A practical guide to biomethane / RNG production

Six strategies to maximize your output and improve your productivity.

Biogas upgrading eBook

vaisala.com/biogas

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Biomethane / renewable natural gas

The global energy ecosystem is in transition, and biomethane has a central, dual role to play – securing global gas supply and helping economies to decarbonize.

Unlike fossil-based natural gas, biomethane – also known as renewable natural gas – can be produced virtually anywhere. This is great news for the many countries whose energy infrastructure is designed around gaseous fuels. Compared to updating infrastructure, switching the source of gas is relatively quick and easy. Furthermore, the ecological effects of drilling for fossil natural gas deep underground or below the ocean floor can be avoided by upgrading biogas produced from renewable sources to biomethane.

Since biomethane is an upgraded form of biogas, it is truly a green alternative to natural gas. Biogas is produced from biodegradable waste from farms, cities, and industry – food waste, animal feedstock, and even solid sludge waste from municipal waterworks. Instead of being disposed of, these waste streams can be used to produce biogas through a process called anaerobic digestion.

And since money talks, it's important to remember that the cost of fossil-based natural gas has already far surpassed the cost of biomethane. This is partly because of rising energy prices owing to geopolitical factors and partly because biomethane production costs are falling as new and larger plants come online. This makes it an increasingly attractive prospect for countries that are looking to decarbonize their power systems in a cost-effective manner.

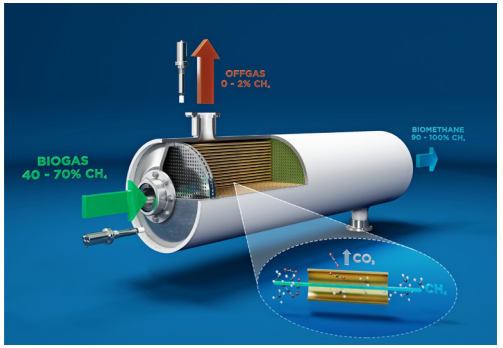
A boost for your biomethane production process

If you are looking to increase the yield and quality of your biogas-to-biomethane upgrading operation, Vaisala has plenty of options on offer to help.

Vaisala's MGP260 biogas instrument family is the first of its kind that is optical, Ex certified, and designed to work in situ, measuring directly inline without sampling systems. It's robust, compact, and has no moving parts – so it's easy to take care of and will provide years of reliable service.

Our biogas instrument family is designed to make biomethane commercially viable by helping you to ensure high-yield, low-loss production with robust, reliable, and continuous measurementdata that you can leverage to manage and optimize your production processes.

Biogas upgrading technologies in a nutshell

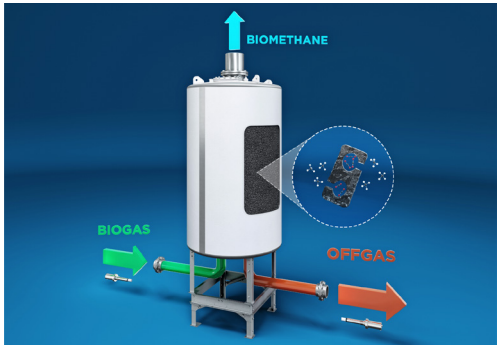


Membrane filtration

Membrane filtration is one of the most common choices for upgrading biogas to biomethane. Before upgrading, the raw biogas is dried and filtered to remove hydrogen sulfide, volatile organic compounds (VOCs), and in the case of gas from wastewater plants and landfill sites, siloxanes. The biogas is then compressed to 10–15 bar before being fed into the membrane unit, where membranes separate out the carbon dioxide, leaving a gas that is mostly methane. Some methane, a potent greenhouse gas, does slip into the offgas through the membranes—making online gas measurement an appealing choice, as it enables better process control and reduces greenhouse gas emissions.

Water Wash

The water wash method is based on the different water solubility of carbon dioxide and methane. Carbon dioxide is dissolved in water in the scrubbing column before being released in the flash and stripping columns. Ultimately, the water is recovered and recirculated back into the scrubbing column.



Pressure-swing adsorption

This technology uses activated carbon or zeolite instead of membrane tubes in a lower pressure environment than in membrane technology—typically between 1 and 1.5 bar. Carbon dioxide is captured by the membrane material while methane passes through it. When the pressure is lowered, the carbon dioxide is released and removed as offgas, which can be captured in a downstream process.

Optimizing your biogas production

Biogas upgrading relies on a constant supply of good quality gas from the anaerobic digester. Poor quality gas will result in an inconsistent flow, making the upgrading process challenging. Unplanned stops and starts in the process harm yield and significantly increase methane emissions. Monitoring the raw biogas stream is central to optimizing the anaerobic digestion process.

Measuring both methane and carbon dioxide with the Vaisala MGP261 biogas instrument allows you to track the methane:carbon dioxide (CH_4:CO_2) ratio easily and continuously.

This parameter can be used as a diagnostic in the same way as liquid pH in the digester. An increase in carbon dioxide concentration concurrent with a decrease in methane concentration can indicate problems like high-sugar feedstock being fed to the digester too fast in cold climates the methane concentration tends to drop if heating and stirring in a wet digester is not sufficient.

Raw biogas humidity is also an important parameter to monitor. As a rule, biogas coming from the digester is saturated with humidity, so it needs to be dried before removing hydrogen sulfide, siloxanes, and other impurities. The dewpoint after the drier is critical for activated carbon-based gas pretreatment, membrane upgrading units, and pressure swing adsorption upgrading units. Condensation in any of these gas treatment stages must be avoided, and in the case of membrane upgrading units you must ensure that condensation does not occur when the pressure is increased to 10 bar and above. The MGP261 is a unique tool for online measurement of dewpoint in raw biogas before pretreatment, where corrosive gases such as hydrogen sulfide and ammonia are present. Accurate dewpoint data can be used to improve filtration efficiency, as activated carbon filters perform best when the dewpoint is 8 to 10 °C below the gas temperature.

Optimizing your biogas production

MGP261 — Turbocharge your biogas plant

The MGP261 solves the biggest problem in biogas production — yield. It is a multipurpose tool that can be used to improve anaerobic digestion of industrial and municipal waste in wastewater treatment and landfill gas monitoring. It is also ideal for monitoring the raw biogas fuel feed to CHP engines to ensure reliable operation.

Robust and compact, this 3-in-1 methane, carbon dioxide, and humidity probe gives you always-on, highly reliable measurements so you can increase your yield. Are you ready to turbocharge your biogas plant?

Primary use	Raw biogas monitoring
Installation type	In situ
Sensor	Vaisala CARBOCAP®
Methane (CH_4) measurement range	0 … 100 vol-%
Carbon dioxide (CO_2) measurement range	0 … 100 vol-%
Water vapor (H_2O) measurement range	0 … 25 vol-% -10 … +60 dew point °C (14 … +140 dew point °F)
CH_4 accuracy at +25 °C (+77 °F) and 1013 mbar 1)	0 … 40 vol-%: ±2 vol% 40 … 70 vol-%: ±1 vol-% 70 … 100 vol-%: ±2 vol-%
CO_2 accuracy at +25 °C (+77 °F) and 1013 mbar 1)	0 … 30 vol-%: ±2 vol-% 30 … 50 vol-%: ±1 vol-% 50 … 100 vol-%: ±2 vol-%
H_2O accuracy at +25 °C (+77 °F) and 1013 mbar 1)	0 … 25 vol-%: ±0.5 vol-%
CH_4 repeatability	±0.5 vol-% at 60 vol-%
CO_2 repeatability	±0.3 vol-% at 40 vol-%
H_2O repeatability	±0.1 vol-% at 10 vol-%

1) Including non-linearity, calibration uncertainty, and repeatability; temperature and pressure compensated, excluding crossinterferences to other gases.

Six key strategies for optimizing biomethane production

Six key strategies for optimizing yield and quality, preventing losses, and minimizing costly and harmful methane slip

01

Maximize biomethane yield

Optimize your biogas upgrading process by adjusting the pressure of the upgrading unit based on real-time offgas measurement, and ensure sufficient methane content and calorific value in your produced gas.

02

Get a real-time verview of your process

With an MGP262 installed in the offgas pipe and an MGP261 installed in the raw gas input, you can measure every molecule of CH_4 and CO_2 in your process in real time.

03

Minimize energy consumption

Conserve energy by optimizing compressor pressure and gas recirculation rates in multistage membrane systems. With simultaneous measurement of biomethane and methane slip in the offgas, you can ensure that the methane content of the gas you produce is sufficiently high without increasing methane loss to the offgas. Determining the optimal gas pressure and avoiding excessive recirculation helps to minimize the energy used to produce a given volume of biomethane.

04

Extend membrane lifetime

Upgrading biogas with membrane technology requires a process pressure above 10 bar. If the dew point of your raw biogas is too high before compression, condensation will occur after compression even at high emperatures. You can use the MGP261 to measure water vapor as ppm volume or dew point temperature, helping you to maintain the dew point at or below 0 °C for trouble-free operation of your upgrading plant.

05

Minimize methane slip to offgas

Methane is a potent greenhouse gas and emissions to air are often regulated or subject to carbon credit schemes. You can use the MGP262 to monitor the methane concentration (0–5 vol-% range) released to the air from your upgrading plant.

06

Control your regenerative thermal oxidizer

If your plant is in an area with strict methane emission limits you'll need to remove as much methane as possible from the offgas before it is released to the atmosphere. Regenerative thermal oxidizer (RTO) technology is commonly used to convert methane to carbon dioxide before offgas is released. The MGP262 can be used as a realtime sensor to control the amount of combustible gas going to the RTO process. Accurate dewpoint data can be used to improve filtration efficiency, as activated carbon filters perform best when the dewpoint is 8 to 10 °C below the gas temperature.

Optimizing biomethane production — don’t let your profits slip

MGP262 — Get the green gains

The MGP262 for offgas methane and high-concentration CO_2 keeps your biogas upgrading plant running efficiently. Methane slip is unavoidable, but the MGP262 can help you minimize this costly and harmful phenomenon. With its always-on measurement, the MGP262 gives you the ability to control your upgrading process and focus on producing the best biomethane possible.

Primary use	Biomethane offgas monitoring
Installation type	In situ
Sensor	Vaisala CARBOCAP®
Methane (CH_4) measurement range	0 ... 5 vol-%
Carbon dioxide (CO_2) measurement range	0 ... 100 vol-%
CH_4 accuracy at +25 °C (+77 °F) and 1013 mbar 1)	0 ... 2 vol-%: ±0.1 vol-% 2 ... 5 vol-%: ±5% of reading
CO_2 accuracy at +25 °C (+77 °F) and 1013 mbar 1)	90 ... 100 vol-%: ±1 vol-% 0 ... 90 vol-%: ±2 vol-%
CH_4 repeatability	< ±0.1 vol-% at 1%
CO_2 repeatability	±0.4 vol-% CO_2 at 95 vol-%

1) Including non-linearity, calibration uncertainty, and repeatability; temperature and pressure compensated, excluding crossinterferences to other gases

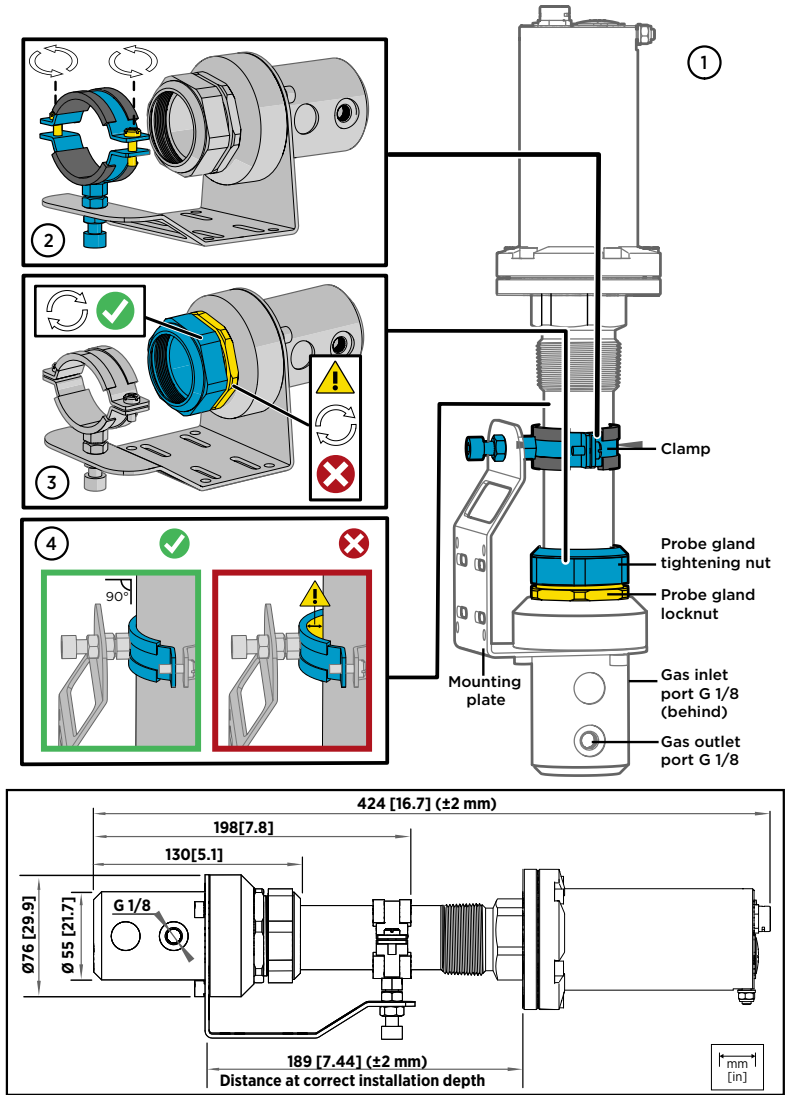
Measuring purified biomethane

The methane and carbon dioxide content of produced biomethane is a key parameter for ensuring optimal plant performance. A methane concentration that is too low has to be avoided for obvious reasons, but a methane concentration that is too high at the expense of gas volume is detrimental to plant performance. The goal is to maximize methane output, and this is typically achieved when methane concentration is in the range 95 … 98% CH_4. The carbon dioxide concentration must also be kept below a set limit to avoid dry ice formation in gas distribution networks or compressed gas containers. The CO_2 limit depends on the gas network, but for H-gas in European cross-border gas transport 2.5% CO_2 is typical.

By measuring gas composition at the outlet of the upgrading unit in addition to measuring incoming raw biogas and the offgas stream, you have much tighter control over your upgrading process. For membrane filter upgrading systems, the gas compression pressure and the recirculation rate can be adjusted based on the readings from offgas and biomethane measurement instruments. The goal is to minimize methane slip into the offgas and maintain the CO_2 concentration of the biomethane stream within acceptable limits.

Thanks to Vaisala's patented CARBOCAP® technology, the MGP261 maintains excellent stability and immunity to cross-influence of other gases such as carbon dioxide, nitrogen, and oxygen even when measuring high methane concentrations. And what's more, with no consumable parts the MGP261 is practically maintenance free. Beyond an optional but recommended calibration check with a compressed gas cylinder annually to ensure proper operation, no other maintenance is required.

Measuring purified biomethane



MGP261 for high-pressure biomethane streams

The biomethane produced in an upgrading unit is at elevated pressure. To measure it with the MGP261, a flowthrough adapter accessory is used together with a pressure regulator. A light flow of 0.5 l/min is sufficient for the MGP261 to carry out accurate measurements with a short response time; note that the pressure at the flow-through adapter must be below 1.5 bar absolute.