

# BIOGAS UPGRADING PLANTS THE GREENEST BIOMETHANE IN THE WORLD

- The lowest life cycle costs
- The highest revenues
- The highest methane efficiency
- Modular built
- Turn-key deliveries

# GREEN ENERGY FROM RENEWABLE RESOURCES

**All human activity creates waste. Waste is also a valuable resource. Excess agricultural produce, manure, wastewater sludge, household and restaurant waste are perfect raw materials for biogas production. The biogas can be upgraded to pure methane, which is used for vehicle fuel or for injection into the natural gas grid.**

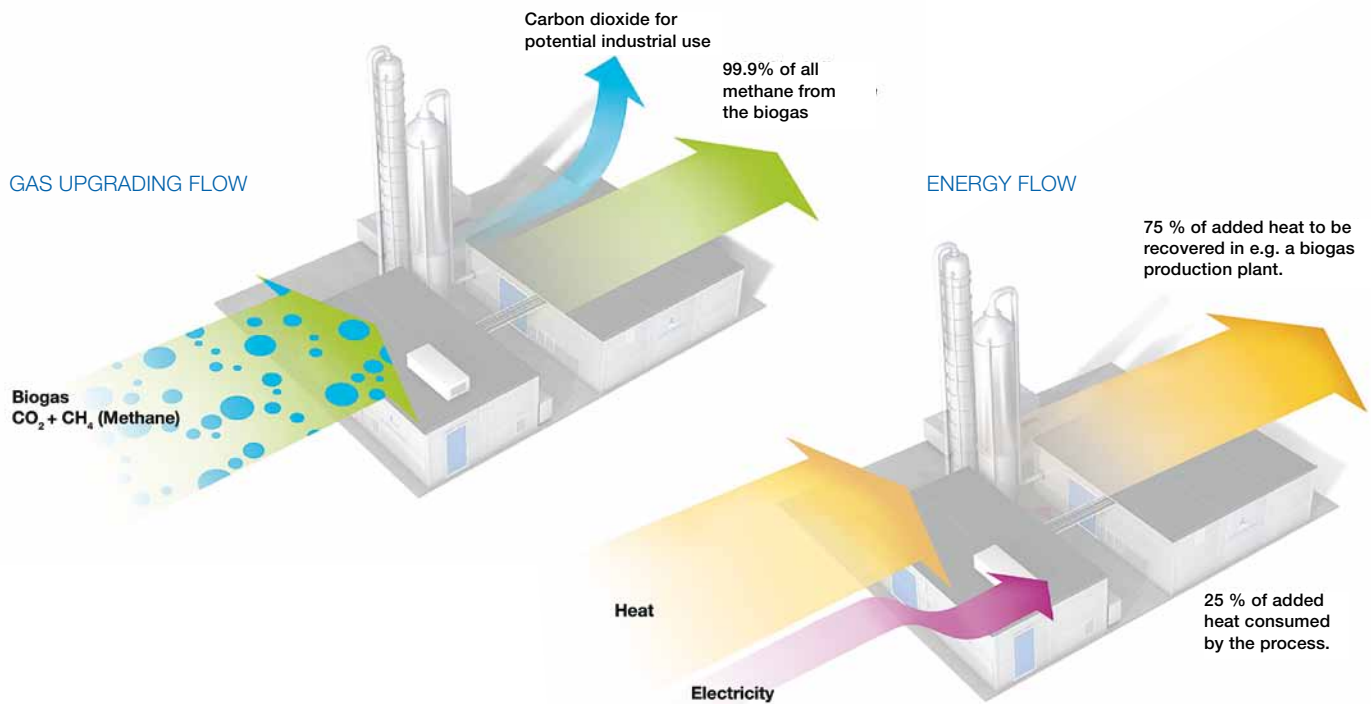
## **A sustainable life cycle**

Purac's business is to deliver plants that use the natural decomposition process to purify water and waste-water and extract methane from biogas. Every step of the way is sustainable both for short and long term. We take care of wastewater and waste, treat it, supply clean water and clean fuels. Every day we help make a better world.

## Outstanding energy efficiency

Purac Puregas has the total process experience and competence to make effective use of the heat generated during the biogas upgrading process. This excess heat is recovered and used to pre-heat the organic waste before the fermentation process begins. Using Purac Puregas heat recovery technology can cut up to 75% of the process energy consumption, which means greatly improved total cost efficiency for your methane gas production. An extra benefit is that our CAPure™ process allows effective utilisation of low cost heat instead of electrical energy, e.g. heating from flue gas coolers and district heating.





### The greenest methane gas in the world

Fermentation of organic solids produces raw biogas that contains 50-70% methane, 30-50% carbon dioxide and traces of sulphur, nitrogen and oxygen. Purac Puregas takes this raw biogas and upgrades it to practically pure methane. The unique chemical absorption process, CApure™, removes CO<sub>2</sub> and H<sub>2</sub>S. The removal system provides more than 99.9% of the methane content in the raw gas biogas and makes it available for commercial use. This is a climate neutral energy source that reduces the global dependency on fossil fuels.

How can we claim that Purac Puregas plants produces the greenest methane gas? We have an absolute minimum of methane slip to the atmosphere, which is critically important since methane has a global warming effect more than 20 times higher than CO<sub>2</sub>\*. The whole upgrading process is also uniquely energy efficient. Great energy savings are possible compared to competitive biogas upgrading methods.

### Total process know-how

Our company's history comes from building the best wastewater treatment plants. Since 1935, we have had international success, with installations in e.g. China, Turkey, Poland, Germany and Scandinavia. Biogas upgrading is an integrated part of this purification process. Years of experience in every aspect of the waste handling system has given us extensive know-how about raw material substrate treatment, purification technology, energy use and, most importantly, process optimisation. We use this experience to optimize every biogas upgrading plant to your specific needs and demands.



\* IPCC Fourth Assessment Report, Working Group 1

# CApure™ BIOGAS UPGRADING

Purac's CApure™ biogas upgrading process uses advanced gas purification and energy saving technologies to produce the highest quality and most environment friendly biomethane with the same properties as natural gas.

## CApure™ process

The CApure™ process captures more than 99.9% of the methane in the raw biogas. The end product contains more than 99% methane and is available for vehicle fuel or to be fed into the natural gas grid. This high-quality, high methane content gas, greatly reduces the need for propane addition before injection to the natural gas grid. Often, there is no propane requirement. Another benefit is that the need for tail gas treatment is removed with the CApure™ process. The siloxane removal is extremely efficient with contents of less than 0.05 mg/Nm<sup>3</sup>, which is the lowest detectable level for today's instruments.



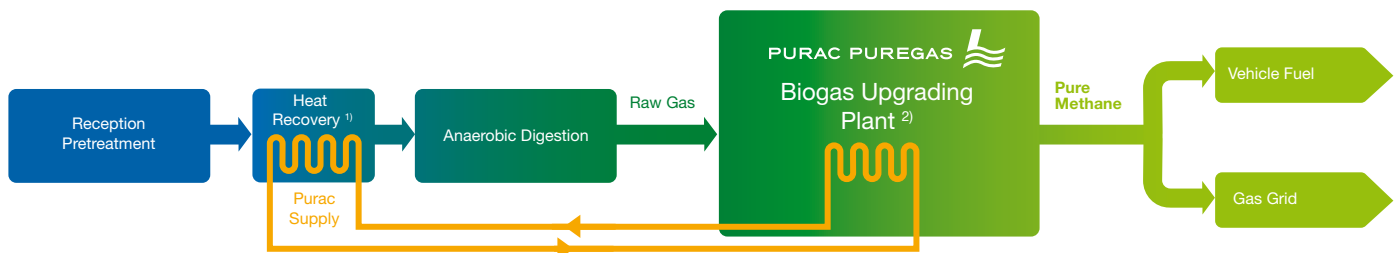
The biogas upgrading unit is designed in modules allowing cost effective variations in plant size and capacity. In the CApure™ upgrading process the sulphur content in the raw biogas is reduced to very low concentrations, typically below 0.5 ppm. Later in the process a special amine is used absorbing 99.5% of the CO<sub>2</sub>. This stripped off, 99.8% pure CO<sub>2</sub> can be used in e.g. green houses, as a cooling agent or generally for industrial use – a valuable bi-product of the biogas upgrading process.

## Heat recovery

Purac's CApure™ process includes a unique heat recovery option. Energy is recovered from the biogas upgrading process and fed into the anaerobic digestion by pre-heating the substrate. Compared with other biogas upgrading techniques, CApure™ heat recovery reduces the need for electric power, which can reduce energy cost by up to 50%.

### HEAT RECOVERY PRINCIPLE

Heat from the biogas upgrading is used to preheat the substrate fed into the biogas reactor.



<sup>1)</sup> Heat recovery by pre-heating substrate fed to digestion with waste heat from CApure™ process.

<sup>2)</sup> Factory manufactured, approved by notified body for commissioning with gas before delivery to site.



Parts manufacturing for Linköping, Sweden.



Plant manufacturing for Linköping, Sweden, 3450 Nm<sup>3</sup>/h.

### Service and operation

After commissioning, Purac Puregas offers a complete service and operation package, ensuring that the biogas upgrading plant is controlled and supervised around the clock. The package can include remote operation, supervision, control, service, maintenance and telephone support. Most importantly, we take the responsibility for the process optimisation, suggesting and implementing improvements for the long-term.

### High-quality, standardised custom design

The CAPure™ technology is based on a modularised design. This allows manufacturing of standardised, pre-fabricated units that can be pre-tested, process optimised and quality controlled in the factory before delivery, reducing time and cost for installation and commissioning. The modules are built in our factory ensuring total quality control and operation reliability. All modules are also tested and approved by a certified independent control authority, making sure that our biogas upgrading plants meet the most stringent international quality, safety and performance requirements.

### Benefits of chemical absorption technology

There are three main technologies in the biogas upgrading industry: CAPure™ - chemical absorption technology, Water Scrubber technology and PSA - pressure swing absorption technology. CAPure™ technology offers the highest methane content in the market. This means the greenest gas available, and that the lost income from methane loss is at minimal. An additional benefit is that there is no cost for destructing the methane that other technologies are unable to capture. Thanks to the high methane content of the CAPure™ gas, very small amounts of propane or even none is required to increase the energy value of the biogas. Finally, with CAPure™ technology there is no need to increase the working pressure of the raw biogas, which translates to greatly reduced energy needs.

#### Parameter

Parameter	CAPure™	Water Scrubber	PSA
Methane loss	< 0.1%	< 1-2%	< 3 - 10%
Methane in upgraded gas	> 99%	> 97%	> 96%
Working pressure (bar)	0	3-7	3-7
Electricity (kWh / Nm <sup>3</sup> raw gas)	0.10 – 0.11	0.35	0.35
Heat use (kWh / Nm <sup>3</sup> raw gas)	0.5 – 0.6	NA	NA
Heat recovery (kWh / Nm <sup>3</sup> raw gas)	0.38 – 0.45	NA	NA
Total energy (kWh / Nm <sup>3</sup> raw gas)	0.23 – 0.26	0.35	0.35
Controllability, nominal load	50-115%	50-100%	100 + 15%
Meeting rule 30	Yes	Not known	Not known

# IN SUCCESSFUL OPERATION



Purac's CApure™ technology for biogas upgrading has been in successful commercial operation since 2002. By 2010, we have built 10 plants in Sweden, Norway and Germany, with great variations in size and capacity.

## Odour-free process

The CApure™ biogas upgrading process is completely odour-free. The sulphur in the foul smelling raw biogas passes through an active carbon filter where it is separated from the biogas and becomes chemically bound to the carbon. The carbon bed is changed when it is saturated with sulphur. For safety reason an odouriser is added to the completely odour-free CApure™ methane.

## Focus on life cycle costs

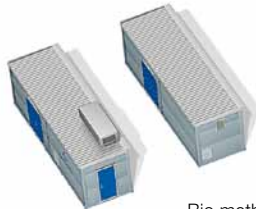
Every Purac Puregas upgrading plant is built with a strict focus on keeping the life cycle costs to an absolute minimum. On top of that we offer services and new technology to optimise already existing plants over time. In several plants we have been able to reduce the power consumption by up to 20% and the cost of energy by up to 30%.

**Biogas Plant 0–300 Nm<sup>3</sup>/h**  
1 module



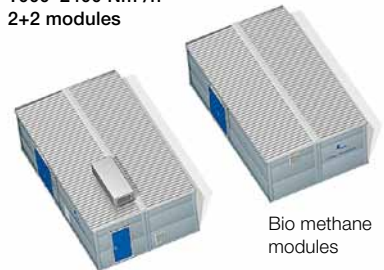
Liquid system  
Electricity control  
Bio methane module

**Biogas Plant 300–1000 Nm<sup>3</sup>/h**  
1+1 module



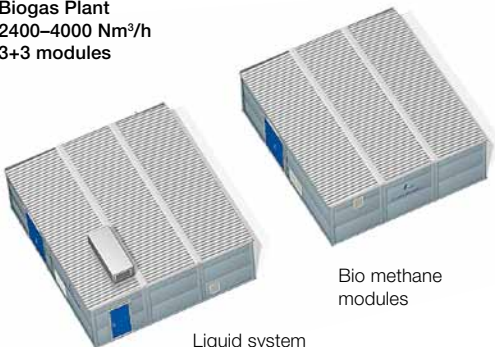
Liquid system  
Electricity control  
Bio methane module

**Biogas Plant 1000–2400 Nm<sup>3</sup>/h**  
2+2 modules



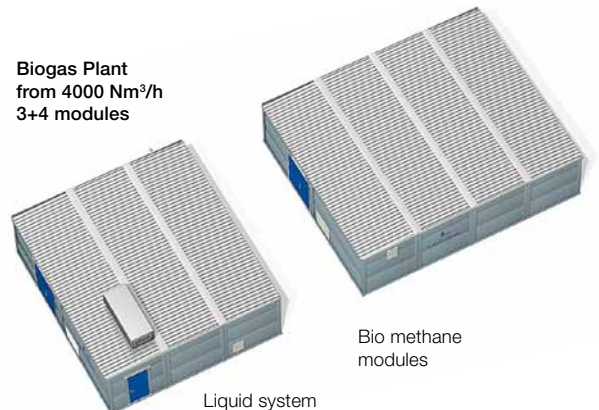
Liquid system  
Electricity control  
Bio methane modules

**Biogas Plant 2400–4000 Nm<sup>3</sup>/h**  
3+3 modules



Liquid system  
Electricity control  
Bio methane modules

**Biogas Plant from 4000 Nm<sup>3</sup>/h**  
3+4 modules



Liquid system  
Electricity control  
Bio methane modules

## REFERENCE LIST

City, country	Year	Capacity	Substrate	Gas use	Please note
Borås, Sweden	2002	450 Nm <sup>3</sup> /h, 260 scfm	Co-digestion	Vehicle fuel, local biomethane grid	Upgraded from 300 Nm <sup>3</sup> /h, Methane slip < 0.06%, Electricity consumption < 0.06 kWh / Nm <sup>3</sup> raw biogas, Heat consumption < 0.55 kWh / Nm <sup>3</sup> raw biogas
Gothenburg, Sweden	2006	1600 Nm <sup>3</sup> /h, 930 scfm	WWTP	Natural gas grid	
Kalmar, Sweden	2008	200 Nm <sup>3</sup> /h, 120 scfm	Co-digestion	Vehicle fuel, local biomethane grid	Methane slip < 0.06%, Electricity consumption 0.10 kWh / Nm <sup>3</sup> raw biogas, Heat consumption < 0.55 kWh / Nm <sup>3</sup> raw biogas
Falkenberg, Sweden	2009	750 Nm <sup>3</sup> /h, 440 scfm	Co-digestion	Vehicle fuel, local biomethane grid	
Stockholm, Sweden	2009	800 Nm <sup>3</sup> /h, 470 scfm	Co-digestion	Vehicle fuel, local biomethane grid	Electricity consumption 0.11 kWh/Nm <sup>3</sup> raw biogas
Stavanger, Norway	2009	500 Nm <sup>3</sup> /h, 300 scfm	Co-digestion	Natural gas grid	
Könnern, Germany	2009	3450 Nm <sup>3</sup> /h, 2030 scfm	Green crops	Natural gas grid	Meets the German TA luft requirements for methane slip
Oslo, Norway	2010	750 Nm <sup>3</sup> /h, 440 scfm	WWTP	Vehicle fuel, local biomethane grid	New contract, in operation September 2010
Karlstad, Sweden	2010	200 Nm <sup>3</sup> /h, 120 scfm	WWTP	Vehicle fuel, local biomethane grid	
Linköping, Sweden	2010	3450 Nm <sup>3</sup> /h, 2030 scfm	Co-digestion	Vehicle fuel, local biomethane grid	



Gothenburg, Sweden, 1600 Nm<sup>3</sup>/h, 930 scfm.



Falkenberg, Sweden, 750 Nm<sup>3</sup>/h, 440 scfm.



Stockholm, Sweden, 800 Nm<sup>3</sup>/h, 470 scfm.



Stavanger, Norway, 500 Nm<sup>3</sup>/h, 300 scfm.



Linköping, Sweden, 3450 Nm<sup>3</sup>/h, 2030 scfm.



Karlstad, Sweden, 200 Nm<sup>3</sup>/h, 120 scfm.



**Könnern, Germany**

The biogas upgrading plant of the biogas park Könnern Süd receives raw gas from one of the world's largest biogas plants. Up to 3450 Nm<sup>3</sup>/h of raw gas is treated. The upgraded gas contains 99.4% of biomethane. The process works under very little pressure, less than 500 mbar. Depending on inlet gas quality, the plant delivers up to 1800 Nm<sup>3</sup>/h of biomethane.

Purac Puregas designs and builds the greenest and lowest life cycle cost biogas upgrading plants in the world.

The company is part of Läckeby Water Group, a Sweden based, independent, privately owned industrial group. Läckeby Water Group offers contracting, products and service for water and wastewater treatment and biogas production.

The company is established on three continents and has built plants in 70 countries worldwide. With sales of approximately EUR 70 million, Läckeby Water Group is a leading company in its field.



[www.lackebywatergroup.com](http://www.lackebywatergroup.com)

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