



**GREEN
METHANE**

THE ITALIAN BIOMETHANE



**BIOGAS UPGRADING TO BIOMETHANE
ITALIAN "BEST AVAILABLE TECHNIQUE"**

www.gm-greenmethane.it

TECHNOLOGY

THE BIOGAS UPGRADING PROCESS

The system operates in continuous mode.

The Raw Biogas is pre-treated (depending on the nature of the biogas) and compressed to between 4 and 15 bars. This pressure range gives the opportunity to adapt the plant to specific needs (for example, to maximize CO₂ capture, minimize energy consumption, etc.).

The CO₂ in the Biogas is then absorbed by a Potassium Carbonate (K₂CO₃) solution in the Absorption Column, leaving depurated Biomethane; Carbonate is converted into Potassium Bicarbonate (KHCO₃).

The CO₂ is then released in the Stripping Column, where the Bicarbonate is converted back to Carbonate, regenerating the solution.

Finally the regenerated K₂CO₃ solution is recycled into the Absorption Column.

ELECTRICITY CONSUMPTION

0.15 - 0.2 kWh/Nm³ biogas

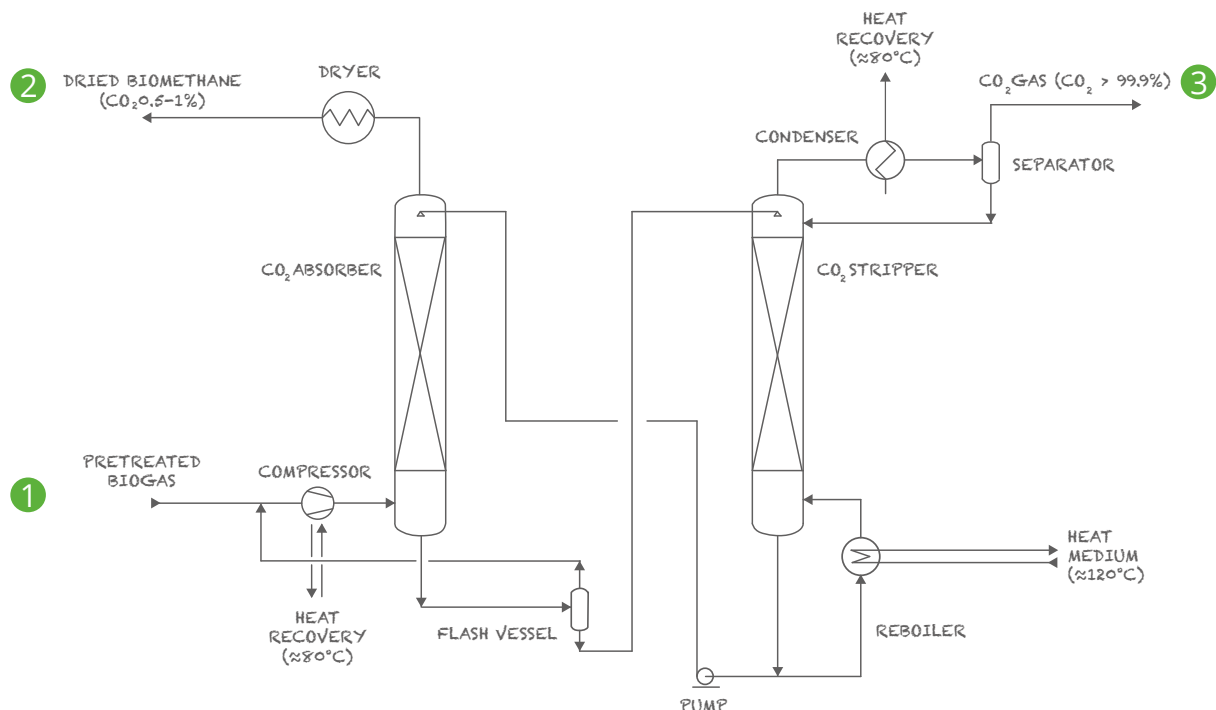
NO -OR NEGLIGIBLE- THERMAL ENERGY COST

CO₂ IN THE BIOMETHANE

0.5 - 1%

METHANE RECOVERY

>99.9%



1 BIOGAS:

Pressure: any

CO₂: 20-60%

CH₄: 80-40%

Other gases: as per grid injection regulations/fuel standards.

2 DRIED BIOMETHANE:

Pressure: 4-15 bar (g)

CO₂: 0.5-1%

CH₄: balance

Other gases: as per grid injection regulations/fuel standards.

Dew Point: -5°C @ 70 bar (g)

3 OFF-GAS:

Pressure: 0 bar (g)

CO₂: 99.94%

CH₄: 0.06%

H₂S: as by environmental regulations.

10 REASONS TO CHOOSE GM



Our certifications:

UNI EN ISO 9001
UNI EN ISO 14001
BS OHSAS 18001

More info at:
www.gm-greenmethane.it

1 ENVIRONMENTAL PROTECTION

Methane losses in Off-gas vented to atmosphere are lower than 0.1% of total methane in Biogas feed: no Off-gas post-treatment needed. GM-HPC (Hot Potassium Carbonate) technology is a BAT (Best Available Technique) thanks to the low level of pollutants emission and to the low consumption of feedstock, chemicals, water and energy.

2 METHANE RECOVERY >99.9%

Methane recovered from raw Biogas is higher than 99.9%. A higher methane yield by some percentage points increases significantly the profitability of the investment compared to other upgrading technologies.

3 ENVIRONMENTAL FRIENDLY PROCESS - NO CHEMICALS CONSUMPTION

The water based K_2CO_3 solution is not volatile and does not degrade, unlike the amine based scrubbing solutions. GM process is a chemical absorption, with no chemicals consumption, unlike water scrubbing technology, which needs chemicals for process water conditioning.

4 MINIMUM ELECTRICITY CONSUMPTION

GM Biogas upgrade process requires minimal power: 0.15 to 0.2 kWh/Nm³ of Biogas, depending on the requested Biomethane pressure at battery limits. Compared to membrane multi-stages process, no Biogas is recycled to compressor. Compared to water washing, GM process is not affected by weather condition and power consumption is less due to lower solution circulation and to negligible recycling to compressor of methane absorbed by washing solution.

5 PROVEN TECHNOLOGY

More than 360 worldwide applications in CO₂ removal.

6 SMALL-SIZED, SIMPLE AND RELIABLE PLANT

Due to high efficiency in CO₂ removal and reduced solution circulation, columns are smaller compared to water wash technology: typical height is lower than 12 m.

7 BEST SYSTEM AVAILABILITY: >99% STOP-START IN ONE MINUTE

Due to the simplicity of the process, GM plant run time is higher than 99%. GM plant is fully automated and can be quickly and easily stopped and restarted.

8 LOW MAINTENANCE COSTS

GM process for Biogas upgrading to Biomethane ensures low maintenance costs, thanks to unit's robust and simple design. Biogas compressor is the most critical item.

9 CO₂ CAN BE TOTALLY RECOVERED

CO₂ removed by the GM scrubbing process is available at high purity (>99.9%, dry basis) and can be used directly or liquefied and utilised in several applications.

10 BEST EFFICIENCY IN CO₂ REMOVAL

Residual CO₂ content in produced Biomethane is typically lower than 1%

...WHAT ABOUT DISADVANTAGES?

GM process requires a thermal energy input for absorbing solution regeneration. However...

THERMAL ENERGY BALANCE

Low consumption : ranging from 0.35 to 0.55 kWh/Nm³ of Biogas (depending from CO₂ concentration in Biogas to be treated and required Biomethane pressure at BL)

Thermal energy can be sourced from CHP off-gas, typically as pressurized water superheated at 130-140 °C. (If Biomethane is utilized as biofuel, it is convenient to install a CHP plant, fed with NG from network, for the electric power requirement of the whole site).

90 to 100% of overall thermal energy input will be recovered as heating water at 70-80 °C, which can be utilized as heating media for AD, for digestate drying or for other site needing

IN CONCLUSION:

NO -OR NEGLIGIBLE- THERMAL ENERGY COST

THE PLANT

THE PLANT

Compact unit. Skid mounted.

High quality components.

Quick assembly.

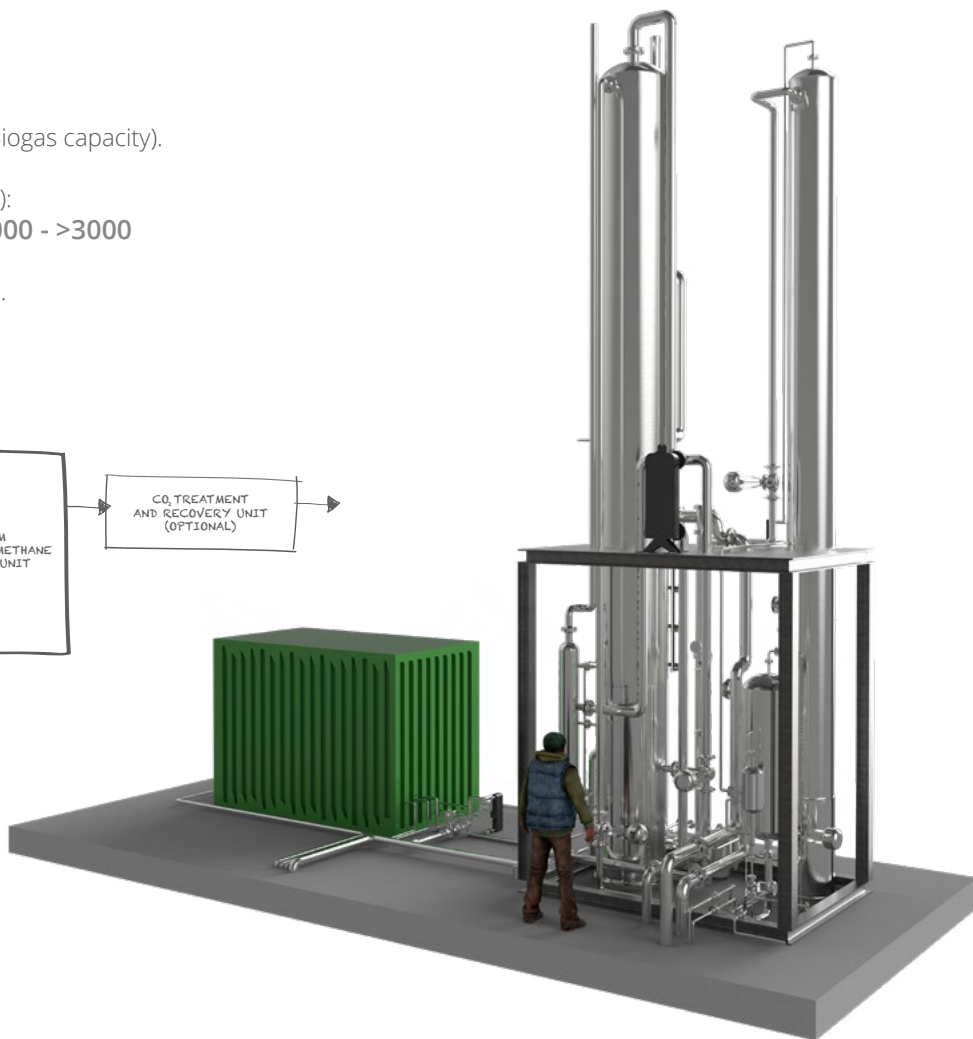
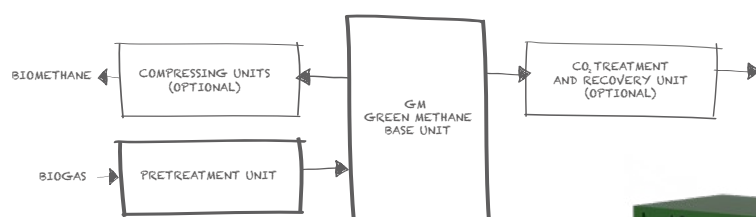
Reduced spacing 3m x 5m x H10m
(for the typical unit with 500 Nm³/h of Biogas capacity).

Range of unit capacity (Nm³/h of Biogas):
200 – 500 – 750 – 1000 – 2000 – 3000 – >3000

Operating capacity range: 20% to 110%.

MINIMUM ELECTRICITY CONSUMPTION

GM Biogas upgrade process requires minimal power: 0.15 to 0.2 kWh/Nm³ of Biogas, depending on the requested Biomethane pressure at battery limits. Compared to membrane multi-stages process, no Biogas is recycled to compressor. Compared to water washing, GM process is not affected by weather condition and power consumption is less due to lower circulation of absorbing solution.



Biogas upgrading plant from OFMSW operating since 2016.

Capacity: 125 Sm³/h of biomethane
(about 200 Nm³/h of raw biogas)

BIOGAS SOURCES

GM-Green Methane process is suitable for scrubbing any type of Biogas produced by Anaerobic Digestion of a variety of **organic substrates**, including:



OFMSW (Organic Fraction of Municipal Solid Waste)



Agricultural and food industry waste
Gas from landfills
Slaughterhouse wastes



Sludge from wastewater treatment
Algae



Agricultural by-products
Animal waste (manure)
Energy crops

QUALITY OF BIOMETHANE AND ATMOSPHERIC EMISSIONS

GM operates since 2016 a biogas upgrading plant treating 200 Nm³/h of biogas by AD of OFMSW from a Waste Treatment plant located in Northern Italy. In 2017, **CNR-IIA (Consiglio Nazionale delle Ricerche - Istituto sull'Inquinamento Atmosferico, Italian National Research Council - Institute for Atmospheric Pollution)** carried out two sampling and analysis campaigns on Biogas, Biomethane and Off-gas streams. The measurements are according to UNI TR 11537-2016 and EN 16732 standards.

The results achieved are summarised in the report CNR IIA 0003441/2017 “**Verifica delle prestazioni di un impianto per l’upgrading del biogas a biometano tramite Hot Potassium Carbonate**” (Checking of performance of a biogas upgrading to biomethane plant by Hot Potassium Carbonate).

The results show that:



Biomethane produced meets the requirements of UNI TR 11537-2016 and EN 16732 standards



Methane lost with Off-gas is lower than 0.1% of total methane in biogas feed (measured loss = 0.06%)

GM technology ensures:



Higher yield
Lower environmental footprint

COMPARING TECHNOLOGIES

THE BIOMETHANE REVOLUTION BEGINS IN ITALY

GM plants for biogas **upgrading** to biomethane utilise a patented technology applied since more than 60 years in several industrial applications. It offers the best **performance** compared to the other upgrading technologies currently available.



GM IS ECO-FRIENDLY

Typical methane content in the Off-gas is less than **0.1%**, with no need of Off-gas post treatment.



GM IS EFFICIENT

Methane recovered from raw biogas is more than **99.9%**.



GM CUTS THE ELECTRICITY COST

Electricity consumption is lower than **0.2 kWh/Nm³ of biogas**.



GM CUTS MAINTENANCE COSTS

Simple, strong and reliable technology.



GM IS GREEN

No hazardous materials are utilised.

NO OTHER TECHNOLOGIES CAN ACHIEVE THE PERFORMANCE OF GM PLANT

	TECNOLOGIA GM	Other upgrading technologies				
		Water	Amine	PSA	Membrane	Water plus membrane
	✓	✗	✓	✗	✗	✗
	✓	✗	✓	✗	✗	✗
	✓	✗	✓	✗	✗	✗
	✓	✓	✗	✓	✗	✗
	✓	✓	✗	✓	✓	✓

SERVICES

NO EXPENSIVE REPLACEMENT OF MEMBRANES

Green Methane Biogas upgrading process has low maintenance cost due to the unit's robust design and simplicity. The yearly maintenance cost can be guaranteed by a full service contract.

Green Methane approach involves collection of all required information and exchange of views and ideas with the customer, in order to make a detailed analysis to assess the viability of the project. GM supports the customer in the preparation of the business plan, proposing the best technical and financial options to maximize the profitability of the project.

This approach assures the seamless execution of the Engineering, Procurement & Construction phases of the project.



AUTHORIZATION PROCESS

GM supports and partners with the customer through the whole project authorization process, from coordination with authorities and generation of required technical documentation, to interfacing, if necessary, with the manufacturer of biogas technology.

START UP AND OPERATION

Unit start-up is a crucial time for the transfer of know-how to customer staff. A team of skilled Green Methane specialists will be available during the commissioning and start-up to train the operators and assist the production ramp-up of the Biogas upgrading unit.

IMPLEMENTATION AND ASSEMBLY

Green Methane upgrading units can be supplied on turn-key basis, including the site erection.

AFTER SALE SERVICES

Green Methane can provide a customized assistance for the operation and maintenance of the Biogas upgrading unit. The assistance is offered as packages, which content can fit case by case.

SUMMARY TABLE

Packages		Process and Technical Advice H24/7	Planned maintenance	Unplanned maintenance	Remote control and monitoring
Consultancy	GM - S1				
Maintenance	GM - S2.1				
	GM - S2.2				
Operation	GM - S3				

ABOUT US

PROVEN AND SIMPLE TECHNOLOGY

More than 360 worldwide applications of CO₂ removal. The plant is small, simple and reliable. Find out more about our plants.



www.gm-greenmethane.it

Green Methane was founded in 2013 by two Italian Enterprises: Marchi Industriale Group & Giammarco-Vetrocoke Group.

MARCHI INDUSTRIALE



Factory of Marano Veneziano (VE) - IT

- 1873** Ferruccio Marchi opens first fertilizer factory in Tuscany.
- 1900** A second factory was established in Marano Veneziano.
- 1984** Marchi Industriale Holding was created.
- 2010** Marchi Energia was established with a mandate to focus on renewable energy.

GIAMMARCO VETROCOKE



Ragusa (Italia) - CO₂ removal from Off-gas methane plant

- 1950** Giammarco-Vetrocoke is founded. Giuseppe Giammarco patents a selective CO₂ absorption process based on K₂CO₃ solutions. GV process is widely applied to various gases with different pressure, temperature and composition.
- 2013** GV is now one of the top three licensors of CO₂ absorption technology in the world, with more than 350 licensed units installed.

RECENT WORLDWIDE REFERENCES

Plant	Location	Inlet Gas capacity (Nm ³ /h)	Year
CO ₂ removal for Syn-Gas (Ammonia Plant)	Russia	276,000	2016
	USA	244,000	2016
	India	126,000	2017
	India	187,000	2017
	Russia	294,000	2017

ITALIAN REFERENCES (non exhaustive list)

Plant	Location	Gas capacity (Nm ³ /h) at inlet	Inlet gas CO ₂ content (% vol)	Year
CO ₂ removal for Hydrogen Plant	Novara	4,750	17%	1994
CO ₂ removal for Hydrogen Plant	Novara	3,200	17%	2001
CO ₂ removal for Hydrogen Plant	Genova	14,500	17%	2003
CO ₂ removal for a Off-gas	Ragusa	2,000	68%	2005
Pretreatment and CO₂ removal from Anaerobic Digestion of OFMSW	<i>Padova</i>	200	40%	2016

CONTACTS

Via Miranese, 72
Marano Veneziano
30034 Mira
(Venice - Italy)

Tel. +39 041 5674260
Fax +39 041 479710
Mail: info@gm-greenmethane.it
Web: www.gm-greenmethane.it



GM BRE 07-10/2017