

MEMBRANE BIOGAS UPGRADING SYSTEM

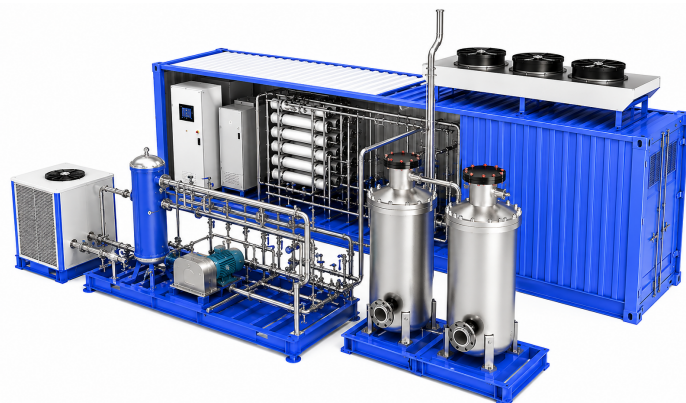


DRY MEMBRANE UPGRADING TO >99.5% BIOMETHANE FOR CBG, RNG, AND GRID INJECTION

Raw biogas typically runs 50-70% CH₄ and 30-50% CO₂. Grid injection or vehicle fuel use means stripping that CO₂ fraction out along with H₂S, moisture, and siloxanes. Membrane life and methane recovery both depend on clean, stable inlet gas, which is where upgrading plants built as a bolt-on afterthought tend to lose performance.

CRA's Membrane Biogas Upgrading System separates CO₂ from raw biogas using a multi-stage hollow-fiber membrane process operating at 8-16 bar feed pressure^L, with no water or solvents. CO₂ permeates through the hollow-fiber walls faster than methane and exits as a permeate stream, while methane-rich gas exits as the retentate. Multi-stage configurations recirculate methane from intermediate permeate streams, pushing recovery above 95%. CRA engineers the upstream gas train, H₂S scrubbing (chemical and biological), dehumidification, and compression, in-house and integrates it with the membrane skid as one package.

The result is a compact, modular, low-OPEX system delivered containerized or skid-mounted for grid injection, Compressed Biogas (CBG/Bio-CNG), Bio-LNG, and industrial use, built under the same ISO 9001, ASME, and CE-marked quality system that governs every CRA skid.



CRA ADVANTAGE

+ High Purity Output (>99.5% CH ₄ , <0.5% CO ₂)	+ Optimal Design & Performance + Accomodate Special Requirements
+ Low OPEX Operation (dry membrane process, no water or chemicals)	+ On-Time Delivery + Responsive & Organized Team
+ Complete In-House Build (upgrading, H ₂ S scrubbing, and compression under one roof)	+ Stringent Quality Management + Fast Turnaround
+ Modular & Flexible (containerized or skid-mounted)	+ Cost Effective Maintenance Packages + Long-Term CRA Support

APPLICATIONS

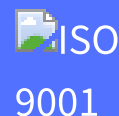
Supplied for biomethane upgrading across CBG, RNG grid injection, and industrial fuel duty

- + Compressed Biogas (CBG)
- + Grid Injection (RNG)
- + Bio-LNG
- + Industrial Heating & Boilers
- + Waste-to-Energy Conversion
- + Power & Energy Utilities

CRA
7, Sector 140A
Noida, UP, 201304

Learn more at www.cra.energy

contact@cra.energy
0120 415 6787 • +91 85060 09433



WORKING & PERFORMANCE



MULTI-STAGE HOLLOW-FIBER MEMBRANE SEPARATION, NO WATER OR SOLVENTS

WORKING

- + Biogas is compressed to 8-16 bar, dried to a dew point of 4-10°C, and desulfurized to <10 ppm H₂S before it enters the membrane module^L
- + CO₂ permeates through the hollow-fiber walls faster than methane and exits as a permeate stream, while methane-rich gas exits as the retentate
- + Multi-stage configurations recirculate methane from intermediate permeate streams, pushing recovery above 95%
- + Product gas is monitored continuously to confirm >99.5% CH₄ and <0.5% CO₂ before it moves to compression or grid injection

WHY MEMBRANE UPGRADING

- + >99.5% CH₄, <0.5% CO₂ In Product Gas
- + >95% Methane Recovery
- + Dry Process, No Water Or Chemicals
- + Compact, Containerized Or Skid-Mounted
- + Complete Upstream Gas Train Under One Roof

Electrical consumption for membrane-based upgrading typically runs 0.15-0.30 kWh per Nm³ of raw biogas processed, well below water scrubbing or PSA at comparable purity^L.

TYPICAL DESIGN & PERFORMANCE PARAMETERS

Feed biogas composition	50-70% CH ₄ , 30-50% CO ₂
Feed pressure	8-16 bar ^L
Biomethane purity	>99.5% CH ₄
CO ₂ in product	<0.5%
H ₂ S in product	<4 ppm
Methane recovery	>95%
Methane slip	<0.5-1% in multi-stage configurations ^L
Electrical consumption	0.15-0.30 kWh/Nm ³ raw biogas ^L
Pretreatment dew point	4-10°C ^L
Pretreatment H ₂ S limit	<10 ppm ahead of membrane; <0.1 ppm after activated-carbon polishing
Capacity range	100 Nm ³ /hr to 12,000+ Nm ³ /hr, available in modular increments ^L
Membrane service life	5-10 years ^L

^L Published literature, sources on file. All other figures per CRA published product data.

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