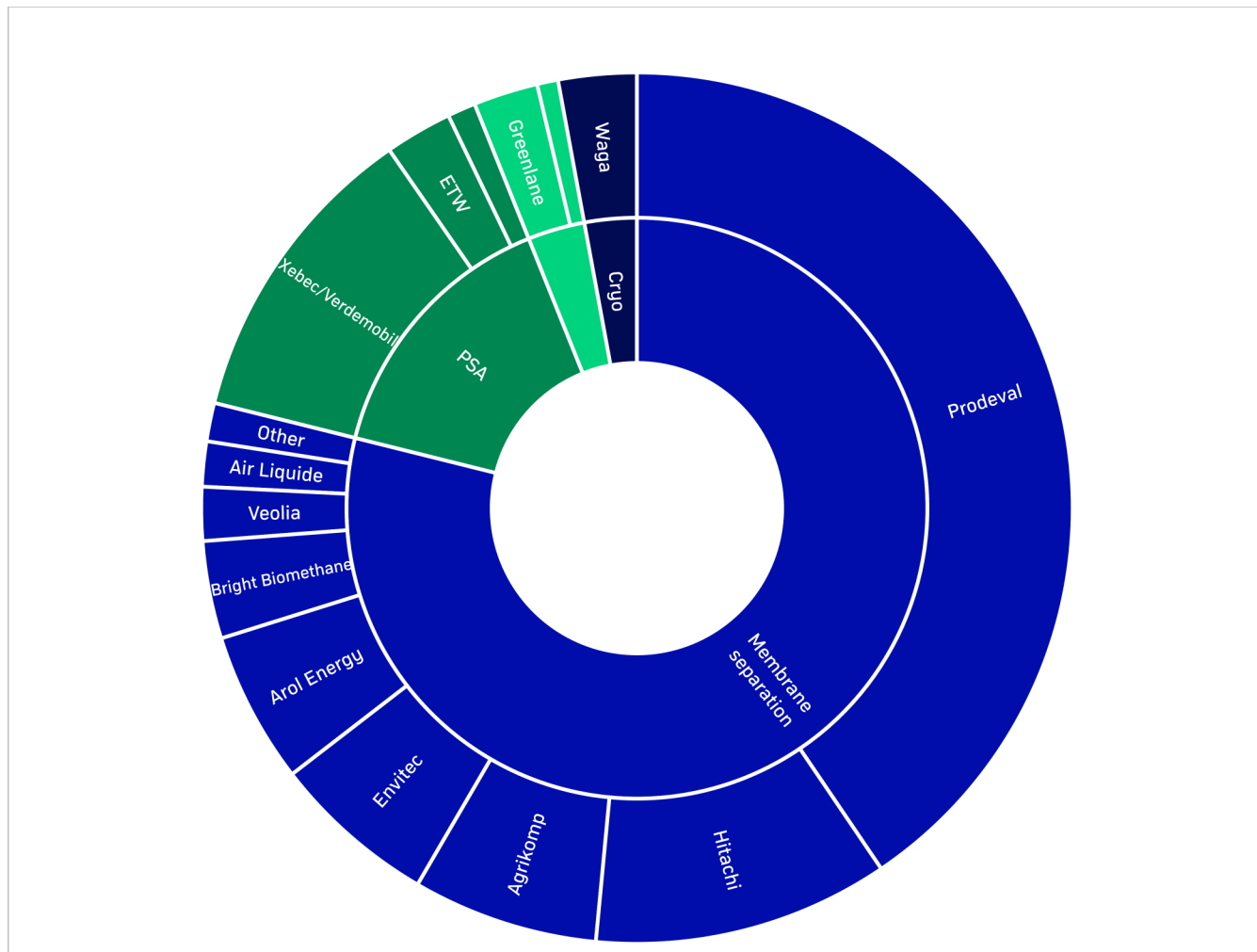
The number of NGVs in the transportation sector is expected to increase from the current 25,000, to approximately 16% of vehicles in 2035, and 32% of vehicles by 2050. There is presently 78 CNG filling stations in France.

In addition, biomethane is currently being considered as a option to reduce the GHG emissions of its train network.

UPGRADING SNAPSHOT

Based on the installed capacity, the most popular upgrading system in France is Membrane separation, followed by the PSA. The details are presented in the following Figure.

Figure 7. Upgrading suppliers in France, installed capacity, m3/hr*



* This graph utilizes the data BiogasWorld has received from upgrading suppliers operating in France.

MARKET DRIVERS - FRANCE

- In August 2021, the French Parliament adopted the *Climate and Resilience Law* (“2021 Climate Law”)
 - The law focuses primarily on the manufacture and advertisement of consumer goods and services, however, it is worth noting:
 - The impact and use of water must be recorded over the entire lifecycle, and more stringent laws are in place for greenwashing
 - How companies use the words “carbon-neutral” and “carbon negative” in their advertisements is more strictly regulated
- PPE (Multiannual Energy Program)
 - The PPE established a 10-year growth plan for the development of France’s renewable energy sector, including feed-in tariffs to support growth: included in the definition of renewable energies are biomethane and bio-hydrogen, produced from biogas.
 - Targets of 7%, or 21 TWh, of biomethane in natural gas grid by 2030 (if decrease in production costs can reach 75 EUR per MWh in 2023 and 60 EUR per MWh in 2028. If the cost reductions are more, the target is up to 10% by 2030. Per [Sia Partners](#), the current production costs are between 80 and 100 Euro per MWh.
 - The PPE has been criticized, however, for its lack of ambition for the sector, reducing 2023 targets from 8TWh to 6TWh and 2028 targets from 22 TWh to 14TWh.
- Feed-in tariff - Biomethane
 - The feed-in premium grants an open-window procedure to biogas plants with installed capacities between 500kW and 12MW
 - Since passing the *Law on Energy Transition for Green Growth* (LTECV), market premiums have been set which aim to gradually replace the FiT mechanism
 - All the projects are eligible for a guaranteed price (around €100 per MWh adjusted to the input and project size). Several examples:
 - Agricultural plant, 100 Nm³/h – 123 Euro per MWh
 - Agricultural plant, 200 Nm³/h – 101 Euro per MWh
 - Landfill, 300 Nm³/h – 77 Euro per MWh
 - No limit in the installations per year
 - Duration of the support: 15 years
 - Changes to PPE (April 2020) introduce auction systems that will allow the allocation of 350 GWh per semester (approximately 20 plants with 200 Nm³/h capacity). Small installations will still use the previous scheme, but the prices decrease.
 - Capacity limit will be used to distinguish between plants that will use old remuneration system and new auction system
 - Target prices according to PPE 2020:
 - 2023: 75 Euro per MWh
 - 2028: 60 Euro per MWh
 - Purchase agreement (for smaller installations):
 - 2023: 90 Euro per MWh
 - 2028: 80 Euro per MWh
- 40% of costs for grid interconnection are paid by GRD and GRT
 - ADEME (French Environment and Energy Management Agency) recommends biomethane injection into the distribution grid whenever possible.
 - Direct subsidies and grants are offered by ADEME (French Environment and Energy Management Agency) EU funds and regional councils.

- Guarantee of origin (GoO) system
 - GoOs are traded valorized by the retailer
 - Registry is mandated and is managed by GRDF
 - GoO in France are currently priced at 1-2EUR/MWh (compared to 9-11EUR/MWh in the Netherlands and 13EUR/MWh in Denmark)
- Value-added tax reduction
 - Purchase of commodities is subject to a reduced VAT rate if they are related to investments in the improvement, the transformation, the fittings, the conservation or certain equipment of buildings constructed more than two years prior
 - Reduced VAT rate of 5.5%
 - The reduced VAT rate applies to services, equipment and delivery. For the equipment to be eligible, it shall be delivered and installed by the same company
- Use of biomethane as vehicle fuel (bioNGV), bus fuel, and within the train network is discussed but there are no support mechanisms yet.
- In 2020 a national strategy to develop decarbonized hydrogen for use in as transport fuel was announced, the plan includes a mechanism which ensures a decarbonized guarantee of origin.
 - The plan allocates 2 billion EUR for “renewable and low-carbon hydrogen”
 - This amount is expected to increase to 5.7 billion EUR by 2030
 - ADEME has also launched a call for tenders “*Ecosystèmes territoriaux hydrogène*” which facilitates investment in hydrogen production and distribution infrastructures between 2021 and 2023.
- Some financial options are available including Bpifrance that provides loans, guarantees and equity to French micro-businesses, SMEs and mid-caps within the state, or its territories, to assist in the financing, development, and construction of new projects- including biogas

GERMANY

CURRENT MARKET OVERVIEW

Per latest information, there are 242 biomethane facilities producing approximately 11 TWh per year. The majority of plants use energy crops as the main feedstock, however, this will rapidly decline as new regulations preventing indirect land use change (ILUC) come into effect.

Biomethane sales in Germany grew nearly 5.5% between 2019 and 2020 to 10,269GWh, surpassing 10 TWh for the first time. Almost 90% of biomethane is converted to electricity (due to early subsidy schemes applying only to electricity generation). However, the 20-year contracts are expiring and the plant owners are looking to transport sector to sell the produced biomethane. Overall, the market has been stagnating, however, recent regulatory changes have increased the appeal of biomethane as a fuel for heavy transport sectors.

In addition, biomethane is increasingly considered as an option to make up for shortcomings in the generation of other renewable energies.

Additionally, Germany exports biomethane. In the last years export amounts fluctuated between 150 and 200 GWh.



TARGETS

The Bundestag updated its Renewable Energy Sources Act (2021), raising the consumption targets of renewable energy to 65% by 2030. To achieve this, Germany plans on tendering 56.7 GW of renewable capacity between 2021 and 2028. Of the 56.7 GW, 4 GW is designated for expanding biomass capacity (2.8 GW for solid biomass and 1.2 GW for biomethane-fired technologies).



UPCOMING CHANGES

Legislative changes introduced in 2020 acknowledge the potential of biomethane, potentially reigniting the German biogas industry. It is expected the changes brought on by REDII will increase the share of NGV within the transportation sector.

Hydrogen demand in Germany is projected to increase from 191 TWh in 2022/23 to 342 TWh in 2040, requiring significant expansions to the gas network, and increasing demand for 'green' blue hydrogen.



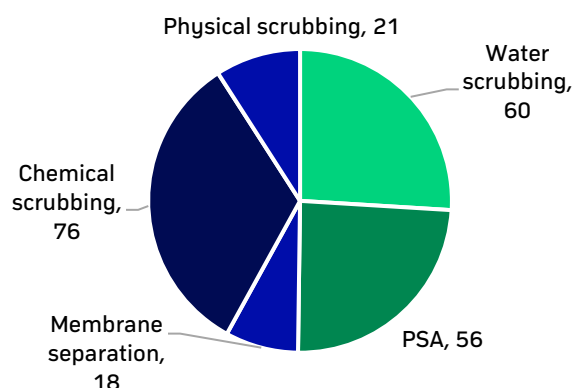
BIOMETHANE AS FUEL

There are approximately 900 CNG filling stations in Germany with an output just over 1 TWh. Nearly all of these stations have now transitioned to biomethane.

Biomethane powered heavy transport is projected to revitalize the German biogas sector.

Fuel requirements are established by standard DIN EN 16723-2:2017.

Figure 8. Biogas Upgrading in Germany, number of plants



UPGRADING SNAPSHOT

As in the last year the most used upgrading technologies are chemical and water scrubbing, followed closed by PSA technology.

Companies that work in the German market include Greenlane, Greenmac, Envitec, Carbotech, ETW, Hitachi, Malmberg, Schwelm, Wartsila and Weltec Biopower.

MARKET DRIVERS - GERMANY

- In May of 2021, REDII's direct was passed into law in the German parliament
 - REDII includes clear criteria restricting ILUC, when food or feed crops are diverted to AD and biogas production
 - Targets were set at 14% for all road and rail transport to be carbon-free by 2030, however, the new law has been criticised for its emphasis on electric mobility (being counted 4x), while leaving biomass and waste-derived fuels at the 2020 level- 6%. It is argued that this will push conventional biofuels out of the personal transport market by 2024
- The 2 key drivers in Germany have been the Renewable Energy Sources Act (EEG) and the Gas Network Ordinance (GasNZV), which together drove Germany to be a dominant developer of biomethane.
- [Changes to EEG](#) in 2014 and 2017 brought cutbacks in available subsidies, particularly where energy crops are used. Former subsidies expired in 2021, however, the 2021 changes add the category "subsidized plants" for systems under 100kW which went into operation before January 1, 2021, offering a feed-in tariff until the end of 2027.
- December of 2020 [modifications were made to the EEG](#) that came into effect January 1, 2021, targeting 65% energy from clean sources by 2030. The increase in renewables is paired with a decrease in the renewable tax levied on German energy bills.
- The 2021 EEG modifications introduces a 'Southern Quota' on December 1, 2022, tendering 150MW of highly flexible biomethane for CHP annually in Southern Germany.
- Tender model introduced in 2017: producer can apply for a supplement and subsidy, especially attractive for larger facilities. As part of the 2021 EEG modifications, the annual tender volume was increased to 600MW, and the maximum bid values were increased to 16.4 ct/kWh for new systems and 18.4 ct/kWh for existing systems.
 - Although the new EEG strengthens small-scale digesters, they remain less economical compared to their larger counterparts.
- As a whole, biomethane industry is not directly supported by grants or other support mechanisms, but some support schemes are available:
 - Tax exemption and biofuel quota trade for vehicular fuel application of biomethane.
 - Biomethane qualifies under the Renewable Energies Heat Act.
 - There is no statutory eligibility for the FIT of RNG into the gas network – producers of RNG need to market it themselves. But use of RNG in electricity generation is eligible for FIT.
- CO2 reduction obligation for fuel companies is 4%, in 2020, obligation increased to 6%.

ITALY

CURRENT MARKET OVERVIEW

As of 2021, there are 25 biomethane plants in Italy (producing approximately 2 Bn Nm³ annually).

Italy is second only to Germany in terms of the number of biogas facilities. As biomethane support schemes and transportation NGVs develop, the Italian biomethane sector is expected to grow rapidly. The EBA predicts Italy to become a European leader within the Bio-LNG market.

The Italian government has designated 1.92 bln EUR to developing its biomethane and hydrogen industries as part of its green economic recovery strategy.

The main feedstock used in biomethane plants is agricultural wastes (comprising 80% of biogas facilities), and landfill gas (12%). Roughly half of facilities currently generate biomethane for the transportation sector.



IN DEVELOPMENT

There are approximately 4 projects under construction and scheduled to be operational by the end of 2022.

Following Eni SpA's purchase of FRI-EL Greenpower, it was announced that they would begin converting some of their 21 biogas facilities in Italy to RNG production.



MARKET SIZE

Per Italian Biogas Consortium forecast, in 2030 the maximum technical potential of the biomethane sector could meet the 10% of domestic natural gas demand, equal to about 8 billion m³. With over 1000 CNG fuelling stations, the growth of the biomethane industry as centered around the development of the CNG for transport market.

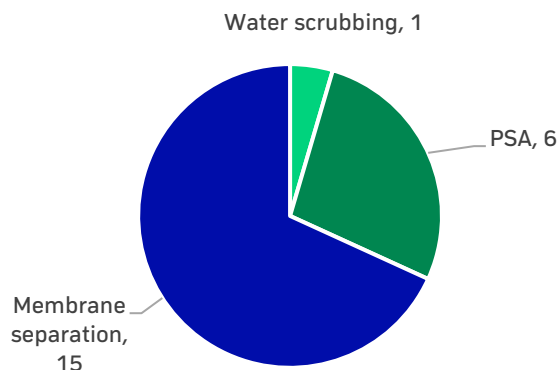


BIOMETHANE POTENTIAL

Biomethane for transportation has been the most significant driver of the industry in Italy.

Biogas Italy estimates that by 2025 there will be approximately 3.5 bcm, growing to close to 5.5 bcm by 2030. One-third of anticipated output is expected to go to the transportation sector.

Figure 9. Biogas Upgrading in Italy, number of plants



UPGRADING SNAPSHOT

Data is available on 22 of Italy's 25 facilities. Membrane separation is the most used upgrading technology in Italy, being used in 15 plants out of 22.

Companies that work in the Italian market are Air Liquide, ETW, Malmberg, Pentair, Prodeval and Xebec.

MARKET DRIVERS - ITALY

- Italy National Energy Strategy sets up the target of 28% of RES in total energy consumption by 2030
 - This would require 224 TWh of renewable energy capacity to be operational, 22TWh of which has been designated for bioenergy: 12 for biogas/biomethane
- The Recovery and Resilience Plan (RRP) was announced in April 2021, as an economic recovery package following the pandemic. Of the total package, 1.92 billion EUR has been designated for developing the biomethane and hydrogen sectors in Italy.
 - Other areas of the Plan include improving the climate resiliency of infrastructure, increasing the production and distribution of hydrogen, increasing the availability of sustainable transportation
 - The plan aims to increase the efficiency of biogas plants in the agricultural sector, support the development of new upgrading facilities, promote sustainable practices within its biomethane industry, promote the replacement of obsolete or low-efficiency vehicles, and improve the efficiency of heat recovery.
- The Integrated National Plan for Energy and Climate for 2030 targets 22% renewable energy in transport fuel by 2030, as set by the REDII directive.
 - The plan further outlines the contribution of biomethane to account for 75% on final energy consumption in the transport sector (0.08 Mtoe or 1.1 billion cubic meters) by 2030
- Biomethane promotion scheme
 - Scheme is based on the certificates of release for consumption ("Certificati di Immissione in Consumo di biocarburanti", better known as "CIC")
 - A company that releases non-renewable fuels for consumption has to hold CIC enough to cover its obligation. Obligations were updated in January of 2021. And now require for 2021 are 10% for biofuels and 1.5% for advanced biofuels. From 2022, the obligation for advanced biofuels changes to 2.5%, and then to 3.0% in 2023
 - As a basic rule, one CIC is assigned every 10 GCal of biomethane. Some exclusions apply, double counting mechanism is into force.
 - Support scheme gives preference to small-scale digester projects
 - Advanced biomethane is produced from specific feedstock, including organic fraction of municipal waste, manure, crop waste, etc.
 - During the first 10 years of advanced biomethane production, the plant can request a special scheme where each certificate is valued at 375 Euro
 - The GSE will withdraw the advanced biomethane which is produced for a maximum share equal to 75 % of the obligation, minus any shares of "obliged subjects" that do not intend to join the arrangement. The withdrawal of the biomethane will take place at a price equal to that of the MPGAS (Spot Market for Gas) reduced by 5 % and the GSE will recognize the value of the corresponding CIC, assigning each certificate a value of 375 Euro
- Ministerial Decree introduced in October 2018 allowing biomethane produced by the agricultural sector to be used as bio-fuel (agricultural tax incentives)
- All requirements for natural gas quality and European technical regulations for additional biomethane elements are presented in Technical Regulation UNI/TR 11537:2016 Injection of biomethane in natural gas transport and distribution networks. This regulation is being revised now, no updated has yet been given.

NETHERLANDS

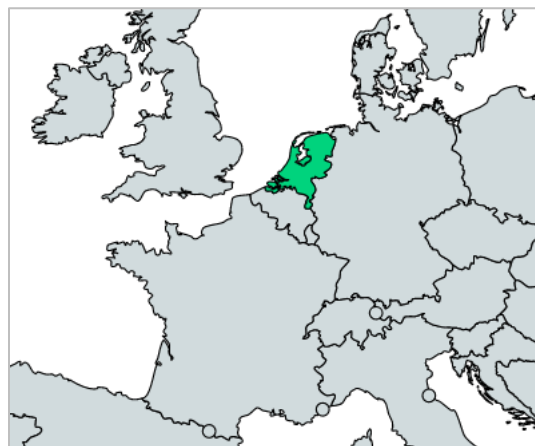
CURRENT MARKET OVERVIEW

As of 2021, there are 61 biomethane units in the Netherlands with more than half the plants (29 plants) using the agricultural waste as feedstock. The majority of biomethane is injected into the gas grid.

Additionally, Netherlands has its own national renewable gas registry, operated by Vertogas.

In recent years the Dutch agricultural industry has undergone a shift from co-fermentation to mono-fermentation of manure. This has been the result of a new program which has allowed farmers to lease an installation from the cooperative, rather than having to buy it themselves.

As part of its 2030 Climate Agreement, the Netherlands has set targets to replace 70PJ (19TWh) of natural gas used by households and industry with 2 billion m³ of green gasses. The roadmap, released in 2019, predicts 30-50% of the final demand for energy will consist of either biomethane or hydrogen. This has been further propelled forward by the Dutch commitment to disconnect



IN DEVELOPMENT

There are 2 projects scheduled to be operational by the end of 2022 and beginning of 2023.



MARKET SIZE

It is estimated that if the Netherlands utilized all agricultural manure, it could double its biomethane output.

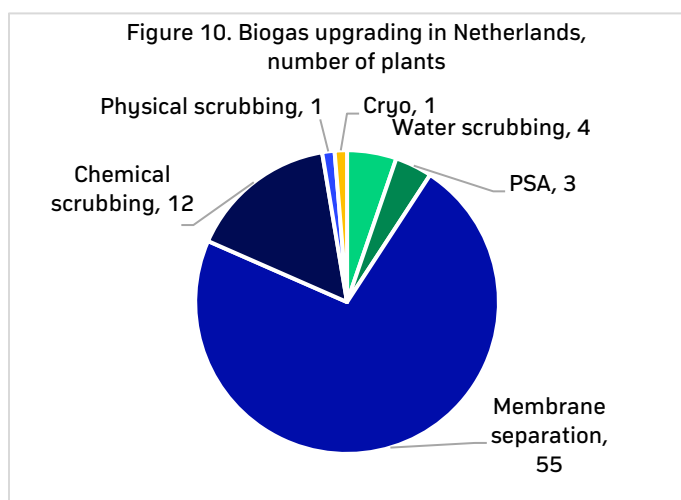
The implementation of REDII has resulted in an increase in policy ambition, targeting the share of renewable energies in the transport sector to reach approximately 27% by the end of the decade. Currently, only approximately 12.5% of transport fuels is comprised of renewable energies, more than doubling the current output to meet targets.



TRANSPORT SECTOR

At gas stations, biomethane becomes bio-CNF (it should be at least 82% methane). There are nearly 200 CNG fuelling stations in the Netherlands.

Blending obligations are in place for fuel stations, and [90% of the NG](#) in the transport sector is comprised of biomethane. There are at least 170 filling stations (CNG and biomethane) and in more than half, 100% biomethane is available.



UPGRADING SNAPSHOT

Figure 10 includes 67 facilities and has been updated with BiogasWorld's latest figures provided by upgraders operating in the Netherlands

Membrane separation is the most used upgrading technology in Netherlands, being used in 47 plants. Chemical scrubbing is used in 12 units.

Companies that work in this market are Bright Biomethane, Carbotech, DMT, Greenmac and Pentair.

MARKET DRIVERS - NETHERLANDS

- FiT (SDE++ [Stimuleren duurzame energieproductie en klimaattransitie])
 - Has now taken over and added to the SDE+ regulation, which was active between 2013 and 2020
 - Sustainable Energy Transition Incentive Scheme (SDE ++) will stimulate the roll-out of renewable energy and CO₂-reducing technologies by compensating the unprofitable top of these technologies. This is done through an operational support
 - The scheme is based on tenders
 - Bidders are required to submit zero-subsidy bids as part of award criteria
 - Main difference with SDE+ is that now it is possible to apply for a subsidy for other technologies that reduce CO₂ or other greenhouse gases and the competition is allowed on the basis of avoided tons of CO₂ equivalent, instead of cost price for renewable energy
 - Biogas and biomethane projects fall into the following categories:
 - Renewable heat: geothermal, aqua thermal, biomass and solar thermal
 - Renewable gas: fermentation and gasification
 - Other CO₂ reducing technologies: electric boiler, large-scale heat pump, industrial waste heat, hydrogen through electrolysis and carbon capture and storage (CCS)
 - The maximum subsidy intensity that technologies could claim in SDE ++ in 2020 is €300 per tonne of CO₂
 - The second round budget is beginning of SDE++, awarding 11 billion EUR of projects and public support of up to 8 billion EUR. The intake of bids will begin again in the fall or 2022.
 - The SDE++ subsidy cannot be combined with EU investment supports
- The ODE (Opslag Duurzame Energie- en Klimaattransitie) is the only relevant tax allowance for renewable energies (including biomass) in the Netherlands.
- The Energy Investment Allowance (EIA scheme) is also available for eligible biogas installations
 - A fund of 150 million EUR has been allocated to support the development of small-capacity units
 - Earmarks funds for hydrogen production, including hydrogen from biogas

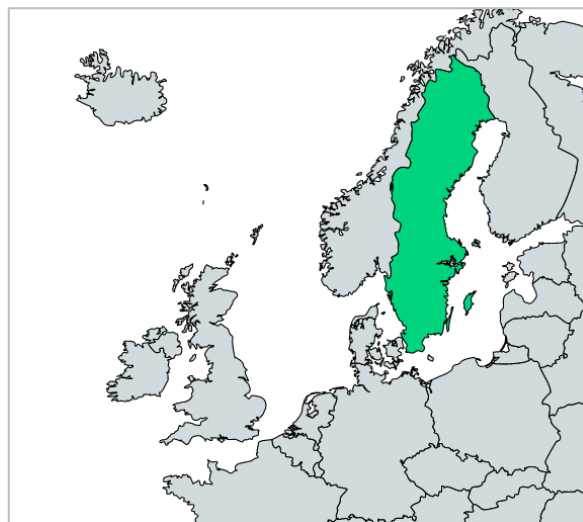
SWEDEN

CURRENT MARKET OVERVIEW

There are 71 biogas upgrading plants in Sweden (about 65% of biogas is upgraded) producing approximately 1.4TWh of biomethane. 14 plants inject biomethane into the gas grid.

The use of biogas for transportation has increased rapidly over the last 10 years, to where now most biogas is upgraded for the purpose of vehicle fuel reaching a 95% share in Swedish vehicle gas.

About half of its biomethane (~2 TWh) is imported from Denmark where it is subsidized, thus pressing down the biomethane prices making them more competitive with natural gas.



GOALS

There is currently no official strategy or goal for biomethane or other energy gases in Sweden, however, the Swedish biogas industry has launched a proposal (2018) to target 15 TWh of biogas/biomethane use by 2030, 12Twh in the transport sector and 3Twh in industry (Source: Energigas, 2021)

As of 2017, Sweden had reached 22% renewables in transport, 2% above the EU's 2020 goal.

There is also a vision to have a fossil-independent vehicle fleet powered 100% by biomethane by 2030, and zero net GHG emissions by 2045.



MARKET SIZE

Currently, Sweden will only realise 5-10% of its technical potential by 2030, however, Energigas aims utilize new supports and is targeting 30% of gas into its grid to originate from biogas by 2030 and 100% biogas by 2050 (Source: NGVA, 2021, Regatec 2019).

Climate neutral energy sector 2045 of which at least 85 % GHG emission reduction is targeted in Sweden.

- 100 % renewable electricity production 2040
- 63 % GHG emission reduction in non-EU ETS sector in 2030 and 75 % 2040 compared to 1990
- 70 % GHG emission reduction in domestic transport by 2030



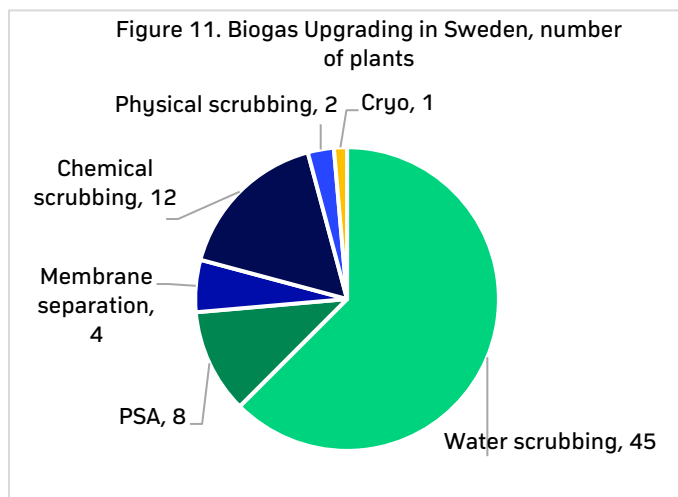
TRANSPORT SECTOR

Sweden is building market for liquified biogas as motor vehicle fuel with 8 stations in place and 32 approved. Total of 50 stations is forecasted for 2025. As of 2021, there are 3 facilities producing LBG, with more currently under construction or in planning phases.

There are nearly 200 filling stations for CNG in Sweden.

Energigas estimates that the biomass potential for Sweden with the current conditions could be increased to 30-37TWh by 2030.

With low average temperatures, Sweden is exploring the idea of a hydrate system for storage and transport of biomethane, particularly in areas with no grid accessibility. This remains one of the most prominent barriers to the development of the biomethane for transportation market in Sweden.



UPGRADING SNAPSHOT

Water scrubbing is the most used upgrading technology in Sweden, being used in 45 plants. Chemical scrubbing is used in 12 units.

Bright Biomethane, Carbotech, DMT, Greenlane, Hitachi, Malmberg and Wartsila are present in the market.

MARKET DRIVERS - SWEDEN

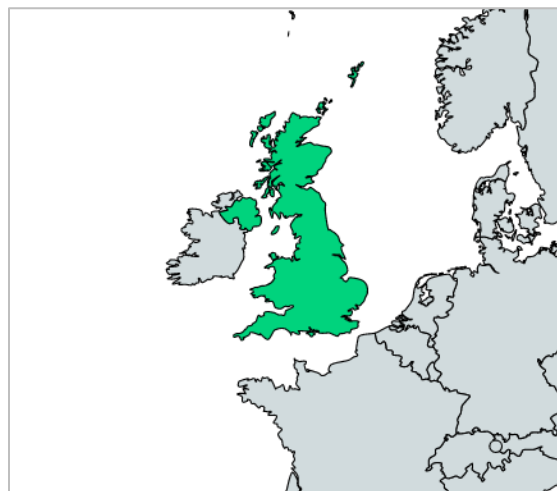
- Energy and CO₂-Tax
 - Biofuels are eligible for tax exemption (energy and carbon dioxide taxes are levied on the supply, import and production of fossil fuels)- approved until the end of 2030
 - For biogas sold or used as a motor fuel the maximum deduction amounts to 100% from energy tax and 100% of CO₂-tax
 - The CO₂-tax rate 2021 corresponds to 2579 SEK/1000Nm³ (~23 EUR /MWh).
 - Exemptions from CO₂ and energy tax for biogas or biomethane for heating (including industrial uses) is approved by the Commission until the end of 2030.
- The Swedish gas industry received a commitment of long-term government support for increasing biogas production over the 2022-2040 period, to achieve the state's goal of a circular economy. Energigas Sverige's "Green Gas 2050" plan outlines how Sweden can become carbon-neutral across all sectors of its economy.
- With the implementation of REDII, all suppliers of biofuels (including biomethane used in transport), that are eligible for taxation, must apply through the Swedish Energy Agency for tax exemptions or other support systems.
 - To receive a valid Sustainability Decision, a supplier must prove a control system that covers all aspects of production and distribution (parts of the supply chain) meets sustainability requirements.
- As of January 1, 2020, cities can enforce polluting zones which restrict noise and emissions from vehicles to 3 different restriction levels. Only NGVs, hydrogen vehicles, and electric vehicles are allowed in all three zones.
- Production support/premium
 - Production support for biogas and biomethane from manure 0.20 SEK /kWh (or ~20 EUR /MWh) until 2023.
- Local climate investment program (Klimatklivet 2015-2026):
 - Investment support (up to approx. 45 %) for all types of GHG reduction measures, including support to biomethane plants and filling stations.
 - The budget for 2021 is 2.4 billion SEK/yr (~0.24 Billion EUR /yr).

UNITED KINGDOM

CURRENT MARKET OVERVIEW

There are currently 92 biomethane plants in the UK with the total installed capacity of nearly 75,000Nm³/hr. Produced biomethane is mainly injected into the National Grid from certified Renewable Heat Incentive (RHI) installations (since 2014), however, this may shift towards the transportation sector with the programs expiry.

70% of plants use mainly agricultural feedstocks (energy crops and manure), The rest treat sewage, food waste and industrial wastes. Currently, only about 15% of household food wastes in the UK are recycled through AD, with estimates showing over 10,000,000 tonnes of food is not recycled from industrial food waste sources. The UK is aiming to combat this through its new Environment Bill (2021), which prevents this waste from being sent to landfill and increasing the uptake of AD nutrient recycling.



DEMAND

Demand for biomethane comes from several venues:

- Gas Central Heating (under RHI), but there are a lot of alternatives
- Back-up power generation (RNG to be stored and delivered via gas grid)
- Use of RNG as vehicle fuel for public transport and trucks
- Renewable Transport Fuel Scheme (RTFS) requires companies sell fossil fuels with an increasing proportion of biofuels mixed



MARKET SIZE

Per [ADBA](#), Biomethane could deliver 30% of UK's 2030 carbon budget by producing annually up to 8 billion m³ of biomethane.

Further, ADBA estimates that the full potential of the UK biomethane sector could reduce approximately 6% of the UK's total emissions.

An additional 4 500 plants need to be built and operated to fulfil its full potential.



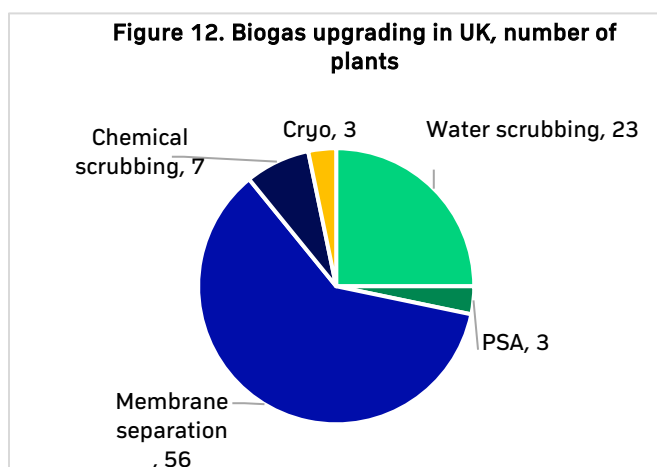
TRANSPORT SECTOR

By the End of 2021, [ADBA estimates](#) 1 – 1.5% of the UK's 130,000 long haul HGVs will be running on biomethane. The UK's biomethane heavy transport sector has doubled over the past 12 months and is expected to double again over the next 12.

Of the total 186 million litres equivalent of renewable fuels, biomethane made up under 10%.

There are currently 29 CNG/LNG refuelling stations in the UK, by 2030, Cadent (largest gas distribution network) estimates that approximately 120 RNG/biomethane filling stations will be needed, growing the UK network which presently is comprised of 7 filling stations.

Figure 12. Biogas upgrading in UK, number of plants



UPGRADING SNAPSHOT

Membrane separation is the most used upgrading technology in the UK, being used in 56 plants.

The upgrading suppliers present in this market are Bright Biomethane, Carbotech, CryoPur, DMT, Envitec, Gasrec, Greenlane, Hitachi, Malmberg, Pentair, Prodeval, Wartsila and Weltec Biopower.

MARKET DRIVERS - UK

- At the beginning of November, 2021, the new [Environment Bill \(2021\)](#) received Royal Assent, however, it is still being amended within the House of Lords, included in the Bill is:
 - The expansion of food waste collection services with the goal of preventing these forms of wastes from ending up in landfills
 - Increasing resource efficiency and waste reduction, with an emphasis on improving the environment in addition to soil health and quality
- In the follow-up to COP26, the UK government published its [Net Zero Strategy: Build Back Greener](#), a part of its wider [Ten Point Plan for a Green Industrial Revolution](#). The strategy includes:
 - The UK has committed to delivering 5GW of hydrogen production capacity by 2030, and has set up the Industrial Decarbonization and Hydrogen Revenue Support (IDHRS) scheme, which will fund hydrogen production and carbon capture projects
 - Investments in low-carbon farming and agricultural innovations (via the Farming Investment Fund and the Farming Innovation Programme) for equipment, technology, and infrastructures
- **Green gas support scheme**
 - Replaced the Non-Domestic Renewable Heat Incentive (RHI), and opened the 30 of November, 2021, it will be open to new applications for 4 years.
 - The scheme has two associated caps:
 - The Applications Budget Cap (ABC), where applications are checked against the budget to ensure funds are available
 - The Overall Scheme Expenditure Budget Cap (OSEB), which is set above the ABC and relates directly to the levy collection
 - Will support only biomethane produced from anaerobic digestion (AD) of biomass feedstocks and injected into the gas grid
 - The tariff will be tiered to reflect the cost of producing biomethane at different scales. The opening tariffs are:
 - Tier 1: First 60,000 MWh of eligible biomethane – tariff amount: 5.51 p/kWh
 - Tier 2: Next 40,000 MWh of eligible biomethane – tariff amount: 3.53 p/kWh
 - Tier 3: Remaining (above 100,000MWh) eligible biomethane – tariff amount: 1.56 p/kWh
 - Tariff payments will be available to participants for 15 years

SECTION 3.

EMERGING MARKETS

AUSTRALIA

CURRENT MARKET OVERVIEW

The vast majority of biogas in Australia is currently utilized in CHP projects, however, this is beginning to change as the government recognizes the potential of biomethane for assisting the decarbonization the Australian economy. There is just one operating biomethane facility at the moment, with a second in the late stages of development.

Bioenergy (primarily biomass and biogas CHP) accounts for 47% of Australia's renewable energy generation, and 3% of total consumption.

Still in its infancy, the Australian biomethane market has enormous potential for growth and development. Once the government finalizes the legal changes surrounding biomethane, and support strategies role out, it is reasonable to assume the market will undergo rapid expansion.



IN DEVELOPMENT

Just one facility is currently in development, however, the Australian government is currently reforming policies which will spur investment and development of its biomethane and hydrogen industries.



MARKET SIZE

According to [Australia's Bioenergy Roadmap](#), up to 23% of the total pipeline gas market could be covered by renewable gases (105PJ/annum).



BIOMETHANE POTENTIAL

It is estimated that bioenergy could account for up to 20% of Australia's total energy consumption by 2050.

Under conservative scenarios, biomethane would contribute to around 9% of gas consumption by 2050. With targeted policy support, this share could grow to up to 33% by 2050.

UPGRADING SNAPSHOT

There is currently just one biomethane upgrading unit in New South Wales, Australia, operating commercially. A second facility at Sydney's Malabar WWTP is in development. A pilot project is currently underway in Western Australia, upgrading biogas to hydrogen.

Major players within the Australian market include Veolia, HoSt, and Hazer Group.

MARKET DRIVERS - AUSTRALIA

- Through the Clean Energy Finance Corp., the Australian government is attempting to become a global leader in the production of affordable, scalable, low-emissions technologies
 - To achieve this goal, it has launched a 1 billion AUD investment fund to fast-track emerging low-emissions technologies and carbon capture and storage.
 - The Clean Energy Finance Corp., however, can currently only invest in short-term, proven technologies, and not the more experimental projects in need of investment in their R&D.
- The Australian government has set out in its National Hydrogen Strategy more than 1.2 billion AUD for clean hydrogen production, including large-scale hydrogen and biomethane injection projects
 - The Clean Industrial Hubs programme designates an additional 464 million AUD for the regional development of hydrogen development
- Early in November 2021, the Clean Energy Regulator finished its planning and design of a biomethane strategy. This will allow biomethane from waste and agriculture which reduce emissions to receive Australia carbon credit units.
- Regulations are being explored for the appropriate use and specifications of digestate
- Natural Gas law is currently under review to create uniform regulations for upgraded biomethane.
 - On August 20, 2021, reforms were approved to amend the National Gas Law and National Energy Retail Law to bring hydrogen, biomethane, and other renewable gases under their scope, providing legal certainty for the industry.
- To facility the regional supply of biowaste for AD, organics bans are being explored.

SECTION 4.

COMPETITIVE LANDSCAPE

UPGRADING MARKET

SUMMARY

In recent years, the biogas upgrading market has been in strong development phase with many companies on the market to offer their solutions. The figure below presents the major players (in alphabetical order).

Figure 13. Biogas upgrading suppliers

Water scrubbing	PSA	Membrane separation	Chemical scrubbing	Cryo
<ul style="list-style-type: none"> •Chaumeca •Econet •Greenlane •Malmberg 	<ul style="list-style-type: none"> •Air Liquide •Carbotech •ETW •Greenlane •Guild Associates •NeoZeo •Quadrogen •Sysadvance •Xebec 	<ul style="list-style-type: none"> •AgriKomp •Air Liquide •Arol Energy •Axiom •Bright Biomethane •DMT •Eisenmann •EnviTec Biogas •Hitachi Zosen INOVA •Honeywell •Pentair •Prodeval •Unison Solutions •Veolia •Weltec Biopower 	<ul style="list-style-type: none"> •Ammongas •Bilfinger •Carbonoro •Greenmac* •Hitachi Zosen INOVA •Honeywell •Morrow Renewables •Schwelm •Wartsila 	<ul style="list-style-type: none"> •CryoPur •FirmGreen •Waga Energy

*As of 2021, Greenmac is part of Bright Biomethane

It is important to note that due to limits in data acquisition, incomplete public information and some private data, the study may analyze fewer projects than are actually in operation in Europe and the North America. BiogasWorld conservatively estimates that only 65-70% of existing plants are analyzed in this section. To have a full picture of the European market, BiogasWorld suggests additional market study.

The current competitive analysis is based on information on more than 1 200 upgrading units:

- 197 plants in the North America
- 1,218 plants in Europe
- 34 in Asia, Africa, Oceania, and South America

The data for Asia, Africa and South America is mentioned with the sole aim to show the world presence of each upgrading technology supplier.

Graphs below represent the technology share based on the number of operational units (Figure 14) and installed capacity (Figure 15).

Figure 14. Share of analyzed upgrading technology suppliers, based on number of units

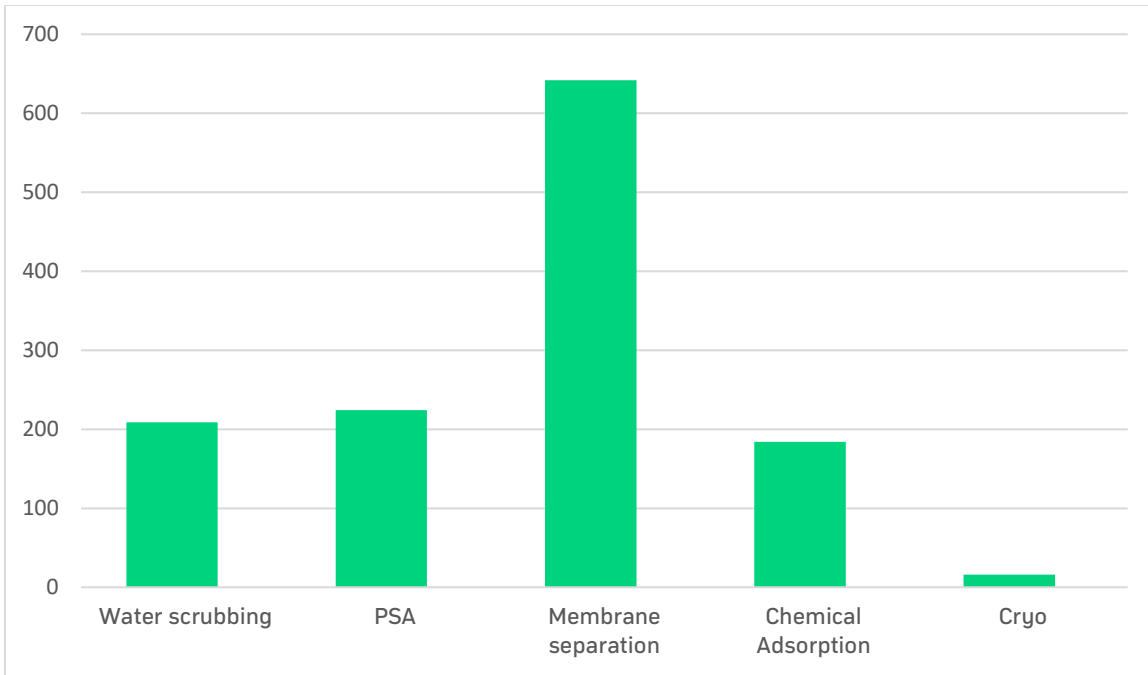
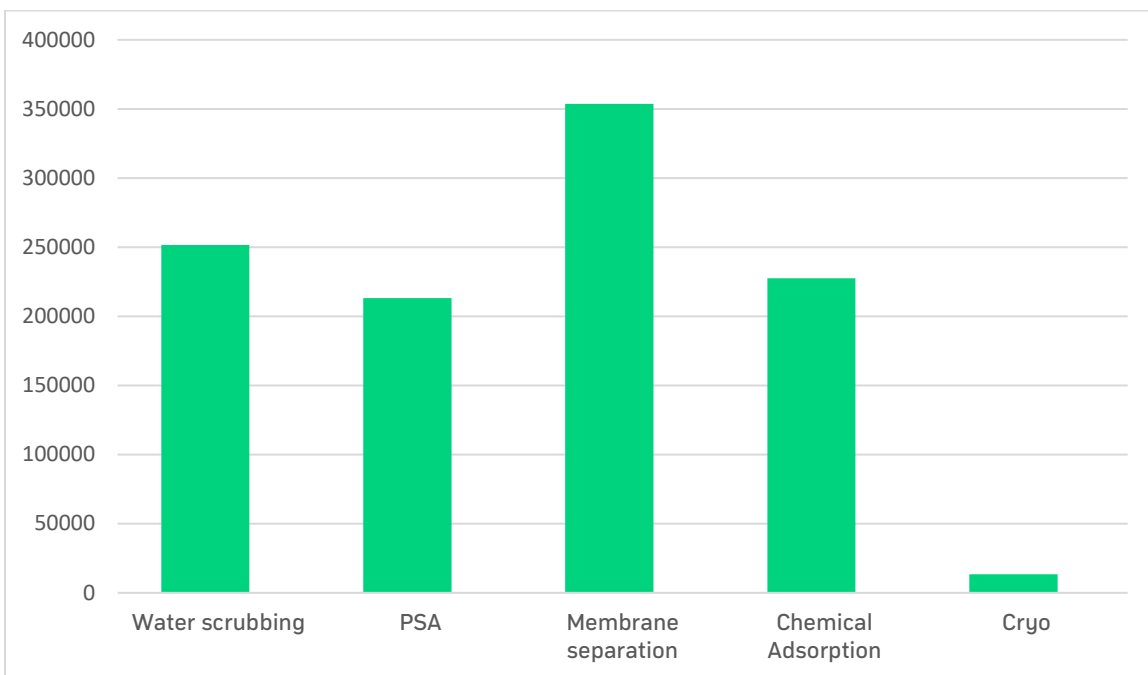


Figure 15. Share of analyzed upgrading technology suppliers, based on installed capacity, m3/hr

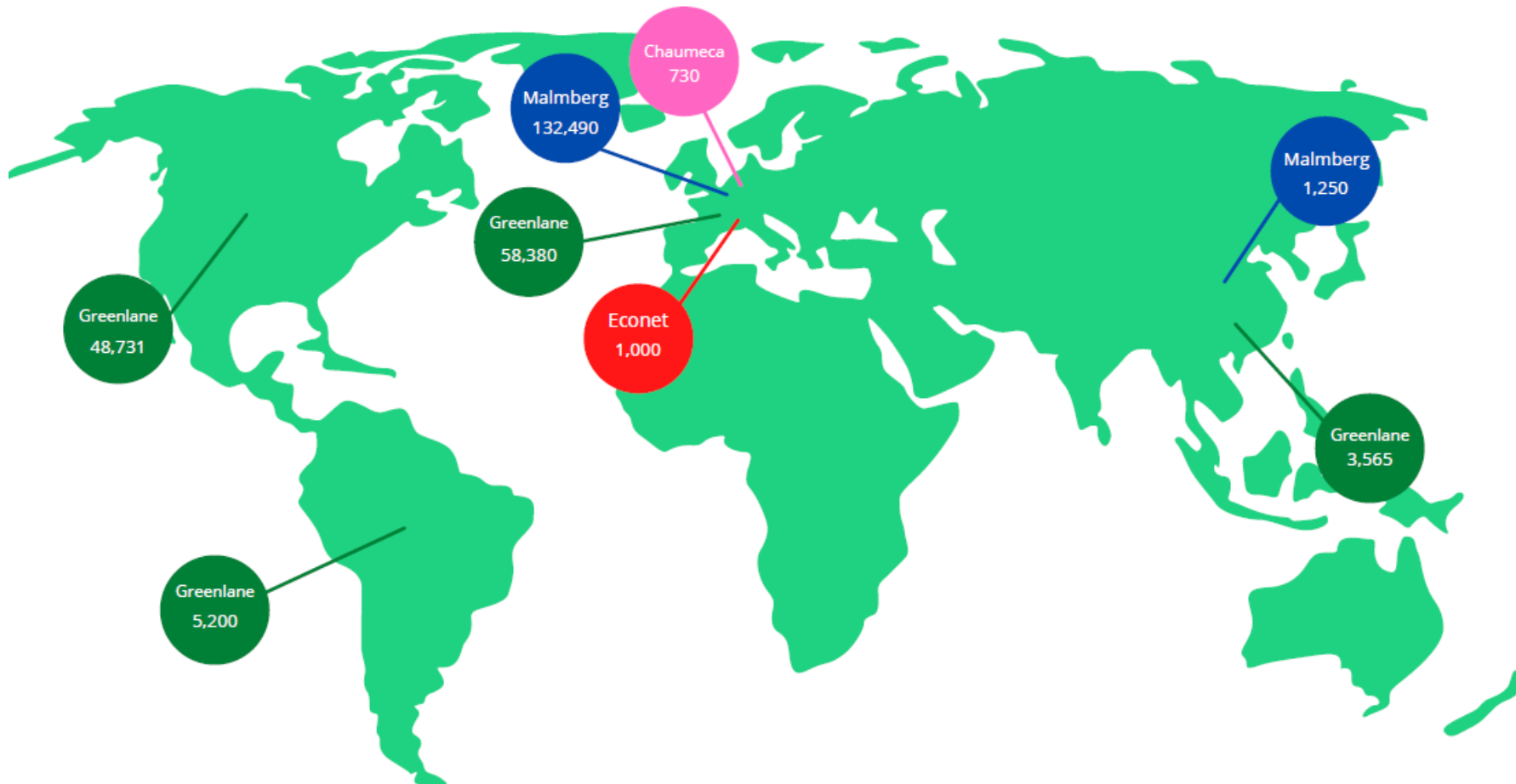


Water scrubbing

MAJOR SUPPLIERS – WATER SCRUBBING

COMPANY	Number of plants in operation	Capacity, plants in operation, m ³ /hr	Installed capacity during last 3 years (2019-2021), m ³ /hr	Number of plants under construction (2022-2023)	Capacity, under construction, m ³ /hr
CHAUMECA	5	730	Not available	Not available	Not available
ECONET	3	1,000	Not available	Not available	Not available
GREENLANE	83	115,956	4,531	1	410
MALMBERG	119	134,340	22,025	1	600

Figure 16. Presence of water scrubbing suppliers, installed capacity of units in operation, m3/hr

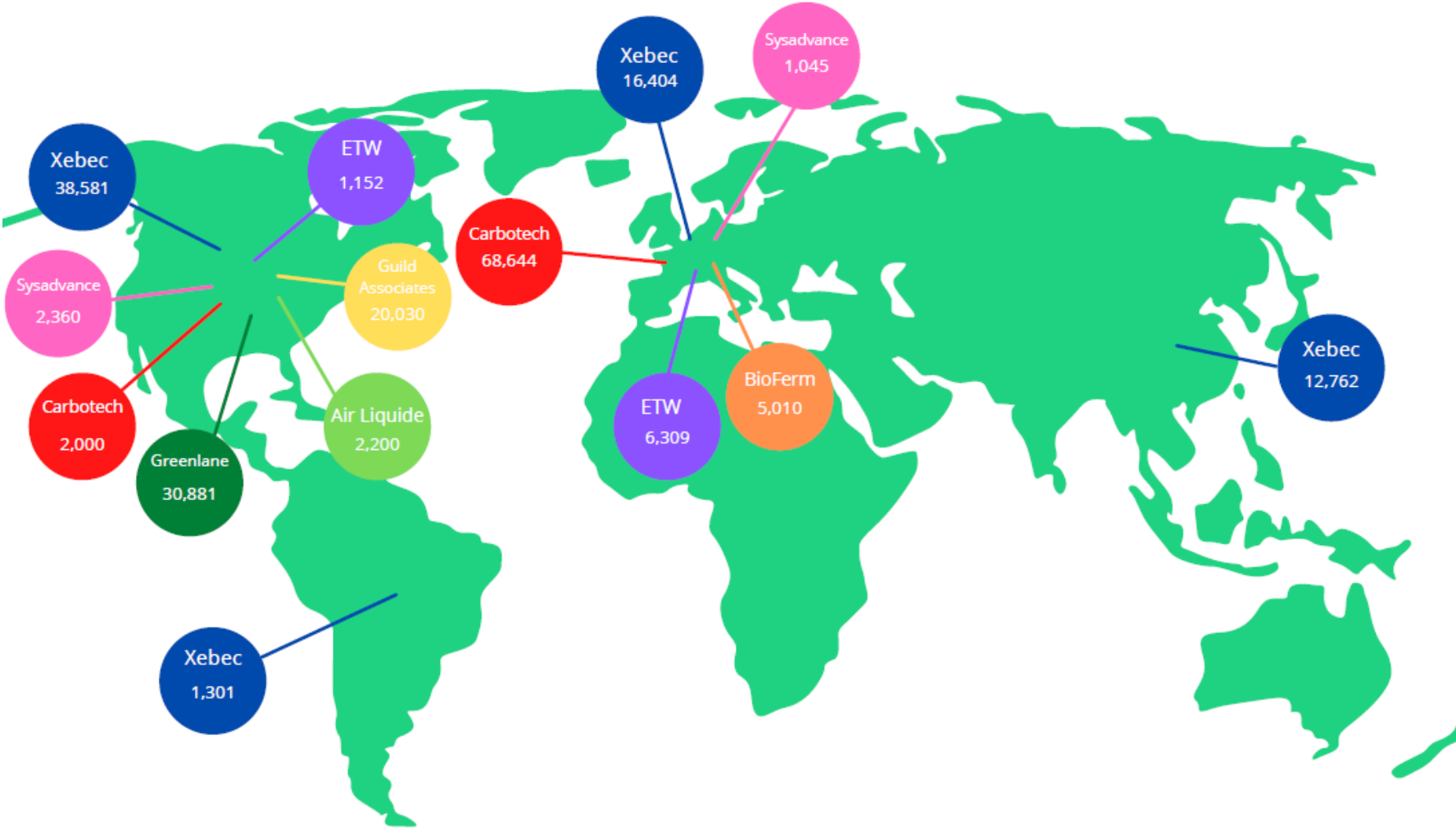


PSA

MAJOR SUPPLIERS – PSA

COMPANY	Number of plants in operation	Capacity, plants in operation, m³/hr	Installed capacity during last 3 years (2019-2021), m³/hr	Number of plants under construction (2022-2023)	Capacity, under construction, m³/hr
AIR LIQUIDE	1	2,200	Not available	Not available	Not available
BIOFERM	8	8,731	2,277	Not available	Not available
CARBOTECH	76	70,644	Not available	Not available	Not available
ETW	12	7,461	3,750	1	2,700
GREENLANE	6	30,881	19,521	Not Available	Not available
GUILD ASSOCIATES	7	20,030	Not Available	1	570
SYSADVANCE	7	3,405	2,030	Not available	Not available
XEBEC	104	69,049	16,519	1	460

Figure 17. Presence of PSA suppliers, installed capacity of units in operation, m3/hr



Membrane Separation

MAJOR SUPPLIERS – MEMBRANE SEPARATION

COMPANY	Number of plants in operation	Capacity, plants in operation, m ³ /hr	Installed capacity during last 3 years (2019-2021), m ³ /hr	Number of plants under construction (2022-2023)	Capacity, under construction, m ³ /hr
AB ENERGY	1	1000	1000	Not available	Not available
AGRIKOMP	20	3,346	3,166	16	2,500
AIR LIQUIDE	33	101,406	Not Available	Not available	Not available
AROL ENERGY	27	5,285	5,065	45	9,305
AXIOM	12	2,220	558	Not available	Not available
BRIGHT BIOMETHANE	100	35,676	30,598	5	2,010
CLARKE ENERGY	2	330	250	1	2550
DMT	58	37,891	22,471	10	17,104
EISENMANN	3	425	Not available	Not available	Not available
ENVITEC	58	31,570	10,780	Not available	Not available
HITACHI	54	15,300	10,090	5	1,350
HONEYWELL	4	20,900	Not available	Not available	Not available
PENTAIR	43	33,147	5,860	Not available	Not available
PRODEVAL	203	49,171	42,866	72	15,880
UNISON/BIOCNG	9	1,700	Not available	Not available	Not available
VEOLIA BIOTHANE	7	1,875	1,875	9	1,122
WELTEC BIOPOWER	7	3,930	1,320	Not available	Not available

Figure 18. Presence of membrane separation suppliers, installed capacity of units in operation, m3/hr



Chemical Scrubbing

MAJOR SUPPLIERS – CHEMICAL SCRUBBING

COMPANY	Number of plants in operation	Capacity, plants in operation, m ³ /hr	Installed capacity during last 3 years (2019-2021), m ³ /hr	Number of plants under construction (2022-2023)	Capacity, under construction, m ³ /hr
AMMONGAS	27	41,660	15,210	Not available	Not available
CARBONORO	2	240	240	Not available	Not available
GREENMAC	26	9,695	758	Not available	Not available
EMS BILFINGER	2	3,750	Not available	Not available	Not available
HERA	4	195	Not available	Not available	Not available
HITACHI	40	17,270	930	1	700
HONEYWELL	2	22,400	Not available	Not available	Not available
MORROW	13	68,694	Not available	Not available	Not available
SCHWELM	23	7,404	2,160	Not available	Not available
WARTSILA	44	54,900	22,590	2	9132

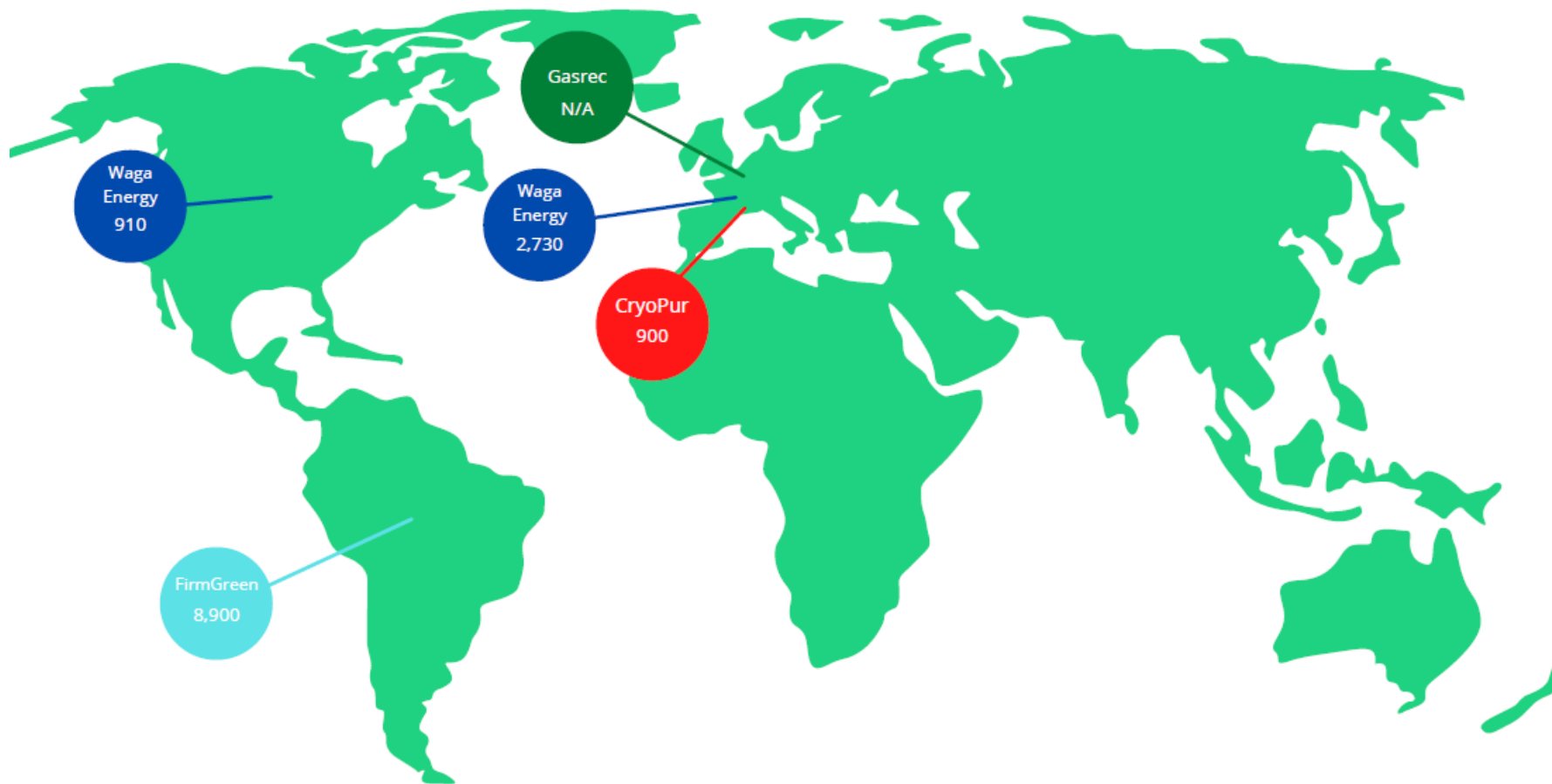
Figure 19. Presence of chemical scrubbing suppliers, installed capacity of units in operation, m³/hr

Cryo

MAJOR SUPPLIERS – Cryo

COMPANY*	Number of plants in operation	Capacity, plants in operation, m ³ /hr	Installed capacity during last 3 years (2019-2021), m ³ /hr	Number of plants under construction (2022-2023)	Capacity, under construction, m ³ /hr
CRYO PUR	2	900	900	Not available	Not available
FIRMGREEN	1	8 900	Not available	Not available	Not available
GASREC	1	Not available	Not available	Not available	Not available
WAGA ENERGY	12	3,640	2,190	6	1,840

Figure 20. Presence of cryo suppliers, installed capacity of units in operation, m3/hr



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APPENDIX 1.

BIOMETHANE PLANTS IN CANADA

Do not distribute

BiogasWorld Media Inc.

City	Province	Project Name	System Type	Biogas Usage	Project Company	Status	Upgrading type	Upgrading technology	Date
Aldersyde	AB	Highwood Organics Processing	Agriculture/Commercial/SSO	RNG	Highwood Organics Processing	Substantial Development	Not available	Not available	
Calgary	AB	Green Impact Partners Project		RNG/Biofuel	Green Impact Partners Inc.	Substantial Development	Not available	Not available	
Edmonton	AB	Gold Bar - Epcor	WWTP	RNG	Gold Bar WWTP - EPCOR	Under Construction	Not available	Not available	NA
Edmonton	AB	G4 Insights - ATCO - Pilot project (PyroCatalytic Hydrogenation (PCH))	Woody Biomass	2nd gen RNG	NA	Online	Not available	Not available	2019
Lacombe	AB	Lacombe Biorefinery	Agriculture	2nd gen RNG	RNG	Substantial Development	Not available	Not available	2022
Lethbridge	AB	Lethbridge Biogas	Agriculture	CHP/ RNG in dev	PlanET	Substantial Development	ETW	PSA	2021
Acme	AB	Korova Feeders Ltd.	Agriculture	RNG		Substantial Development	Not available	Not available	
Whitecourt	AB	Millar Western Forest Products Ltd.	Industrial	RNG	demonstration project, ATCO	Substantial Development	Not available	Not available	
Vegreville	AB	Two Hills RNG Facility	Agriculture/SSO	RNG	ATCO Energy Solutions,Future Fuel Ltd.		Not available	Not available	
Abbotsford	BC	Fraser Valley Biogas	Agriculture	RNG	Avatar Energy (no longer exists),bought by EverGen in 2021	Online	water adsorption	Greenlane	2010
Abbotsford	BC	Net Zero Waste Project	Commercial	RNG	EverGen, FortisBC	Under Construction	Not available	Not available	
Chilliwack	BC	Dicklands Farms	Agriculture	RNG/heat	CH4 Biogas	Substantial Development	Not available	Not available	NA
Delta	BC	City of Vancouver Landfill	Landfill	RNG/heat	FortisBC, Quadrogen Power systems	Online	Membrane	DMT	2020
Delta	BC	Seabreeze Farm	Agriculture	RNG/heat	CH4 Biogas	Online	water adsorption	Greenlane	2015
Clayhurst	BC	Horseshoe Valley Ranch	Agriculture	RNG	FortisBC, Scovan Engineering Inc., Gemini	Under Construction	Not available	Not available	
Fruitvale	BC	REN Energy (phase 1)	Industrial	2nd gen RNG	(gasification, gas cleaning and	Under Construction	Not available	Not available	
Kelowna	BC	Glenmore	Landfill	RNG/heat	Fortis BC	Online	PSA	ARC technologies	2014
Park siding	BC	REN Energy (phase 2)	Industrial	RNG	FortisBC, REN Energy		Not available	Not available	2022
Prince George	BC	Foothills Boulevard Regional Landfill	Landfill	RNG	FortisBC	Online	Not available	Not available	2020
Richmond	BC	Lulu Island	WWTP	RNG/heat	Fortis BC (Greenlane - RNG)	Under Construction	water adsorption	Greenlane	2021
Salmon Arm	BC	Salmon Arm	Landfill	RNG/heat	Fortis BC	Online	PSA	Xebec	2013
Surrey	BC	Surrey Biofuel Facility, Orgaworld	SSO	RNG	Fortis BC	Online	water adsorption+PS	Greenlane/Sysadvnc	2016
Victoria	BC	Hartland	Landfill	RNG	NA	Under Construction	Not available	Not available	2021
Williams Lake	BC	Williams Lake	Woody Biomass	2nd gen RNG	Fortis BC	Concept	Not available	Not available	NA
Augusta	ON	Waste Disposal Site	Commercial	RNG	H&D Properties Ltd.	Under Construction	Not available	Not available	
Aylmer	ON	Walker Dairy	Agriculture	RNG	AB Energy, DLS, ECONOMAX, WALKER RNG	Online	Membrane	AB Energy	2021
Blenheim	ON	Ridge - Chatham	Landfill	RNG	Aria	Under Construction	Not available	Not available	2019
Brampton	ON	Anaerobic Digestion Facility Project	SSO	RNG		Substantial Development	Not available	Not available	2024
Cornwall	ON	City of Cornwall project	WWTP/SSO	RNG		Concept	Not available	Not available	
Dundalk (Southgate)	ON	Mattawa Renewable Power Corp.	Agriculture/Commercial/SSO	RNG	Enbridge	Substantial Development	Not available	Not available	
Hamilton	ON	Hamilton Transfer Station	SSO/Commercial	RNG	Bradam Canada Inc., injecting for Fortis	Under Construction	Not available	Not available	
Hamilton	ON	Woodward Avenue WWTP	WWTP	RNG/heat	NA	Online	water adsorption	Greenlane	2011
Havelock	ON	Kawartha Biogas	Commercial	RNG	PurEnergy	Substantial Development	Not available	Not available	NA
Ilderton	ON	Stanton Farms Biogas	Agriculture	RNG	FortisBC grid	Under Construction	Not available	Not available	2021
Kirkland Lake	ON	CHAR Technologies Facility	Agriculture	RNG	CHAR Technologies	Under Construction	Not available	Not available	
Drumbo	ON	Drumbo	SSO	RNG	Storm Fisher, Genecis Bioindustries Inc.	Substantial Development	Not available	Not available	
London	ON	London Dairy AD Project	Agriculture	RNG	Storm Fisher	Substantial Development	Not available	Not available	2022
London	ON	Storm Fisher (Previously Harvest Power)	Commercial	RNG	Storm Fisher	Online	Membrane	Hitachi	2019
London	ON	Green Shields Energy Facility	SSO/plastics	P2G	Marketing, RNG injected and sold to	Substantial Development	not applicable	not applicable	2022
Middlesex	ON	Stanton Bros. Ltd	Agriculture	RNG/CHP	NA	CHP online/ RNG concept	Not available	Not available	NA
Niagara Falls	ON	Niagara Falls Renewable Natural Gas plant	Landfill	RNG	Environmental	Under Construction	Not available	Not available	2022
North York	ON	Dufferin Organics Processing Facility	SSO	RNG	Enbridge, City of Toronto	Online	PSA	Xebec	NA
Oshawa	ON	Northwood Transfer Station	Commercial	RNG	RIC (EOR) Inc.	Under Construction	Not available	Not available	
Peel	ON	Peel Region digester	SSO	RNG	NA	Cancelled	Not available	Not available	NA
Roblin	ON	Napanee Transfer Station	SSO/Commercial	RNG	Bradam Canada Inc., injecting for Fortis	Under Construction	Not available	Not available	
Shakespeare	ON	Faromor CNG Corp.	Agriculture	RNG	Rfaromor CNG Corp., FortisBC	Under Construction	Not available	Not available	
Stratford	ON	OCWA-Suez-Stratford RNG project	WWTP/SSO	2d gen RNG	Suez	Substantial Development	Not available	Not available	NA
Timmins	ON	Timmins WWTP+SSO	WWTP/SSO	RNG		consideration	Not available	Not available	
	ON	Gerdau Steel-True Energy (Methane+Hydrogen)		P2G	plastics	Substantial Development	not applicable	not applicable	NA
Ange-Gardien	QC	Projet Ange-Gardien	Agriculture	RNG	Qarbonex	Substantial Development	Not available	Not available	2024

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City	Province	Project Name	System Type	Biogas Usage	Project Company	Status	Upgrading type	Upgrading technology	Date
Berthierville	QC	EBI - Rive Nord	Landfill	RNG	EBI Energie	Online	Membrane	Honeywell	2003
Cowansville	QC	Cowansville	Commercial	RNG	Bahler Biogas	Under Construction	PSA	Xebec	2022
Candiac	QC	ADM (Archer Daniels Midland)-Agri-Industrie	Agriculture	RNG	NA	Under Construction	PSA	Guild	2022
Cowansville	QC	Régie intermunicipales de gestion des matières résiduelles de Brome-Misissquoi	Landfill	RNG	Waga Energy	Under Construction	Cryo	Waga	2022
Chicoutimi	QC	GFL Environmental Inc (before Matrec)	Landfill	RNG	Matrec	Concept	Cryo	Waga	2022
Duvernay Est.	QC	Usine de traitement des eaux usées La Pinière	WWTP	RNG		Substantial Development	Not available	Not available	2024
Farham	QC	Nature Energy	Agriculture	RNG	Nature Energy	Substantial Development	Not available	Not available	2023
La Salle	QC	Centre de traitement des matières organiques (CTMO) SUD : Centre de biométhanisation	SSO	RNG	NA	Substantial Development	Not available	Not available	2025
Laval	QC	Station La Pinière	SSO	RNG	NA	Substantial Development	Not available	Not available	2023
Lachine	QC	Confidential	Agriculture	RNG	Confidential	Concept	Not available	Not available	NA
Mirabel	QC	Confidential	Agriculture	RNG	NA	Substantial Development	Not available	Not available	2024
Montreal	QC	CTMO EST	SSO	RNG	Suez	Substantial Development	Not available	Not available	2022
Montreal	QC	Montreal Organic Waste Treatment Centre	Landfill	RNG	Suez	Substantial Development	Membrane	Methanis Membrane System	
Neuveville	QC	Carbonaxion Bioénergies inc. (anciennement LET Neuveville)	Landfill	RNG	Carbonaxion, PyroGenesis Canada Inc., Pyro Green-gas (AirScience Technologies Inc.)	Substantial Development	Membrane	Pyro Green-Gas	2023
Quebec city	QC	CBAQ	SSO	RNG	NA	Under Construction	water adsorption	Greenlane	2022
Rivieres-du-Loup	QC	SEMER	SSO	RNG	SEMER	Construction	Chemical Adsorption	Not available	2022
Saguenay	QC	Agriméthane Saguenay	Agriculture	RNG	Nutrino et de la Fromagerie Boivin	Substantial Development	Not available	Not available	
Saint-Pie	QC	Qarboycle	SSO	RNG	Qarbonex	Substantial Development	Not available	Not available	2023
Sainte-Pie	QC	CTBM	SSO	RNG	CTBM	Construction	Not available	Not available	2022
Sainte-Sophie	QC	Waste Management	Landfill	RNG	WasteManagement,	Concept	Not available	Not available	2023
Ste-Sophie-de-Levard	QC	Groupe Bioénertek inc.	Agriculture	RNG	Groupe Bioénertek inc.	Substantial Development	Not available	Not available	2023
Saint-Hyacinthe	QC	St.-Hyacinthe	SSO	RNG	Filtrum Construction	Online	water adsorption	Greenlane	2017
Saint-Nazaire d'Acton	QC	Centre d'Interprétation et de Valorisation des Résidus Agricoles (CIRVA)	Agriculture	RNG	NA	Substantial Development	Not available	Not available	NA
Ste-Étienne des Grès	QC	Ste-Étienne des grès Landfill	Landfill	RNG	Waga Energy	Under Construction	Cryo	Waga	2021
Terrebonne	QC	Vision Enviro Progressive (before BFI Usine de triage Lachenaie)	Landfill	RNG	BFI	Online	water adsorption	Greenlane	2014
Trois-Rivières	QC	Confidential	Commercial	RNG	Confidential	Concept	Not available	Not available	NA
Varennes	QC	SEMECS	SSO	RNG	CCI Bionergy	Construction	Not available	Not available	2022
Victoriaville	QC	Coopérative de solidarité Carbone	Agriculture	RNG	Coop Carbone	Substantial Development	Not available	Not available	2023
Warwick	QC	COOP Agri-Energie	Agriculture	RNG	Le Groupe Génitique, Pyro-Green Gas	Online	Membrane	AirScience (Pyro-Green)	2021

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APPENDIX 2.

BIOMETHANE PLANTS IN THE USA

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BiogasWorld Media Inc.

City	State	Project Name	System Type	Biogas usage	Project Company	Status	Upgrading type	Upgrading provider	Date
Summerdale	AL	Magnolia Sanitary Landfill	Landfill	RNG	Climate Capital Funds, LLC., AEP Renewable Fuels	Under Construction			2022
Sebastian	AR	Fort Smith SLF	Landfill	RNG	Cambrian Energy Development LLC; Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2006
Washington	AR	Eco-Vista Landfill	Landfill	RNG	WM Renewable Energy, LLC	Under Construction	Not available	Not available	
Buckeye	AZ	Butterfield RNG 1, LLC, Butterfield Dairy and Milky Way	Agriculture	RNG	LLC	Under Construction	Not available	Not available	2021
Eloy	AZ	Caballero Dairy	Agriculture	RNG	Brightmark, Chevron	Substantial Development			2022
Gila Bend	AZ	Sunoma Renewable Biofuels - Paloma Dairy	Agriculture	RNG	Paloma Dairy, Southwest Gas, Fortistar	Online			2021
Maricopa	AZ	Maricopa RNG 1, LLC - Milky Way Dairy	Agriculture	RNG	Southwest Gas, AMP Americas, Equilibrium, Green Gas Partners	Under Construction	Not available	Not available	2022
Phoenix	AZ	City of Phoenix 23rd Ave. WWTP	WWTP	RNG	part of flow goes to 91st Ave WWTP	Online	Not available	Not available	
Snowflake	AZ	Snowflake	Agriculture	RNG		Substantial Development			
Stanfield	AZ	Green Gas Partners Project	Agriculture	RNG	Green Gas Partners	Online	Not available	Not available	
Tolleson	AZ	City of Phoenix 91st Avenue WWTP	WWTP	RNG	Ameresco, Inc.	Online	Not available	Not available	
Tucson	AZ	Tres Rios	WWTP	RNG	Southwest Gas	Online	Membrane	DMT	2021
Bakersfield	CA	ABEC Lakeview Farms Dairy Digester	Agriculture	RNG	California Bioenergy LLC [Project Developer]	Online			2018
Bakersfield	CA	Kern Dairy Cluster Biomethane Upgrading Facility (Belonave, McMoo, Vanden, Palla Rosa, Lakeview, Newhouse, Trilogy, Maple, West Wind, Western Sky, T&W Farms, Carlos Echeverna, Old River, Belonave, BV, Bos Farms, Hamstra Dairy)	Agriculture	RNG	CalBioGas, a joint venture between California Bioenergy, Chevron U.S.A.	Online	Not available	Not available	2020
BLOOMINGTON	CA	RIALTO WRF (Rialto Bioenergy Facility), San Bernardino	WWTP	RNG	Anaergia, Waste Management, Republic Services, Southern California Edison, Anaheim Public Utility, Southwest Gas Utility, City of Rialto, the Sanitation Bureau of the City of Los Angeles, and the Sanitation Districts of Los Angeles County and of Orange County	Online	Not available	Not available	
Buttonwillow	CA	Buttonwillow cluster (Albert Goyenette, Maya Dairy, Skyview Dairy, Southern Cross, Whiteside)	Agriculture	RNG	California Bioenergy LLC	Under Construction	Not available	Not available	
Carson	CA	Joint Water Pollution Control Plant / LA county	WWTP	RNG		Online		Unison/BioCNG	2020
Ceres	CA	Aemetis Biogas Central Dairy Digester Project (Ackerman Dairy, Double D Dairy, AAFK Central, Ahlem Farms Jerseys - AAFK Central Dairy, Oliveira Dairy, S&S Dairy, Trinkler Dairy,	Agriculture	RNG	Maas Energy Works	Under Construction	Not available	Not available	2022
Chino	CA	Inland Bio-Energy	Industrial	RNG	ES Engineering	Online	membrane	DMT	2012
Chowchilla/Merced	CA	Merced-South Cluster (DJ South Dairy, Five H Dairy, Hoogendam Dairy, Meirinho Dairy, Red Rock Dairy, Rockshar Dairy, Vander Woude Dairy, Vista Verde Dairy)	Agriculture	RNG	Maas Energy Works	Under Construction			
Contra Costa	CA	Keller Canyon LF	Landfill	RNG	Ameresco, Inc.	Substantial Development	Not available	Not available	
CORONA	CA	CORONA WWTP 1	WWTP	RNG/Heat		Online	Not available	Not available	
Edison	CA	Bakersfield Metropolitan SLF (BENA)	Landfill	RNG	Bena Power Producers	Substantial Development	Not available	Not available	
EL NIDO	CA	Merced Cluster (Double Diamond Dairy, Homen Dairy, Melo Dairy, Ahlem Farms)	Agriculture	RNG	Maas Energy Works	Under Construction			
Fresno	CA	Fresno/Clovis Regional Wastewater Reclamation Facility	WWTP	RNG		Substantial development	Membrane	Air liquide	2012
Hanford	CA	Lakeside Cluster (Dixie Creek Dairy, High Roller Dairy, Lakeside Dairy, Poplar Lane Dairy)	Agriculture	RNG	Maas Energy Works	Under Construction	Not available	Not available	
Hanford	CA	Hanford Kings Cluster (Cloverdale Dairy Biogas, Red Top Madera, Rancho Teresita, Rocking Horse, Valadao Dairy)	Agriculture	RNG	CalBioGas, a joint venture between California Bioenergy, Chevron U.S.A.	Under Construction			

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City	State	Project Name	System Type	Biogas usage	Project Company	Status	Upgrading type	Upgrading provider	Date
Handord	CA	Hanford Lakeside Cluster (Decade centralized dairy, Double L Dairy, Lone Oak #1 Dairy, River Ranch Dairy Digester)	Agriculture	RNG	Maas Energy Works	Under Construction			
Hanford	CA	Flint Dairy Biogas Project (Demonstration Project)	Agriculture	RNG	ENV-TWO LLC	Substantial Development			
Hilmar	CA	Hilmar cluster (James Ahlem Dairy, Nyman Brothers Dairy, Yosemite Jersey Dairy)	Agriculture	RNG	California Bioenergy	Under Construction			
Kings	CA	AgLand project (poultry)	Agriculture	RNG		Substantial Development			2024
Lindsay	CA	Hilarides Dairy Digester	Agriculture	RNG	[Construction & Installation]	Online	PSA	Xebec	2004
Livermore	CA	Altamont Landfill & Resource Recovery Facility	Landfill	RNG	High Mountain Fuels	Online	PSA	Guild Associates	2009
Los Banos	CA	Soares dairy farms (RNG Moovers Project)	Agriculture	RNG	Aria Energy, Aligned Digesters, bp, Centarus (RNG delivery to injection point)	Substantial development			
Madera	CA	Aligned Digester Co. LLC / Red Top Jerseys Dairy	Agriculture	RNG - On Hold	Aligned Digesters	Substantial development	PSA	BioFerm	
McFarland	CA	San Joaquin Renewables	Asgriculture	RNG	San Joaquin Renewables, Cresta Fund Management, Silver Peak Energy Partners	Under Construction			
Merced	CA	Merced Dairy Cluster	Agriculture	RNG	AgLand Renewables LLC (AgLand), a subsidiary of Maryland-based CleanBay Renewables Inc.	Substantial development	Not available	Not available	2024
Modesto	CA	Keyes ethanol plant	Agriculture	RNG	Aemetis, Inc.	Under Construction			2022
Oroville	CA	North State Rendering	Commercial	RNG	Seahold (CNG directly)	Online	Not available	Unison/BioCNG	
Oroville	CA	North State Digester	Commercial	RNG	Biogas Energy	Offline	Not available	Not available	
Oroville	CA	Yosemite Clean Energy Facility	Commercial	RNG/Hydrogen	Yosemite Clean Energy, Repotec	Under Construction			
Perris	CA	CR&R Anaerobic Digester	Commercial	RNG	SoCalGas, CR&R Incorporated, Eisenmann, Greenlane/Sysadvance	Online	Water adsorption + PSA	Greenlane/Sysadvance	2017
Petaluma	CA	Petaluma Ellis Creek WRF (mobile pipeline)	WWTP	RNG		Under Construction	Not available	Not available	2019
Pixley	CA	Calgren cluster (Hollandia Farms, Cornerstone Dairy Digester, Trilogy Dairy, Williams Family, K&M Visser Dairy, Pixley Dairy, Legacy Dairy, 4K Dairy, FM Jerseys, Little Rock, Riverview Dairy, Sousa & Sousa, Vander Poel, Vander Eyk, Circle A Dairy, Avalon, de Boer, Fern Oaks, Hettinga Centralized, Northstar Dairy, Schott Dairy, Simoes Centralized, JDS Ranch, JR Dairy)	Agriculture	RNG	Maas Energy Works	Online			
Rialto	CA	Sun Valley Recycling Park (WM)	Commercial	RNG	Anaergia	Substantial Development			
Rialto	CA	Mid Valley landfill	Landfill	RNG	Archaea	Under Construction			
Riverdale	CA	Five Points Cluster (Van Der Hoek Dairy, Van Der Kooi Dairy, Vanderham Dairy, Wilson Dairy)	Agriculture	RNG	Maas Energy Works	Under Construction	Not available	Not available	
Roseville	CA	Pleasant Grove WW	WWTP	RNG		Under Construction	Not available	Not available	
Sacramento	CA	Sacramento BioDigester	SSO	RNG	CleanWorld	Online	Membrane	Unison/BioCNG	2013
San Diego	CA	Point Loma Wastewater Treatment Plant	WWTP	RNG/CHP/fuel cell		Online	Membrane	Air liquide	2012
San Joaquin	CA	Forward Landfill	Landfill	RNG	Ameresco, Inc.	Substantial Development	Not available	Not available	
San Mateo	CA	City of San Mateo WWTP	WWTP	RNG		Online	Membrane	Unison/BioCNG	2017
San Rafael	CA	LAS GALLINAS VALLEY STP	WWTP	RNG	Tetra Tech, Unison Solutions	Substantial Development	Membrane	Unison/BioCNG	
Santa Clara	CA	Newby Island SLF Phases I, II, & III	Landfill	RNG	Republic Services, Inc.	Substantial Development	Not available	Not available	
Simi Valley	CA	Simi Valley	Landfill	RNG		Substantial Development	Not available	Not available	
South San Francisco	CA	Blue Line Biogenic CNG Facility	Commercial	RNG	Blue Line Transfer Inc., Zero Waste Energy	Online	Membrane	Unison/BioCNG	2015
South San Francisco	CA	Blue Line Biogenic	SSO	RNG	ZeroWaste	Online	Membrane	Unison/BioCNG	2013
Tulare	CA	West Visalia Cluster (S&S Dairy, De Groot North, De Groot South, Udder Dairy)	Agriculture	RNG	California Bioenergy LLC (CalBio), Chevron U.S.A. Inc.	Online			2020

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City	State	Project Name	System Type	Biogas usage	Project Company	Status	Upgrading type	Upgrading provider	Date
Tulare	CA	South Tulare Cluster (Dykstra Dairy, Wreden Ranch, T & W Dairy, Moonlight Dairy, Aukeman Dairy, El Monte Dairy, Horizon Jersey, Riverbend, Scheenstra, Curtimade, Dairyland Farms, Elk Creek Dairy, Friesian Farms, Rib-Arrow Dairy, Ribeiro Dairy, Rio Blanco)	Agriculture	RNG	California Bioenergy, 4 Creeks Engineering, Anaergia, 4C Global	Online			
Tulare	CA	Hamstra Dairy Digester	Agriculture	RNG		Online			2020
Victorville	CA	SoCal Biomethane - Victor Valley Wastewater Reclamation Authority	WWTP	RNG	Southwest Gas	Under Construction			2021
VISALIA	CA	North Visalia cluster (injection in Gosnen, Double J Dairy, Jacobus De Groot #2, Mellema Dairy, Milky Way Dairy, Mineral King Dairy, Rancho Sierra Vista Dairy, Rob Van Grouw, Art Leyendekker Dairy, Elkhorn Dairy, Gerben Leyendekker Dairy, GP Dairy)	Agriculture	RNG	CalBioGas, a joint venture between California Bioenergy, Chevron U.S.A.	Under Construction			
Wasco	CA	Poso Creek Dairy Biogas	Agriculture	RNG	California Bioenergy	Substantial Development			
Wasco	CA	Boschma Biogas LLC	Agriculture	RNG	California Bioenergy	Substantial Development			
Boulder	CO	City of Boulder, Colorado WWTF	WWTP	RNG	Western Disposal Services, Xcel Energy to transport RNG	Online	Not available	Not available	2020
Englewood	CO	South Platte Water Renewal Partners (former Littleton/Englewood)	WWTP	RNG		Under Construction	Not available	Not available	
Grand Junction	CO	Persigo (Grand Junction) WWTF	WWTP	RNG		Online	Membrane	BioCNG	2016
Longmont	CO	City of Longmont	WWTP	RNG		Online	Water adsorption	Greenlane	2015
Weld County	CO	Heartland biogas	Commercial	RNG	Heartland biogas	Offline	Water adsorption + PSA	Greenlane	2015
Yuma	CO	Yuma County Anaerobic Digester	Agriculture	RNG		Substantial Development	Not available	Not available	
Ellington	CT	Oakridge Dairy LLC	Agriculture	RNG	SJI, REV LNG LLC	Under Construction			2022
Blades	DE	Bioenergy Innovation Center	Agriculture	RNG/CHP		Under Construction			
Georgetown	DE	Sussex 1	Agriculture	RNG	CleanBay Renewables	Substantial Development	Not available	Not available	2019
Seaford	DE	Bioenergy innovation center (poultry)	Agriculture	RNG	Bioenergy DevCo, Chesapeake Utilities Corporation	Under Construction	Not available	Not available	
Okeechobee	FL	Sobek (Larson dairy, JM Larson)	Agriculture	RNG	Brightmark, Chevron, injected into Teco People Gas pipeline	Under Construction	PSA	Greenlane	2021
Raiford	FL	New River Solid Waste Association (NRSWA)	Landfill	RNG	Fortistar, New River Solid Waste Association (NRSWA)	Under Construction		Air liquide	2021
Trenton	FL	Alliance Dairy Digester	Agriculture	CHP, RNG in dev	DVO, Inc. (formerly GHD, Inc.) for CHP, TECO Peoples Gas will build, own and operate RNGplant	Under Construction			
Ball Ground	GA	Eagle Point Landfill LLC	Landfill	RNG	Aria Energy	Substantial Development	Membrane	Air liquide	
DeKalb	GA	Live Oak LF	Landfill	RNG	Jacoby Energy Development, Inc.	Online	Membrane	Air liquide	2009
DeKalb	GA	Seminole Road MSW Landfill	Landfill	RNG/CHP	DeKalb County Sanitation, GA	Online	PSA	Arc Technologies	2012
Ewa Beach	HI	Honolulu WWTP	WWTP	RNG/Heat		Online	Membrane	DMT	2018
Des Moines	IA	DES MOINES METRO WRA WWTP	WWTP	RNG		Under Construction	Not available	Not available	
Dubuque	IA	Dubuque Metro Landfill	Landfill	RNG	City of Dubuque, Enerdyne	Under Construction			
Dubuque	IA	DUBUQUE Water and Resource Recovery Center	WWTP	RNG	BioResource Development, LLC / Sell to US Gain	Online	PSA	Not available	2018
Muscatine	IA	MUSCATINE WATER POLLUTION CONTROL PLANT	WWTP	RNG		Concept	Not available	Not available	
Nevada	IA	Nevada Biorefinery (Verbio Renewable Natural Gas Plant)	Agriculture	RNG		Online	Not available	Not available	2021
Paullina	IA	Roorda Dairy	Agriculture	RNG	ProAg Engineering, Brightmark	Under Construction		Brightmark	
Dubuque	IA	SIOUX CENTER WWTP	WWTP	RNG	Bartlett & West, Sioux city	Online	Membrane	DMT	2020
Hansen	ID	Hansen RNG	Agriculture	RNG		Under Construction	Not available	Not available	
Huntington	ID	Star Bioenergy - New Dawn Dairy	Agriculture	RNG		Under Construction			
Jerome	ID	AgPower Jerome LLC - Double A Dairy Digester	Agriculture	RNG	Montauk Renewables	Online	Not available	Not available	2011

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City	State	Project Name	System Type	Biogas usage	Project Company	Status	Upgrading type	Upgrading provider	Date
Jerome	ID	Bettencourt Dairy B6 Farm Digester	Agriculture	RNG	Cargill, Inc. (Project Developer, System Designer, System Design Engineer); Environmental Fabrics, Inc. (System Designer, Biogas Membrane Supplier)	Under Construction			
Jerome	ID	Pico Energy RNG	Agriculture	RNG		Under Construction	Not available	Not available	
Parma	ID	Boise Biogas	Agriculture	RNG	Integrated Biogas Alliance (IBA)	Under Construction		Greenlane	2021
TWIN FALLS	ID	TWIN FALLS Dairy - Sevana Bioenergy	Agriculture	RNG	Meridiam, Sevana Bioenergy	Under Construction			2022
Wendell	ID	Bettencourt Dairies	Agriculture	RNG	Shell, Shell Downstream Bovarius	Under Construction			
Cook	IL	Green Era Urban Farming Campus	Commercial	RNG		Under Construction			
Decatur	IL	Archer Daniels Midland corn processing facility	Commercial	RNG	Archer Daniels Midland/Ameren Illinois	Online	Not available	Not available	2017
Madison	IL	Roxana LF	Landfill	RNG	Biogas Energy Solutions, LLC	Substantial Development	Not available	Not available	
St. Clair	IL	Milam Recycling and Disposal Facility	Landfill	RNG	WM Renewable Energy, LLC	Online	Membrane + PSA	Not available	2015
Will	IL	Prairie View RDF	Landfill	CHP, RNG in dev	WM Renewable Energy, LLC	Under Construction			
Zion	IL	Zion RNG	Landfill Gas	RNG		Substantial Development			
Danville	IN	Twinbridges Landfill	Landfill	RNG	Kinetrex Energy, Wabash Valley Power Alliance	Under Construction			2022
Fair Oaks	IN	Fair Oaks Dairy - Digester 1 / AMP Americas (RDF) (Part of cluster)	Agriculture	RNG	AMP Americas	Online	membrane	DMT	2018
Fair Oaks	IN	Fair Oaks Dairy - Digester 2 (RDF) (Part of cluster)	Agriculture	RNG	AMP Americas	Online	Water adsorption	Greenlane	2018
Fair Oaks	IN	Herrema Dairy Digester (Part of cluster)	Agriculture	RNG	AMP Americas	Online			2018
Fair Oaks	IN	Windy Ridge Dairy Digester (Part of cluster)	Agriculture	RNG	AMP Americas	Online			2018
Huntington	IN	Huntington AD project	Agriculture	RNG	Star Energy Holdings	Under Construction	Membrane	DMT	2019
INDIANAPOLIS	IN	Indy High BTU Renewable Natural Gas Plant (South Side landfill)	Landfill	RNG	EDL, Kinetrex Energy, South Side Landfill	Online			2020
Jackson	IN	Rumpke Medora Landfill	Landfill	RNG	Rumpke Waste and Recycling, Archaea	Under Construction			
Monticello	IN	RAKR Farms	Agriculture	RNG/CHP		Substantial Development	Not available	Not available	
Monticello	IN	Liberty Landfill	Landfill	RNG	Kinetrex Energy, Wabash Valley Power Alliance	Under Construction			2022
Reynolds	IN	Bio Town Ag, Inc. Digester	Agriculture	CHP, RNG in dev	Opal Fuels LLC, Clarke Energy USA Inc. (a KOHLER Company)	Online, RNG under construction			
Wyatt	IN	Prairie View Landfill	Landfill	RNG	Kinetrex Energy, Wabash Valley Power Alliance	Under Construction			2022
Dodge City	KS	Warrior RNG Project	WWTP	RNG		Online	PSA	Guild Associates	2018
Dodge City	KS	Hilmar Cheese Company	Industrial	RNG		Substantial Development			2023
Johnson	KS	Johnson County LF-Shasnee	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2016
Lawrence	KS	Hamm SLF Renewable Power Producers	Landfill	RNG	Renewable Power Producers	Online	PSA	Xebec	2017
Plains	KS	High Plains Ponerosa Dairy	Agriculture	RNG	Shell, Shell Downstream Galloway	Under Construction			
Topeka	KS	TOPEKA OAKLAND WWTP	WWTP	RNG		Under Construction	Membrane	Prodeval	2020
Ashland	KY	Big Run Landfill (Boyd County Landfill)	Landfill	RNG	Archaea	Online	Membrane	DMT	2021
Jeffersonville	KY	Montgomery County landfill	Landfill	RNG	Archaea	Under Construction			
Louisville	KY	Outer Loop RDF	Landfill	RNG	WM Renewable Energy, LLC	Online	Not available	Not available	2018
Avondale	LA	River Birch Landfill	Landfill	RNG	River Birch, Inc.	Online	Membrane	Air liquide	2010
Jefferson Davis	LA	Jefferson Davis Parish Landfill, Welsh	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2016
Keithville	LA	Woolworth Road Landfill	Landfill	RNG		Online	PSA	Not available	2018
Oakdale/Allen	LA	Timberlane	Landfill	RNG		Online	Not available	Not available	2020
St. Landry	LA	St. Landry Parish LF	Landfill	RNG	District, LA	Online	Membrane	Unison/BioCNG	2012
Jessup	MD	BTS Biogas LLC/Devco Bioenergy	Commercial	RNG	Bioenergy Devco	Under Construction			
Jessup	MD	Maryland Food Center	SSO	RNG/CHP	Bioenergy Devco	Under Construction		DMT	2022
Piscataway	MD	Piscataway WRRF bioenergy plant	WWTP	RNG	Washington Suburban Sanitary Commission	Under Construction			2024
Westover	MD	Westover (poultry)	Agriculture	RNG	CleanBay Renewables	Under Construction	Not available	Not available	
Clinton	ME	Flood Brothers Farm	Agriculture	RNG	Summit Natural Gas	Under Construction			
Old Town	ME	Juniper Ridge Landfill	Landfill	RNG	Archaea	Under Construction			
Caledonia	MI	Walnutdale Family Farms LLC,	Agriculture	RNG		Concept			
Coopersville	MI	Castor RNG Project (Beaver Creek Farm)	Agriculture	RNG	Brightmark, Chevron	Substantial Development			2022
Davison	MI	Richfield Landfill	Landfill	RNG	Blue Skies Energy, LLC	Online	Membrane	Honeywell	2016
Greenville	MI	Meadow Rock Dairy	Agriculture	RNG	Brightmark, Chevron, ANR Pipeline.	Under Construction			2022
Grand Rapids	MI	Grand Rapids Water Resource Recovery Facility	WWTP	RNG		Under Construction			
Hartford	MI	Red Arrow RNG project	Agriculture	RNG	Brightmark, Chevron, ANR Pipeline.	Under Construction			2022
Kent	MI	Kent County Business Park for Waste Recovery	Commercial	RNG	Continous Materials, Anergia	Under Construction			2025
Lansing	MI	Wood Road	Landfill	RNG		Substantial Development			
Morenci	MI	SunRyz RNG project	Agriculture	RNG	Brightmark, Chevron	Under Construction			2022

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City	State	Project Name	System Type	Biogas usage	Project Company	Status	Upgrading type	Upgrading provider	Date
Northland	MI	Arbor Hills Landfill	Landfill	RNG	GFL Environmental, Opal Fuels LLC	Substantial Development			2023
Pewamo	MI	Steekblik Dairy	Agriculture	RNG		Concept			
Three Rivers	MI	Westside Recycling and Disposal Facility	Landfill	RNG	DTE Biomass Energy	Online	Chemical adsorption	Not available	1999
Walker	MI	Three Mile Road Station	Commercial	RNG	DTE Energy	Online			2021
Wayne	MI	Riverview Land Preserve	Landfill	RNG	City of Riverview, MI, APM Americas	Online	Membrane	Unison/BioCNG	2013
Wayne	MI	Sauk Trail Hills Landfill	Landfill	RNG	APM Americas	Online	Water adsorption	Greenlane	2013
Wayne	MI	Woodland Meadows Landfill-Van Buren	Landfill	RNG	APM Americas	Online	Not available	Not available	
Wayne	MI	Riverview Land Preserve 2	Landfill	RNG	APM Americas	Substantial Development	Not available	Not available	
Brooklyn Park	MN	Brooklyn Park Transfer Station	SSO	RNG		Substantial Development			
Dakota	MN	Pine Bend Landfill	Landfill	RNG	Forti-star(operator),injected to Xcel Energy	Under Construction			2022
Morris	MN	Riverview Dairy Digester	Agriculture	RNG	DVO, Inc. (formerly GHD, Inc.) [Project Developer, System Designer, System Design Engineer]	Online	Membrane	DMT	2020
Albany	MO	Roeslein Alternative Energy - Ruckman Farm Digester	Agriculture	RNG	Roeslein Alternative Energy [Project Developer]	Online	PSA	Guild Associates	2016
Browning	MO	Roeslein Alternative Energy - South Meadows Farm Digester - R	Agriculture	RNG		Online	Not available	Not available	
Green City	MO	Roeslein Alternative Energy - Valley View Farm Digester	Agriculture	RNG		Online	Membrane	Air liquide	2016
Harris	MO	Roeslein Alternative Energy - Locust Ridge Farm Digester	Agriculture	RNG		Online	PSA	Not available	2017
King City	MO	Roeslein Alternative Energy - Homan Farm Digester	Agriculture	RNG	Roeslein Alternative Energy	Online	Not available	Not available	2020
Mercer	MO	Roeslein Alternative Energy - Somerset Farm Digester	Agriculture	RNG	Roeslein Alternative Energy	Under Construction	Not available	Not available	2019
Princeton	MO	Roeslein Alternative Energy - Hedgewood Farm Digester	Agriculture	RNG	Smithfield Foods and Roeslein Alternative Energy	Online	Not available	Not available	2020
Unionville	MO	Roeslein Alternative Energy - Green Hills Farm Digester	Agriculture	RNG	Roeslein Alternative Energy	Under Construction	Not available	Not available	2019
Unionville	MO	Roeslein Alternative Energy - Whitetail Farm Digester	Agriculture	RNG	Roeslein Alternative Energy	Under Construction	Not available	Not available	2018
Walnut	MS	Northeast Mississippi Landfill (NEML) site	Landfill	RNG	Management Authority and operated by	Online	Membrane	Air liquide	2018
Walnut	MS	Northeast Mississippi Regional Landfill	Landfill	RNG	Air Liquide-MEDAL	Online	Membrane	Air liquide	2017
Yellowstone	MT	Billings City Landfill	Landfill	RNG	LFG Technologies, Inc.; Montana-Dakota Utilities Co.	Online	PSA	Guild Associates	2010
Anson County	NC	Poultry project	Agriculture	RNG	Leyline Renewable Capital, Ductor	Under Construction			
Clinton	NC	Sampson and Duplin Counties - 19 family farms	Agriculture	RNG	Align, Dominion, Smithfood	Under Construction			2021
Clinton	NC	BF Grady Road	Agriculture	RNG/CHP		Under Construction			
Kenansville	NC	Optima KV RNG Plant	Agriculture	RNG	Cavanaugh & Associates [System Designer]; Optima BioEnergy [Project Developer]	Online	Membrane	Unison/BioCNG	2017
Lenoir	NC	Foothills Environmental Landfill	Landfill	RNG		Substantial Development	Not available	Not available	
Lilesville	NC	Catawba Biogas	Commercial	RNG/CHP		Substantial Development			
Monroe	NC	Union County Green Energy Biogas Park	Commercial	RNG		Substantial Development			
Roseboro	NC	Sampson County Landfill	Landfill	RNG	GFL Environmental, Opal Fuels LLC	Substantial Development			2023
Rougemont	NC	Upper Piedmont Environmental Landfill	Landfill	RNG		Substantial Development	Not available	Not available	
Stantonsburg	NC	Wilson County Green Energy Biogas Park	Commercial	RNG		Substantial Development			
Tar Hill	NC	Smithfield, Optima Bio	Commercial	RNG/CHP		Online	Not available	Not available	2018
Warsaw	NC	C2e Renewables NC Digester	Agriculture	RNG	Carbon Cycle Energy (C2e) [Project Developer]	Under Construction	Membrane	DMT	2018
Butler	NE	Butler County Landfill Inc. (David city landfill)	Landfill	RNG	Timberline Energy, LLC (Aria Energy)	Online	Membrane	DMT	2018
Douglas	NE	State Street Landfill (Douglas County)	Landfill	RNG	BioResource Development, LLC	Online	PSA	Not available	2015
Fremont	NE	Fremont WWTP	WWTP	RNG		Under Construction	Membrane	DMT	2019
LINCOLN	NE	THERESA STREET WWTP - Lincoln	WWTP	RNG	HDR Engineering, Building Crafts Incorporated, and Black Hills Energy	Online			2021
Springfield	NE	Sarpy County SLF	Landfill	RNG	BioResource Development, LLC	Online	Not available	Not available	
South Sioux City	NE	South Sioux City Digester	WWTP	RNG	Big Ox Energy	Offline	Not available	Not available	

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Bethlehem	NH	Bethlehem	Landfill	RNG	Casella Waste Systems, Inc.	Under Construction	Not available	Not available	2021
Ellington	NJ	Oakridge Dairy	Agriculture	RNG	Elizabethtown Gas, SJI, REV LNG LLC,	Under Construction			2023
Linden, NJ	NJ	Linden Renewable Energy	Commercial	RNG		Substantial Development			
North Arlington	NJ	Kingsland Landfill	Landfill	RNG	inc.	concept	Not available	Not available	
North Arlington	NJ	NJMC 1-E Landfill	Landfill	RNG	Savannah Energy	concept	Not available	Not available	
Mesquite	NM	R-Qubed Energy - Dona Ana Digester	Agriculture	RNG	entec biogas USA [Project Developer, System Designer]; R-Qubed Energy [Project Developer]	Cancelled	Not available	Not available	
Yerington	NV	CEA Desert Hills	Agriculture	RNG		Substantial Development			
BROOKLYN	NY	NEWTOWN CREEK WPCP - Brooklyn	WWTP	RNG		Under Construction			
Byron	NY	Yellowjacket RNG Projct (Boxler Dairy, Lamb farm, Lamb Lakeshore Dairy, Swiss Valley Farms, RNG to be transported to Zuber Farms Digester)	Agriculture	RNG	RCM International LLC [Project Developer, System Designer, System Design Engineer], Brightmark Energy	Online	Membrane	Bright Biomethane	2019
Cayuga	NY	Spruce Haven Farm	Agriculture	RNG	Cayuga RNG is a joint venture owned by a subsidiary of UGI Energy Services, a subsidiary of UGI Corp., and Global Common Energy LLC.				2022
Hunt	NY	Hunt	Agriculture	RNG		Under construction	Membrane	Bright Biomethane	2021
King Ferry	NY	Willet Dairy (Part of Helios project)	Agriculture	RNG	Brightmark Energy	Under Construction			2021
Newark	NY	EL-VI Farms Digester - Upgrades	Agriculture	RNG	Cayuga RNG, UGI Energy Services	Under Construction			2023
Ogdensburg	NY	Woodcrest Dairy Digester	Agriculture	RNG	System Designer, System Design Engineer]	Concept			
Perry	NY	Gardeau Crest Farm (NY) (Part of Helios project)	Agriculture	RNG	Brightmark Energy	Under Construction	Membrane	Bright Biomethane	2021
Richmond	NY	Fresh Kills SLF (Staten Island)	Landfill	RNG	Montauk Energy Capital	Online	Chemical adsorption	Honeywell	2013
Scipio	NY	Allen Farms	Agriculture	RNG	Cayuga RNG Holdings, GHI Energy (subsidiary of UGIES), Global Common Energy LLC	Under Construction			2022
Seneca	NY	Seneca Meadows SWMF	Landfill	RNG	Aria Energy; Innovative Energy Systems, LLC	Online	Membrane	Air liquide	2014
Stanley	NY	Lawnhurst Farms Digester (part of Helios project)	Agriculture	RNG	Brightmark Energy, Chevron	Online	Membrane	Bright Biomethane	2021
Warsaw	NY	Swiss Valley Farms Digester	Agriculture	RNG	DVO, Inc. (formerly GHD, Inc.) [Project Developer, System Designer, System Design Engineer], Brightmark	Online	Membrane	Bright Biomethane	2019
Amsterdam	OH	Apex Sanitary Landfill	Landfill	RNG	Montauk Energy Capital	Online	Membrane	Air liquide	2018
Cardington	OH	Ringler Energy, LLC Digester	Agriculture	RNG/CHP	quasar energy group, LLC. [Project Developer, System Designer, System Design Engineer]; Ringler Energy [Project Developer]	Online	Membrane	BTU biogas/Air products	2014
Columbus	OH	Central Ohio BioEnergy (Renewable Energy Facility)	Commercial	RNG	Equilibrium Capital	Online			
Columbus	OH	quasar energy group - Central Ohio BioEnergy	Commercial	RNG/CHP	Kurtz Bros., Inc [Project Developer]; quasar energy group, LLC. [Project Developer, System Designer, System Design Engineer]; Solid Waste Authority of Central Ohio [Project Developer]	Online	Membrane	BTU biogas/Air products	2010
Fairborn	OH	Dovetail Energy	Agriculture	RNG	Renergy	Under Construction	Not available	Not available	
Franklin	OH	Franklin County SLF	Landfill	RNG	Aria Energy	Online	Chemical adsorption	Acron Technologies	2015
Hamilton	OH	Rumpke SLF, Inc. (Cincinnati)	Landfill	RNG	GSF Energy; Montauk Energy Capital	Online	PSA	Xebec	2006
Haviland	OH	quasar energy group - Haviland Digester	Agriculture	RNG/CHP	quasar energy group, LLC. [Project Developer, System Designer, System Design Engineer]	Cancelled	Membrane	BTU biogas/Air products	2012

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Lowellville	OH	Carbon Limestone Landfill	Landfill Gas	RNG		Substantial Development			
Moraine	OH	Stony Hollow Landfill Inc.; North Sanitary Landfill-Dayton; Pinnac	Landfill	RNG	DTE Biomass Energy	Online	Chemical adsorption	Not available	2003
Newark	OH	NEWARK WWTP & SEWER SYSTEM	WWTP	RNG		Online	PSA	Guild Associates	2011
Oberlin	OH	Lorain County	Landfill Gas	RNG		Substantial Development			
Shiloh	OH	Noble Road Landfill Renewable Natural Gas (RNG)	Landfill	RNG	Fortistar and Rumpke Waste & Recycling	Under Construction		Air Liquide	2021
Waynesburg	OH	American LF	Landfill	RNG	WM Renewable Energy, LLC	Online	PSA	Xebec	2014
Wooster	OH	quasar energy group - Wooster Digester	Agriculture	RNG/CHP	OSU - OARDC (Project Developer); quasar energy group, LLC. (Project Developer, System Designer, System Design Engineer)	Online	Membrane	BTU biogas/Air products	2010
Zanesville	OH	quasar energy group - Zanesville Digester	Agriculture	RNG	OSU - OARDC (Project Developer); quasar energy group, LLC. (Project Developer, System Designer, System Design Engineer)	Online	Membrane	BTU biogas/Air products	2010
Lone Grove	OK	Southern Oklahoma Regional Disposal Landfill	Landfill	RNG		Online			
Oklahoma	OK	East Oak SLF	Landfill	RNG	WM Renewable Energy, LLC	Under Construction	Membrane	Air liquide	2015
Oklahoma City	OK	Southeast OKC Landfill	Landfill	RNG	Aria Energy	Online	Membrane	Air liquide	2008
Oklahoma City	OK	Oklahoma city landfill	Landfill	RNG		Online			
Turpin	OK	Seaboard Foods /High Plains	Commercial	RNG/CHP	Seaboard Foods / High Plains Bioenergy	Online	PSA	Carbotech	2017
Bend	OR	Deschutes County Knott Landfill	Landfill	RNG		Concept			
Boardman	OR	WOF PNW Threemile Project	Agriculture	RNG		Online	Chemical adsorption	Wartsila	2019
Eagle Point	OR	Dry Creek Landfill	Landfill	RNG	Rogue Disposal & Recycling	Concept	Not available	Not available	
Eugene	OR	Eugene/Springfield Water Pollution Control Facility	WWTP	RNG		Substantial Development			
Junction City	OR	JC-Biomethane Biogas Plant	Commercial	RNG		Under Construction	Chemical adsorption	Wartsila/Puregas	2020
Junction City	OR	Shell New Energies Junction City	Agriculture	RNG	Shell	Online			
LAKE OSWEGO	OR	PORTLAND CITY ENVIRONMENTAL SERVICES	WWTP	RNG		Online	PSA	Greenlane/Sysadvance	2019
Lane County	OR	Metropolitan Wastewater Management Commission WWTP	WWTP	RNG		Under Construction	PSA	Greenlane	2020
	OR	Tyson Foods (4 projects)	Commercial	RNG	NW Natural, BioCarbN	Substantial Development			2021
Portland	OR	Columbia Blvd. Wastewater Treatment Plant	WWTP	RNG	NW Natural, City of Portland, BioCarbN	Under Construction			
Tillamook	OR	Hooley	Agriculture	RNG		Substantial Development			
Allegheny	PA	Imperial Sanitary Landfill	Landfill	RNG/CHP	Fortistar (bought in 2019)	Online	Membrane	Air liquide	2007
Allegheny	PA	Monroeville LF	Landfill	RNG	Montauk Energy Capital	Online	Membrane	Honeywell	2005
Belle Vernon	PA	Westmoreland Waste SLF LLC	Landfill	RNG	Noble Environmental	Under Construction	PSA	Not available	
Bethlehem	PA	Bethlehem	Landfill	RNG	with Rudarpa Inc.; Liberty Utilities	Construction	Not available	Not available	2022
Butler	PA	Seneca Landfill Inc. / lego	Landfill	RNG	Keystone Renewable Energy, LLC	Online	Membrane	Air liquide	2010
Cambria	PA	Laurel Highlands LF	Landfill	RNG	Air Liquide-MEDAL; Leaf Clean Energy	Online	Membrane	Air liquide	2006
Elk	PA	Greentree Landfill	Landfill	RNG/CHP/heat	Fortistar (bought in 2019)	Online	Membrane	Air liquide	2007
Johnston	PA	Raeger Mountain landfill (Johnstown)	Landfill	RNG	Montauk Energy Capital	Online	Membrane	Air liquide	2007
Johnston	PA	Shade Landfill	Landfill	RNG	Montauk Energy Capital	Online	Membrane	Air liquide	2007
Johnston	PA	Southern Alleghenies landfill	Landfill	RNG	Keystone Renewable Energy, LLC; Leaf Clean Energy	Online	Membrane	Air liquide	2007
Lackawanna	PA	Keystone Sanitary Landfill, Inc.	Landfill	RNG	Archaea	Under Construction	Not available	Not available	2021
Morrisville	PA	Fairless 1	Landfill	RNG		Substantial Development			
Morrisville	PA	Fairless 2	Landfill	RNG		Substantial Development			
Morrisville	PA	Fairless 3	Landfill	RNG		Substantial Development			
Philadelphia, PA	PA	Point Breeze Renewable Energy	Commercial	RNG		Substantial Development	Not available	Not available	
Pittsburg	PA	Keller Canyon Landfill	Landfill	RNG	Ameresco	Under Construction			
Westmoreland	PA	Valley LF (Harrison City)	Landfill	RNG	Montauk Energy Capital	Online	Membrane	Honeywell	2005
Toa Alta	PR		Landfill	RNG	Autonomous Municipality of Toa Alta, PR	Substantial Development	Not available	Not available	
Vega Baja	PR	Vega Baja Landfill	Landfill	RNG	Municipality of Vega Baja, PR	Substantial Development	Not available	Not available	
Johnston	RI	Rhode Island Bioenergy Facility (Orbit Energy Rhode Island)	Commercial	CHP, RNG in dev	Anaergia	Substantial Development			
Georgetown	SC	Georgetown County Subtitle D LF; Georgetown County Landfill	Landfill	RNG	Dominion, GreenGas USA	Substantial Development			
Honea Path	SC	Twin Chinmeys Landfill	Landfill	RNG	Enerdyne Power Systems, LS Power, U.S. Gain, owned and operated by Greenwood Commissioners of Public Works	Under construction	Not available	Not available	2022
To be confirmed	SC	Cannery (WWTP, commercial, vegetable waste), McCall Farms	Commercial	RNG	GreenGasUSA	Under construction			

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Baltic	SD	Baltic	Agriculture	RNG		Under construction	Membrane	Bright Biomethane	2021
Minnehaha	SD	Athena Project	Agriculture	RNG	and Moody County Dairy	Under Construction			
Moody	SD	Moody	Agriculture	RNG		Under construction	Membrane	Bright Biomethane	2021
Hawkins	TN	Carter Valley Landfill	Landfill	RNG	TenGasCo	Online	Membrane	Air liquide	2008
McMinn	TN	Meadow Branch Landfill	Landfill	RNG	Southern Company Gas	Online	PSA	Air liquide	2011
Shelby	TN	South Shelby Landfill	Landfill	RNG	Water (MLGW)	Online	Not available	Not available	
Shelby	TN	North Shelby Landfill	Landfill	RNG	Clean Energy Renewable Fuels	Online	PSA	Guild Associates	2015
Washington	TN	Iris Glen Environmental Center	Landfill	RNG/CHP/heat	Energy Systems Group, LLC	Online	Membrane	Air liquide	2006
Alvin	TX	Coastal Plains Landfill	Landfill	RNG	Montauk Energy Capital	Under Construction	PSA	BioFerm	2019
Angleton	TX	Seabreeze Environmental Landfill	Landfill	RNG	DTE Biomass Energy	Online	Chemical adsorption	Morrow	2018
Bexar	TX	Tessman Road Landfill	Landfill	RNG	Energy Developments, Inc	Substantial Development			
Cactus	TX	Cactus Digester Gaz Utilisation Plant	Agriculture	RNG		Under Construction			
Collin	TX	Melissa landfill	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2017
Dalhart	TX	JBS USA - Longview	Agriculture	RNG	JBS USA	Online			
Dallas	TX	McCommas Bluff Landfill	Landfill	RNG	Cambrian Energy Development LLC; Clean Energy Renewable Fuels	Online	PSA	AirSciences	2014
Denton	TX	DFW Recycling & Disposal Facility	Landfill	RNG	WM Renewable Energy, LLC	Substantial Development			
Ellis	TX	Skyline LF	Landfill	RNG	WM Renewable Energy, LLC	Online			
Fort Bend	TX	Fort Bend Regional Landfill	Landfill	RNG	Enerdyne Power Systems, Inc.; Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2018
Fresno	TX	Houston - Blue Ridge	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2018
Friona	TX	Del Rio Dairy	Agriculture	RNG	Clean Energy Fuels Corp., TotalEnergies	Under Construction			
Galveston	TX	Galveston County	Landfill	RNG		Online	PSA	BioFerm	2020
Gregg	TX	Pine Hill LF	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2017
Harris	TX	McCarty Road LF	Landfill	RNG	Ameresco, Inc., Republic Services, US Gain	Online			2021
Hidalgo	TX	City of Edinburg Landfill	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2015
Houston	TX	McCarty Road 2	Landfill	RNG	Montauk Energy Capital	Online	Chemical adsorption	Honeywell	1986
Humble	TX	Atascocita RDF	Landfill	RNG	WM Renewable Energy, LLC (Air liquide membrane system), Montauk Energy	Online	Membrane	Air liquide	2018
Hutto	TX	Williamson County	Landfill	RNG		Under Construction			
Johnson	TX	IESI Turkey Creek Landfill	Landfill	RNG/CHP	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2013
Rowlett	TX	Garland Hinton	Landfill	RNG		Under Construction			
SAN ANTONIO	TX	DOS RIOS WATER RECYCLING CENTER	WWTP	RNG	Ameresco, Inc.	Online	PSA	Guild Associates	2016
San Antonio	TX	Covel Gardens	Landfill	RNG		Substantial Development			
Tarrant	TX	Fort Worth Regional LF	Landfill	RNG		Substantial Development	Not available	Not available	
Tarrant	TX	Arlington LF	Landfill	RNG	Renovar Energy Corp.	Online	Not available	Not available	2020
Tyler	TX	Tyler / Greenwood Farms	Landfill	RNG	Morrow Renewables, LLC	Online	Chemical adsorption	Morrow	2016
Milford	UT	Network of 26 family hog farms	Agriculture	RNG	Align Renewable Natural Gas, Dominion Energy (NYSE:D) and Smithfield Foods	Online			2020
North Salt Lake City	UT	Wasatch Resource Recovery	Commercial	RNG	ALPRO Energy and Water and South Davis Sewer District	Online	Membrane	DMT	2018
Chester	VA	Shoosmith	Landfill Gas	RNG		Substantial Development			
Waverly	VA	Waverly project - 20 family farms	Agriculture	RNG	Align Renewable Natural Gas, Dominion Energy (NYSE:D) and Smithfield Foods	Substantial Development			2022
Salisbury	VT	Goodrich Family Farm	Agriculture	RNG	Vanguard Renewables, Vermont Gas, Vermont state, Middlebury College	Online	Membrane		2021
Williston	VT	Casella Waste Systems	Industrial	RNG		Online			
King	WA	Cedar Hills Regional LF	Landfill	RNG	Bio Energy Washington, LLC (BEW)	Online	Membrane	Air liquide	2009

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Outlook	WA	G DeRuyter & Sons Dairy Digester, Outlook-Granger	Agriculture	RNG	DVO, Inc. (formerly GHD, Inc.) (System Designer, System Design Engineer); Regenix [Project Developer, System Designer, Construction & Installation]	Online			2006
Renton	WA	South Treatment Plant - King county south	WWTP	RNG		Online	Water adsorption	Binax (similar to Greenla	2018
Roosevelt	WA	Roosevelt Regional MSW Landfill / Klickitat PUD - H.W. Hill RNG	Landfill	RNG	Republic Services, Inc., Klickitat Public Utility Distric, Montrose	Online	Chemical adsorption	Morrow	2018
Tacoma	WA	Tacoma Central NO. 1	WWTP	RNG		Under Construction	Not available	Not available	
Vashon Island	WA	Vashon	Commercial	RNG	Impact Bioenergy,	Online			2020
Yakima	WA		Commercial	RNG		Concept			
Yakima Valley	WA	Augean Renewable Natural Gas (RNG)	Agriculture	RNG	Promus Enery - Greenlane, Augean Renewable Natural Gas (RNG), Brightmark Energy, Promus Energy, and DeRuyter Dairies	Online	PSA	Greenlane	2019
Appleton	WI	Deer Run Dairy	Agriculture	RNG	US Gain	Online			2020
Brillion	WI	Dallmann Digester	Agriculture	RNG	DVO, Inc. (formerly GHD, Inc.) (Project Developer, System Designer, System Design Engineer)	Online			2012
Campbellsport	WI	Clover Hill Dairy, LLC Digester	Agriculture	RNG	US Gain, Nacelle Solutions	Online	Membrane	DMT	2020
Coon Valley	WI	Deer Run Farm	Agriculture	RNG	DMT, Nacelle solutions	Online	Membrane	DMT	2020
Sturgeon Bay	WI	Dairy Farm	Agriculture	RNG		Online	Membrane	DMT	2020
Brillion	WI	Dairy Farm	Agriculture	RNG		Online	Membrane	DMT	2020
Casco	WI	Kinnard Farms	Agriculture	RNG	DTE Energy	Under Construction			
Cleveland	WI	Maple Leaf Dairy East Digester	Agriculture	CHP/RNG	DVO, Inc. (formerly GHD, Inc.) (Project Developer, System Designer, System Design Engineer)	Online			2010
Cleveland	WI	Maple Leaf Dairy West Digester	Agriculture	CHP/RNG	DVO, Inc. (formerly GHD, Inc.) (Project Developer, System Designer, System Design Engineer)	Online			2010
Dane	WI	Dane County LF #1-Verona	Landfill	RNG	Dane County Public Works, WI	Online	Membrane	Bright biomethane	2019
Dane	WI	Dane County LF #2-Rodefeld	Landfill	RNG	Dane County Public Works, WI	Online	Membrane	Unison/BioCNG	2012
Dane	WI	Ripp's Dairy Valley	Agriculture	RNG	Brightmark Energy, Clean Fuel Partners	Under Construction			
Dane	WI	Endress Dairy	Agriculture	RNG	Brightmark Energy, Clean Fuel Partners	Under Construction			
Waunakee	WI	White Gold Dairy	Agriculture	RNG	Brightmark Energy, Clean Fuel Partners	Under Construction			
Denmark	WI	New Organic Digestion	Commercial	RNG	Big Ox Energy	Online	Not available	Not available	
Dodge	WI	Advanced Disposal Glacier Ridge Landfill LLC	Landfill	RNG	Advanced Disposal Services	Online	Membrane	Air liquide	
Green Leaf	WI	BC Organics (BCO)	Agriculture	RNG	owned and operated by Dynamic	Under Construction			
Hilbert	WI	Holsum Dairy - Elm Road Digester	Agriculture	RNG	previously CHP, U.S. Gain	Online			2020
Hilbert	WI	Holsum Dairy - Irish Road Digester	Agriculture	RNG	previously CHP, U.S. Gain	Online			2020
Janesville	WI	Janesville Wastewater Utility	WWTP	RNG		Online	Membrane	Unison/BioCNG	2012
Kewaunee	WI	Pagels Ponderosa Dairy Digester	Agriculture	RNG/CHP	Developer, System Designer, System Design	Online; RNG under construc	Membrane	Not available	
Kewaunee	WI	Kewaunee-Kenard	Agriculture	RNG		Online			
Madison	WI	Demeter Project	Agriculture	RNG	Brightmark (Clean Fuels Partners), Dane County	Online			2020
Manitowoc County	WI	Calumet Renewable Energy - Dairy Dreams	Agriculture	RNG	DTE Energy	Online	Membrane	Air liquide	2019
Maplewood	WI	S&S Jerseyland	Agriculture	RNG		Online			2012

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City	State	Project Name	System Type	Biogas usage	Project Company	Status	Upgrading type	Upgrading provider	Date
Marshall	WI	Statz Brothers, Inc. 2 Digester (Dane-Statz)	Agriculture	RNG		Online			2015
New Chester	WI	New Chester/Brakebush Digester	Agriculture	RNG	Clean Energy North America, LLC (Project Developer); DVO, Inc. (formerly GHD, Inc.) (System Designer)	Online			
Newton	WI	Grotegut Agriculture, Inc. Digester	Agriculture	RNG		Online			2009
Pickett	WI	UW Oshkosh Foundation, Rosendale Biodigester, LLC Digester	Agriculture	RNG	BIOFerm Energy Systems (Project Developer, System Designer, System Design Engineer)	Online			2013
Walworth	WI	Advanced Disposal Mallard Ridge Landfill Inc.	Landfill	RNG	Modern-Mallard Energy LLC	Online	Membrane	Air liquide	
Charleston	WV	City of Charleston Landfill	Landfill	RNG	Tallarico Energy	Online	membrane	Not available	

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APPENDIX 3.

BIOMETHANE PRICING IN NORTH AMERICA

RNG PRICING IN NORTH AMERICA¹

Summary

In recent years, the North American biogas industry (anaerobic digestion and landfill) has mainly focused on using biogas to upgrade to renewable natural gas (RNG), instead of generating electricity.

The industry is mainly interested in RNG because of its market value and its environmental benefits. For example, in the USA using RNG in transportation to replace fossil fuel for vehicles is the option with the most potential for GHG emissions reduction.

The price of RNG in North America depends on several factors, but the main are the policies and incentives put in place by the different levels of government. Programs of the RFS and LCFS (in the USA) influence directly the price of RNG on the market. Moreover, factors such as location, feedstock, and technology may play an important role.

In Canada, several provinces are actively engaged in RNG procurement. The main utilities involved in RNG offtake are FortisBC in British Columbia, Energir in Quebec and Enbridge in Ontario. Only FortisBC and Energir are signing long-term offtake contracts, while Enbridge has just started their pilot project this year. The RNG pricing is regulated by local Energy Boards, however, due to the confidential nature of certain RNG sales contracts, it is not possible for BiogasWorld to disclose all the prices, types of contracts, and agreements between a producer and a buyer of RNG. This report contains only publicly available data.

Market incentives

Every country, province or state can implement laws and financial incentives to support the development of the RNG industry. Policies such as the ban of organics from landfills are being added to available project financial supports such as PTMOBC in Quebec, Canada.. However, they are not enough to make the projects come true. The main global markets for RNG production (France, Denmark, Germany, Sweden, etc.) have all implemented advantageous feed-in tariffs through policies or regulations.

In North America, the main driver of the RNG industry is the American regulated market that aim to decarbonise fuels for transportation. The state level programs include LCFS Program (Low Carbon Fuel Standard) in California and Washington and Clean Fuels Program in Oregon. RFS (Renewable Fuel Standard) Program is managed at the federal level. The demand for the RFS Program is growing year after year, which greatly influences the price of RNG in North America. The RNG produced in Canada can also be sold to USA. For example, the two biggest RNG producers in Quebec, Canada, are currently selling their RNG to the California market.

As for Canada, British Columbia and Quebec have targets for RNG in gas grid. Quebec has adopted a regulation to [ensure the injection of a minimal quantity of RNG in the natural gas grid](#) (1% in 2020, 2% in 2023 and 5% in 2025). This law, combined with the presence of serious RNG buyers such as Energir, is beneficial for the development of the RNG industry in Quebec. Energir chose a collaborative approach with the producers to establish a reasonable price so the project is realized in the best possible conditions for consumers to meet the targets fixed by the government. Additionally, in November 2021, Energir issued the competitive call for RNG projects that should be operational in 2023 and aim the procurement of 280 mln m3 of RNG.

British Columbia, in its Clean BC Plan, aims to have 15% renewable content in its natural gas by 2030 and BC gas utility, FortisBC, has a FIT RNG program that allows the long-term contracts with the offtake price of up to CAD 30/GJ.

In addition to feed-in tariffs, the incentives that are most often available for RNG projects are as follows:

- Subsidies for the purchase of equipment (% of CAPEX or fixed amount)
- Subsidies for certain specific parts of the facilities (injection facilities, upgrading unit, etc.) (e.g., [SoCalGas](#))
- Interest free loans over a fixed period of time
- Exemption or reduction of taxes (sales, property and energy) (e.g., [Biogas Energy Tax Credit](#))
- Grants for studies and permits

¹ This appendix will use the term "RNG", instead of "biomethane", as in North America this is the most used term

Price and origin of RNG

RNG price can vary greatly and can range from USD 9 to 84 per GJ in North America (Source: [Biocycle](#)). Factors such as location, type of technologies used, value of natural gas, environmental value, and the buyer of RNG can influence the price.

Table 1 shows the maximal value of RNG in the main markets. The maximum value corresponds to a project whose factors are optimized for the given territory.

Table 1: Maximum value of RNG in the main markets

	Quebec (Canada)	British Columbia (Canada)	USA
Maximum feed-in tariff (USD/GJ)	17 (CAD 22*)	23 (CAD 30)	84

Note: All prices are in USD, prices provided in CAD at the source are converted using the following exchange rate: 1.30CAD = 1USD

* This price is an approximation of the maximum prices offered to producers based on discussions with Energir.

RNG Buyers

Marketers

A marketer is a company that charges broker fees for RNG between a producer, the user and other companies that are under the regulations (e.g., oil), mainly through RFS and LCFS programs. Marketers can also connect RNG producers and buyers directly, which increases the competition for the purchase of RNG without geographical limits.

The price a marketer can offer to the RNG producer depends on the duration, type of contract and the value of RINs and LCFS credits. The duration ranges from a few months to 15 years. Here are the existing types of contract:

1. **Fixed price**
 - a. Producer receives a fixed amount for every injected GJ
 - b. Value is generally below the market price; the difference is even bigger for long-term contracts.
2. **Market price**
 - c. Value is the same as the RINs and LCFS credits on the market, on the day-to-day basis.
3. **Hybrid price**
 - d. The value is shared between the fixed price and the market price according to percentages to be determined with the marketer.

There are more than ten marketers active on the RNG market. The price they offer also depends on the risks they are taking (e.g., a guaranteed 15-year fixed price despite a declining RIN market is a risk that reduces the price offered for RNG).

For example, for a market price type contract, a marketer can keep up to 20-25% of the maximum value of RNG as a brokerage. It leaves between 75-80% to the producer. (Source: [TEA](#))

The marketers can also sell RNG on the electricity market (RPS) and on the voluntary market. (Source: [Element markets](#))

Value of RNG in USA

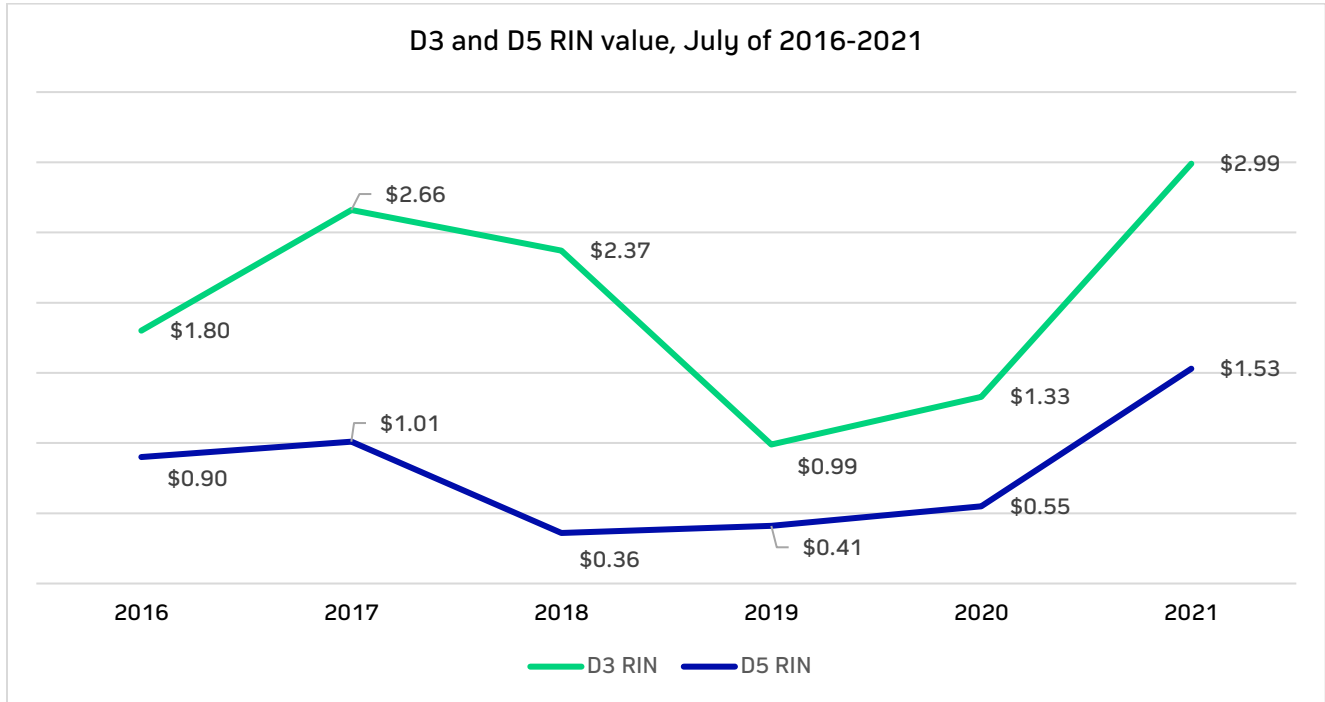
Establishing the value of RNG in USA can be technical. Adding the value of natural gas to the value of RINs and LCFS credits can give you the final price and the maximal value.

RINs

RINs, or Renewable identification numbers, are credits used for RFS program compliance and therefore represent its "currency". A RIN is generated for each gallon of equivalent ethanol produced by RNG, 0.077 MMBtu energy equivalent. There are several types

of RINs depending on the fuels used, such as biodiesel, ethanol, RNG, etc. D3 and D5 RINs are used for RNG projects, depending on the technology and the feedstock used. For example, you will generate D3 RINs if you produce RNG from agricultural residues, municipal biosolids and landfills. D5 RINs are associated with RNG from non-cellulosic residues such as fat, sugars and a majority of food residues (source-sorted organic matter (SSOM), agro-food waste, etc.)

During 2019, the RINs plummeted from more than 2 USD per D3 at the start of 2019 to 0.60 USD in September 2019. Since then, the price has steadily increased to 3.05 USD in October 2021.



The choice of feedstock and technology is therefore crucial for RNG projects that export to the USA because a D3 RIN can be worth more than 3 times a D5 RIN. Due to the market fluctuation, the difference was not as important in 2020, however, it was in 2021.

Currently, there is no calculation that takes into account the use of multiple feedstocks in an anaerobic digestion system (e.g., manure and SSO). This means that the system will generate D5 RINs for the whole production despite the use of manure. To our knowledge, US EPA is working on a calculation system able to consider different types of feedstock.

The following table presents equivalents to facilitate calculations.

Table 2: RINs and GJ equivalence for RNG

RINS	GJ equivalent
12.37 RINs	1 GJ of RNG
1 RIN D3 at 0.83 \$USD	10.27 \$USD/GJ of RNG
1 RIN D5 at 0.58 \$USD	7,18 \$USD/GJ of RNG

Source: Ecoengineers

LCFS

Calculating the value of LCFS credit is significantly more complex than RINs. The difference is that the program establishes a price based on the life cycle analysis depending on the feedstocks, the process, the use of RNG and location. The LCFS program uses the carbon intensity of fuels, also called CI, to compare projects. The lower (or negative) a CI is, the higher the value of the LCFS credit will be. One LCFS credit represents a reduction of GHG emissions of one metric ton of CO₂.

For 2020 to 2030, the assigned average CI for diesel is 82.87 g CO₂ e/MJ. This is the reference point for calculating the value of credits. Here is a list of projects and their CI, approved by [LCFS program](#) :

1. CI of landfills: between 7 and 80.
2. CI of anaerobic digestion plants using biosolids: between 7 and 31.
3. CI of anaerobic digestion plants using SSOM: between 0 and -20.
4. CI of anaerobic digestion plants using agricultural residues (slurry): between -108 and -762

It is important to note that CI values are determined on a case-by-case basis, with scores largely influenced by current manure/waste management practices. In addition, approximately 30 is added to CI scores from the emissions associated with RNG upgrading, pipeline transmission, CNG compression, and CNG vehicle emissions.

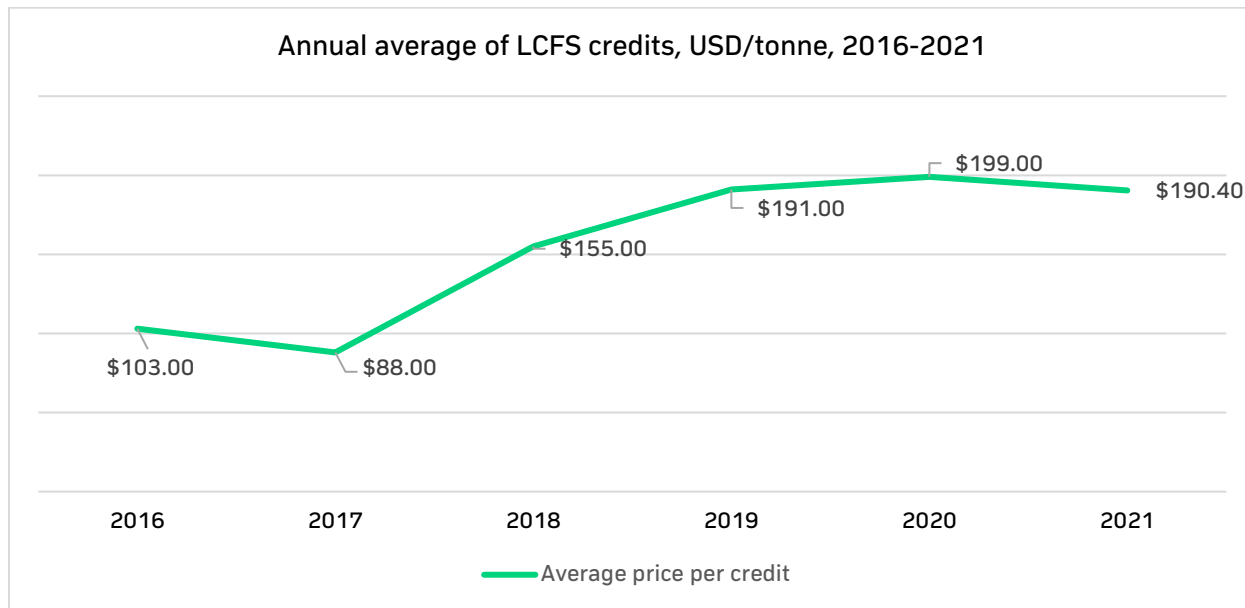
The quantity of credits generated per year is calculated using the following formula:

Quantity of credits = (CI Diesel – CI project/EER) * Annual RNG production (scf, LHV) * Energy density of CNG * EER/10⁶

- EER = Energy Saving Ratio (values available on the LCFS website) = 0.9 for CNG project
- Scf, LHV = cubic foot of RNG per year with a lower heat value
- Energy density of CNG = 0.98 MJ/scf

The number of credits for the project combined with the market value of LCFS credit will allow you to calculate the value (\$/GJ) of a given project.

The following table shows the average value of LCFS credit (\$/MT) between May 2016 and 2021 in USD. MT is a unit corresponding to metric tons (MT) of LCFS credits, which is also equivalent to metric tons of avoided CO₂. **At the end of 2020, the value was 199 USD or 254 CAD.**



Source: [Monthly LCFS Credit Transfer Activity Reports](#)

For example, a project that has a CI of 0 and LCFS credits value of 208\$ USD/MT will have a value of about 17.5\$ USD/GJ for the LCFS part.

While the market of RINs and LCFS is very fluid, the main concern is what will happen after 2022, as the RFS program will be updated. The RFS as the LCFS programs result from policies that can be edited or replaced. This hinders the purchase of long-term credits by companies that are forced to join the programs. As a result, it makes long-term “offtake” offers more complicated for producers. **The main reason for RINs fluctuation is the exemption of small refiners (Small Refinery Exemptions) from being subject to the RFS market.**

Table 3 shows price examples for RNG in the USA according to a contract at the price market.

Table 3. Examples of RNG value on the American market

	SSO/Food waste AD CI = 0 RIN D5 USD/GJ	On-farm AD CI = -200 RIN D3 USD/GJ	WWTP CI = 30 RIN D3 USD/GJ
Value of LCFS	0	65	10
Value of RINs	8.20	19.35	19.35
Value of natural gas	2	2	2
TOTAL Market price	10.20 \$/GJ	86 \$/GJ	31.35 \$/GJ
TOTAL After fees (20 %)	8.16 \$/GJ	68.8 \$/GJ	25.08 \$/GJ

Based on information presented by [EcoEngineers](#).

Note: Fees represent the amount a marketer takes to broker both programs.

Canadian Gas Grids

In Canada, Energir (Quebec) and FortisBC (British Columbia) are the only two active utilities that purchase RNG. The prices and other types of support offered for projects are not public. However, the current price limits include CAD 30/GJ for FortisBC in British Columbia and CAD 22/GJ for Energir in Quebec. Both Energir and FortisBC can buy RNG outside its borders.

Gas utility Enbridge in Ontario has just started its RNG pilot project this year and it does not offer long-term purchase contracts for RNG at this time.

Private Buyers

Industrial companies

The private RNG buyers negotiate the price directly with the RNG producer and/or the local gas utility. This price can be between the value of natural gas (USD 2/GJ) and the value for which the utility is ready to sell the RNG (e.g., Energir and L’Oréal). BiogasWorld was not able to find a recently negotiated price in the industry because the agreements are, most of the time, confidential. It is possible for a gas utility to sell the RNG to a manufacturing company that would like to secure the RNG source by procuring the RNG locally, offering higher than the market price.

The market for voluntary buyers is growing due to the implementation of systems at a number of gas grids (FortisBC, Hawaii Gas, Vermont Gas, National Grid, SoCal Gas, etc.). There is also an industrial market for companies that are obliged to reduce their GHG emissions (e.g., carbon market) such as universities, data centers (Amazon), Ikea, Kingspan, Apple, etc. (Source: [Element markets](#)). In Quebec, there are currently no RNG buyers for direct sale (without injection into the gas grid).

CNG Station/Trucks fleet

To generate a RIN, the RNG must be used as CNG and LNG in transportation. Therefore, the fuel network of stations and the users is important.

For example, UPS is a private buyer that is committed to buying [170 million gallons equivalent of RNG](#) from the company Clean Energy Fuel by 2026. In this type of agreement, the value of RNG is not public. However, according to [Clean Energy](#), the RNG they sell at their CNG station is at the same price as the natural gas.

Other markets

Electricity

The use of biogas to generate electricity is no longer common in North America. While e-RIN program is being discussed, this process is still not laid out. LCFS EV pathways allow the sale of electricity for EV, but the process is too new.

In Canada, Ontario's electricity FIT is no longer offered. In Québec, Hydro Québec is expected to issue a renewable electricity procurement RFP in December 2021, however, the RFP is not technology specific, thus, its applicability for biogas sector should be analyzed.

APPENDIX 4.

UPGRADING TECHNOLOGY SUPPLIERS

Company	Upgrading technology	Country	Contact name	Email	Phone number	Web
AgriKomp	Membrane separation	Germany	Gernot Buchta	g.buchta@agrikomp.de	+33 2 54 56 18 57	https://agrikomp.com/index.php
Air Liquide	PSA, membrane separation	USA	Ryan Connel	ryan.connell@airliquide.com	+1 717 371 3379	https://www.airliquide.com/
Pyrogreen-Gas inc.	PSA	Canada	Gerard Magnin	gmagnin@airscience.net	+1 514 937 4614	https://www.airscience.ca/
Ammongas	Chemical scrubbing	Denmark	Stephane Bosc	stephane@ammongas.dk	45 43 63 63 00	http://www.ammongas.dk/
Arol Energy	Membrane separation	France	Florian Quintin	florian.quintin@arol-energy.com	3 3458141070	www.arol-energy.com
BioFerm	PSA	USA	Corissa Miller	milc@biofermenergy.com	+1 608-467-5523	http://www.biofermenergy.com/
Bright Biomethane	Membrane separation	Netherlands	Maarten Holtkamp	m.holtkamp@brightbiomethane.com	+31631056149	www.brightbiomethane.com
Carbonoro	Chemical scrubbing	Netherlands	Jan Hoppenbrouwers	jan.hoppenbrouwers@carbonoro.com	31 629 07 48 23	https://www.carbonoro.com/
Carbotech	PSA	Germany	Stephan Schilli	stephan.schilli@carbotech.info	+49 201 50709-339	www.carbotech.info
CryoPur	Cryogenic units	France	Geoffroy Mattlinger	geoffroy.mattlinger@cryopur.com	+33 1 80 38 4148	http://www.cryopur.com/en/
DMT Clear Gas Solutions	Membrane separation	USA	Missy Lee	mlee@dmr-cgs.com	+1 503 379 0147	https://www.dmt-cgs.com/
Econet	Water scrubbing	Sweden	Andreas Dahlner	andreas.dahlner@econetgroup.se	+46 (0) 40 10 50 70	http://www.econetgroup.se/
Envitec Biogas	Membrane separation	Germany	Christian Eilert	c.eilert@envitec-biogas.de	+49 25 74 -88 88 137	https://www.envitec-biogas.com
ETW Energietechnik	PSA	Germany	Alexander Szabo	szabo@etw-energie.de	+49 2841-9990-0	http://www.etw-energy.com/home/
Greenlane Biogas	Water scrubbing, PSA	Canada	Philip Taschereau	phil.taschereau@greenlanebiogas.com	1 (438) 686-6670	http://www.greenlanebiogas.com
Greenmac	Chemical scrubbing	Netherlands	Geurt Aalderink	geurt.aalderink@greenmac.nl	31 33 247 10 54	https://therootselaargroup.com/en/greenmac/nl-en/
Guild Associates	PSA	USA	Paul Baker	paulbaker@guildassociates.com	+1 614-760-8013	http://www.moleculargate.com/
Hitachi Zosen INOVA	Membrane separation, Chemical scrubbing	USA/Canada	Ricardo Hamdan	ricardo.hamdan@hz-inova.com	+1 (678) 987-2500	https://www.hz-inova.com/cms/en/

Company	Upgrading technology	Country	Contact name	Email	Phone number	Web
Malmberg	Water scrubbing	Sweden	Christian Swanson	christian.swanson@malmberg.se	+46 44 780 18 00	https://www.malmberg.se/
Morrow Energy	Chemical scrubbing	United States	Paul Morrow	paul@morrowenergy.com	+1 432 563 0447	https://morrowrenewables.com/
NeoZeo	PSA	Sweden	Jonathan Quah	jonathan.quah@neozeo.com	+46 76 409 0 971	http://www.neozeo.com
Pentair process Technologies	Membrane separation	Netherlands	Sjoerd Vandersterren	sjoerd.vandersterren@pentair.com	31 77 323 23 35	www.pentair.com
Prodeval	Membrane separation	Canada France	Patrice Gouin Pierre Yann	p.gouin@prodevalcanada.com p.pierre@prodeval.eu	1 514-465-7814 +33(0)4 75 40 37 37	https://prodevalcanada.com/ https://www.prodeval.eu/en/
Schwelm Anlagentechnik	Chemical scrubbing	Germany	Dirk Rose	d.rose@schwelm-at.de	+ 49 (0) 2336/809 - 392	www.schwelm-at.de
Sysadvance	PSA	Portugal	Adriana Naldi	adriana.naldi@sysadvance.com	+351 229 436 790	https://www.sysadvance.com
Unison Solutions	Membrane separation	United States	Kim Murdock-Timmerman	kmtimmerman@unisonsolutions.com	563 585 0967	https://www.unisonsolutions.com/
Veolia	Membrane separation	France	Marie Esteve	marie.esteve@veolia.com	+33 5 62 89 33 28	http://www.biothane.com/
Waga	Cryogenic units	Canada France	Julie Flynn Laurent Barbotin	julie.flynn@waga-energy.com laurent.barbotin@waga-energy.com	+1-819-531-5334 +33 621 591 281	http://waga-energy.com/?lang=en
Wartsila	Chemical scrubbing	Finland	Joe Ayala	joe.ayala@wartsila.com	+1-281 233 6367	https://www.wartsila.com/
WELTEC Biopower	Membrane separation	UK	Kevin Monson	k.monson@weltec.uk.com	+44 (0) 7764 267274	http://weltec.uk.com/
Xebec Adsorption Inc	PSA	Canada	Carolyn Hébert	chebert@xebecinc.com	1514-241-3042	www.xebecinc.com

APPENDIX 5.

CONSULTING COMPANIES IN CANADA

Company	Services	System Type	Country	Contact name	Email	Phone number	Website
Allien Entrepreneur Général	Biogas engineering and consulting, Construction	NA	Canada	Nancy Plante	nancyplante@cwallen.qc.ca	418. 882. 2277	http://cwallen.qc.ca/
Azura Associates	Biogas engineering and consulting	NA	Canada	Dave Ellis	dave.ellis@azuraassociates.com	519-729-0681	https://www.azuraassociates.com/
Bahler biogaz	Biogas engineering and consulting, Construction	Commercial, Agriculture	Canada	Eric Lefebvre	ericlefebvre@bahler.ca	819 791-7500	www.bahler.ca/
CEM Engineering	Biogas engineering and consulting	NA	Canada	Lisa Barber	lisa@cemeng.ca	905-935-5815	http://cemeng.ca/
Coop Carbone	Project developer	NA	Canada	Benoit Bourque	bbourque@coopcarbone.coop	N/A	http://coopcarbone.coop/fr
Dekany Consulting Inc.	Biogas engineering and consulting	NA	Canada	Sean Mezei	smezei@dekanyconsulting.com	(778) 788-8096	http://dekanyconsulting.com/
DLS Biogas	Construction	Agriculture	Canada	Mark Wescott	mark.wescott@dairylane.ca	1-800-361-2303	http://www.dlsbiogas.com/
Ecosystem	Project Management, Project Developer	NA	Canada	Nicolas Lacroix	Nicolas.Lacroix@ecosystem.ca	514 940-5156	https://ecosystem-energy.com/
EllisDon	Construction	NA	Canada	Jameson Wood	jwood@ellisdon.com	519 455 6770	http://ellisdon.com/
Englobe	Digestate management	NA	Canada	Serge Loubier	serge.loubier@englobecorp.com	819-574-1135	http://englobecorp.com/
Filtrum Construction	Construction	NA	Canada	Serge Poirier	serge.poirier@filtrum.ca	15142109122	http://filtrum.ca/
FNX-Innov	Biogas engineering and consulting, EPC	NA	Canada	Jean-Francois Hince	jhince@fnx-innov.com	(819) 829-3000	https://fnx-innov.com/
Gentique	Biogas engineering and consulting, EPC	NA	Canada	Francois Guay	francois.guay@gntq.ca	418-548-4626 #399	http://gntq.ca/
GHD	Biogas engineering and consulting, EPC	WWTP	Canada	Marie-France Gravelle	marie-france.gravelle@ghd.com	15147749872	http://www.ghd.com/canada/services/renewable-energy/
Groupe Deric	Construction	NA	Canada	Michel Thomassin	michel.thomassin@groupeDERIC.ca	418 781-2228	http://groupeDERIC.ca/
Groupe Helios	Biogas engineering and consulting	NA	Canada	Jean-Guy Cadorette	jgcadorette@groupehelios.com	(450) 646-7140	http://groupehelios.com/
J.L. Richards & Associates Limited	Biogas engineering and consulting, Construction	NA	Canada	Stephen W. Parenteau	ottawa@jlrichards.ca	613-728-3571	http://jlrichards.ca/
ReGenerate Biogas	Biogas engineering and consulting, Project developer	NA	Canada	Daniel Bida	daniel@regeneratebiogas.com	416 258 1306	http://www.regeneratebiogas.com/
Scovan Engineering	Biogas engineering and consulting, Project developer	NA	Canada	Brent Lyon	brentl@scovan.ca	+ 1403-705-6830	https://scovan.ca/
Seneca Enterprises LLC	Biogas engineering and consulting, Construction, EPC	NA	Canada	Eric Marcotte	emarcotte@seneca.ca	514 353-4443	http://seneca.ca/
SNC-Lavalin	Biogas engineering and consulting, Construction, EPC	NA	Canada	Jean-Luc Allard	jeanluc.allard@snclavalin.com	1 514 393 8000 ext 58809	http://www.snclavalin.com/
Stoncrest Engineering	Biogas engineering and consulting	NA	Canada	Wayne Blenkhorn	wayne@stoncrestengineering.com	(519) 625-8025	https://www.stoncrestengineering.com/
Tacoma Engineers	Construction, EPC	NA	Canada	Nathan Proper	nathanp@tacomaengineers.com	519-763-2000	https://tacomaengineers.com/
Terix Envirogaz	Biogas engineering and consulting, System Supplier	WWTP	Canada	Eric Tremblay	etremblay@terixenvirogaz.com	1-888-317-0675	http://www.terixenvirogaz.com/
Tetra Tech	Biogas engineering and consulting, EPC	NA	Canada	Stephen Davidson	stephen.davidson@tetratech.com	1 450 655 9640 ext 237	www.tetratech.com

Company	Services	System Type	Country	Contact name	Email	Phone number	Website
Viridis Environnement	Project developer, Operations biogas engineering and consulting, Waste management	NA	Canada	Simon Naylor	snaylor@viridis-env.com	1-450-813-4970	http://viridis-env.com/
Walker Environmental	Biogas engineering and consulting,	Landfill	Canada	Sahra Shojaei	sshoei@walkerind.com	905-227-4142	http://walkerind.com/
WSP	Biogas engineering and consulting,	NA	Canada	Samuel Launay	samuel.launay@wsp.com	438-843-7840	http://wsp.com/

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APPENDIX 6.

CONSULTING COMPANIES IN THE USA

Company	Services	System Type	Country	Contact name	Email	Phone number	Website
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AMP Americas	EPC	NA	USA	Andy Dvoracek	advoracek@ampamericas.com	3124140768	http://www.ampamericas.com/
Archaea Energy	Project developer	Landfill	USA	Brian McCarthy	bmccarthy@archaea.energy	603-340-4022	https://www.archaeaenergy.com/
Aria Energy	Project developer, Construction, Operations	Landfill	USA	Jay Hopper	jay.hopper@ariaenergy.com	585.948.8580	www.ariaenergy.com
Bartlett & West Engineers	Biogas engineering and consulting	WWTP	USA	Dale Booth	dale.booth@bartwest.com	903 630-9172	www.bartlettwest.com/
Black & Veatch	Biogas engineering and consulting, Construction, EPC	NA	USA	Jonathan Cristiani	cristianijm@bv.com	919-463-3043	https://www.bv.com/
Brightmark Energy	Biogas engineering and consulting, Project developer	NA	USA	Josh Rapport	josh.rapport@brightmarkenergy.com	530 400 6868	https://www.brightmarkenergy.com/
Carollo Engineers	Biogas engineering and consulting	NA	USA	Charlie He	che@carollo.com	602.474.4119	https://www.carollo.com/
Cavanaugh	Biogas engineering and consulting	NA	USA	Gus Simmons	gus.simmons@cavanaugholutions.com	910 392 4462	http://www.cavanaugholutions.com/
ClimeCo	Project developer, Business consulting	NA	USA	Jessica Campbell	jcampbell@climeco.com	4034667303	http://climeco.com/
Custom Energy	Project developer	NA	USA	David Bain	dbain@customenergyinc.com	866.502.5003	https://www.customenergyinc.com/
EcoEngineers	Biogas engineering and consulting	NA	USA	Kathy Macbeth	kmacbeth@ecoengineers.us	515.985.1269	http://ecoengineers.us/
EDL Energy	Project developer	Landfill	USA	Mike Kotyk	mike.kotyk@edlenergy.com	(517) 208-0743	https://edlenergy.com/
ET environmental	Biogas engineering and consulting, Construction	NA	USA	Steve Arnold	sarnold@etenv.com	708 478 8200	http://www.etenv.com/
Fox engineering	Biogas engineering and consulting	NA	USA	Dale Watson	dwatson@foxeng.com	(515) 233-0000	http://www.foxeng.com/
GESS RNG Biogas	Project developer	NA	USA	Lathan Welker	lathan.welker@gessrng.com	984-289-8145	https://gessrngbiogas.com/
Maas Energy Works	Project Developer, Biogas engineering and consulting	Agriculture, Dairy	USA	Nathan Nisly	nathan@maasenergy.com	(530) 710-8545	www.maasenergy.com/

APPENDIX 7.

BIOMETHANE BUYERS IN NORTH AMERICA

Compagnies	Type	Offres	Contacts	Courriels
AMP Americas	Marketer	NA	Andy Dvoracek	advoracek@ampamericas.com
BP	Marketer	Mainly D3 and direct buyer	Aaron Baker	aaron.baker@bp.com
Clean Energy	Marketer	Mainly D3 and direct buyer	Iain Johnstone	iain.johnstone@cleanenergyfuels.com
Clear Blue Markets	Marketer	NA	Nicolas Girod	ngirod@clearbluemarkets.com
Direct Energy	Utility	mainly D3	Mittal Monani	Mittal.Monani@directenergy.com
Element Markets	Marketer	D3-D5	Faizal Hassan	fhassan@elementmarkets.com
Énergir	Utility	Up to 22 CAD/GJ	Mathieu Johnson	mathieu.johnson@energir.com
FortisBC	Utility	Up to 30 CAD/GJ	Colton Aston	Colton.Aston@fortisbc.com
Iogen	Marketer	D3-D5 and direct buyer	Nancy Anderson	nancy.anderson@iogen.ca
Shell	Marketer	Mainly D3 and direct buyer	Tom Carlson	Tom.Carlson@shell.com
The Energy Authority	Marketer	mainly D3	John Raiford	jraiford@teainc.org
Tidal Energy	Marketer	NA	Michael Cadotte	michael.cadotte@tidal-energy.com
TruStar Energy CNG	CNG Stations	NA	Aaron Lay	alay@trustarenergy.com
US Gain	Marketer	Mainly D3 and direct buyer	Stephanie Lowney	slowney@usgain.com

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