

Upgrading to natural gas quality

# From biogas to green gas



**Biogas is produced by fermentation of a mixture that includes crop waste, liquid waste streams and maize, often in combination with manure. Nowadays, biogas is mainly used to produce electricity. But there is a more sustainable and more efficient option: upgrading the biogas and returning it to the gas grid. Biogas that has been upgraded to natural gas quality is called 'green gas'.**

The Netherlands depends on natural gas for around 50% of its primary energy supply. There is therefore a lot of work still to be done to achieve 20% sustainable energy and a 30% reduction in greenhouse gas emissions (such as CO<sub>2</sub>, methane and nitrous oxide) by 2020, as desired by the EU and the Balkenende IV government. The obvious solution is to use the Netherlands' experience as a gas-producing country to achieve these targets.

### *The Netherlands as a green gas country*

The Netherlands has a great deal of knowledge and expertise in relation to gas. It also has an excellent gas infrastructure, which is capable of transporting more energy than the electricity grid. In addition, the Netherlands has biomass at its disposal in the form of waste flows, including those from agriculture and the food industry, and it has ports that can be used to import biomass.

This means that green gas has great potential as an economic engine. This is already being proven in practice: Dutch companies are often forerunners in the development of upgrading techniques for biogas and the supply of green gas is an attractive option for producers of biogas. It is also possible to use upgraded biogas as vehicle fuel.

### *Green gas has added value*

The promotion of sustainable energy by the government will in the future be based on the level of sustainability, which is better for green gas than for electricity production through fermentation. Green gas is the cleanest option: the net reduction in CO<sub>2</sub> emissions is much greater.

### **CLEAN PROFITS IN ZWIGGELTE**

In the province of Drenthe, a number of farmers have formed the Central Drenthe Biogas Cooperative (Coöperatie Biogas Midden Drenthe) to jointly produce sustainable energy. They opted to ferment biomass, in this case mainly manure.

The cooperative intends to upgrade the biogas produced to natural gas quality, so that it can be supplied to the natural gas grid as green gas.

## **From biogas to green gas: upgrading techniques**

**Combined heat and power is used almost everywhere to convert biogas from fermentation plants into electricity and heat. Usually, the heat is not used efficiently, as a result of which around 60% of the energy is lost. Upgrading to green gas does provide maximum efficiency. The technology required is available and is already in widespread use.**

Upgrading to natural gas quality is not just something for the future. It has been done for years in the case of landfill gas and sludge fermentation, and it is being done with biogas to an increasing degree as well. A number of technologies can be used to upgrade biogas to green gas.

### **Increasing energy content and cleaning**

The upgrading process increases the energy content until the Wobbe index matches that of natural gas. To achieve this, CO<sub>2</sub> is removed from the biogas, which results in a higher methane content. Siloxanes, organically active substances, chlorine, sulphur, etc. must also be removed. Cleaning is important to prevent pollution of the air and surface water, and of installations located 'downstream' of the gas production. On the opposite pages (underneath the flap) you can find a number of the solutions that are offered for this purpose in the Netherlands.

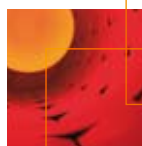
### **GREEN GAS BY GASIFICATION OF BIOMASS**

This folder explains the upgrading of biogas from fermentation plants, which is the current technology. Gasification is a second-generation technology for producing green gas from waste flows. Dahlman Filter Technology developed the Olga technology for this purpose. The photograph shows the 1.1 MWe gasification plant with Olga tar removal system in the French town of Moissannes.



### **DEFINITIONS**

- **Green gas:** collective term for upgraded biogas, SNG and landfill gas that can be used as a substitute for natural gas.
- **Biogas:** is produced by fermentation of biomass.
- **Synthetic natural gas (SNG):** is produced by gasification of biomass or coal.
- **Landfill gas:** produced by landfill sites, has a composition similar to that of biogas.





### *De Marke test farm pilot project*

CCS, DutCH4, LTO-Noord, Techno-Invent, TNO and WUR are developing a technology to upgrade biogas to natural gas quality at farm level. The installation is being developed for a volume of 25 to 300 Nm<sup>3</sup> of biogas per hour. The objective is for the installation to be cheaper than a combined heat and power installation.

The technology is based on a desulphurisation technique developed by TNO that has achieved an upgrading efficiency of 99.9%. The CO<sub>2</sub> is washed out. Sulphur slurry and carrier vapour (with a low methane concentration) are used efficiently.

Among other things, the upgraded biogas will be used at De Marke as fuel for a tractor.

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### *Cirmac International*

Cirmac has been specialising in biogas upgrading systems for over twenty years.

The company supplies complete turnkey systems based on:

- LP Coaab (chemical absorption of CO<sub>2</sub> using Coaab absorption liquid),
- VPSA (CO<sub>2</sub> is adsorbed by molecular sieve coke),
- Membrane technology (methane and CO<sub>2</sub> are separated using permeable membranes).

Capacities of 50 to 5,000 Nm<sup>3</sup>/h are possible for all systems. A big advantage of the LP Coaab technology is the fact that methane loss is less than 0.1%.

All technologies are already being used in systems with capacities of between 160 and 1600 Nm<sup>3</sup>/h. The green gas produced is used as vehicle fuel or is injected into the gas grid.

1 2 3



### *Van der Wiel*

Van der Wiel supplies solutions for upgrading biogas to natural gas quality for an input of 200–1200 Nm<sup>3</sup> per hour. CO<sub>2</sub> is removed by membrane filtration at low pressure. This is a dry process in which no chemicals are used. Contaminations such as sulphur, fluorides and chlorine are removed from the gas using active carbon.

The entire installation is mounted on a galvanised steel skid. The control system is installed in an insulated and ventilated area.

Van der Wiel offers three standard units with a maximum input of 400, 800 and 1200 Nm<sup>3</sup> per hour, for biogas with less than 8% nitrogen and less than 100 ppm of sulphur.

2



### Certified Energy

Certified Energy uses products made by the German manufacturer CarboTech to offer solutions for an input of 100 to 1200 Nm<sup>3</sup> of biogas per hour, with up to 100 ppm of sulphur. The CO<sub>2</sub> from the biogas is adsorbed in active carbon using the PSA technique. As part of this technique, some of the nitrogen and oxygen is immediately removed from the biogas, which improves the energy content. Contaminations are also removed. PSA is a dry process, which means that no treatment of waste water is required and no corrosion occurs. No chemicals are used either. Sulphur does not need to be removed in advance.

3



### Gastreatment Services

This company offers an innovative cryogenic technique that upgrades biogas to natural gas quality and at the same time produces liquid CO<sub>2</sub>, which can be used in greenhouses, breweries, etc.

The system consists of four steps: (1) gas compression, (2) gas drying, removal of contamination, followed by cooling to 25°C, (3) further gas cleaning with a special filter, (4) removal of CO<sub>2</sub> and upgrading to the desired quality. As gas cleaning and CO<sub>2</sub> removal are combined, it is not necessary to remove the sulphur in advance. Methane loss is limited: a maximum of 0.5%. There are standard systems for 50 to 2,200 Nm<sup>3</sup> of biogas per hour.

4

OVERVIEW OF TECHNIQUES FOR UPGRADING BIOGAS	Suitable for a capacity (Nm <sup>3</sup> /h) of			Pre/post-treatment	Methane loss	Other comments
	< 500	500-2000	> 2000			
<b>1 Gas washing</b> Liquid absorbs CO <sub>2</sub>	Yes	Yes	Yes	High	Low	When washing with chemical liquid
<b>2 Membrane filtration</b> Separating CO <sub>2</sub> using membranes	Yes	Yes	No	Medium	High	Easy to apply, quality decreases over time
<b>3 PSA (pressure swing adsorption)</b> Active carbon adsorbs CO <sub>2</sub>	Yes, from 200 m <sup>3</sup>	Yes	Yes	Low	Medium	Also removes some of any N <sub>2</sub> and O <sub>2</sub> that may be present
<b>4 Cryogenic technique</b> Separation of liquid CO <sub>2</sub>	Yes	Yes	Yes	Low	Low	Liquid CO <sub>2</sub> suitable for recycling

This table lists techniques for CO<sub>2</sub> removal. Several solutions are offered for further treatment. Suitability is based on investment and operational costs compared to profits with current technology. Price indication: an upgrading installation for more than 700 Nm<sup>3</sup> of biogas per hour costs over 1 million euros.



Returning green gas to the regional gas grid is one option, but there are others. A pilot project, in which upgraded biogas is used as vehicle fuel, is underway at the De Marke test farm in the province of Gelderland. (photo: De Marke)

## **Also the ideal solution for farmers and market gardeners**

**Many farmers are currently developing initiatives for producing biogas using co-fermentation. In this way they contribute to regional economic developments and, at the same time, they express their social involvement. Sustainably produced green gas may be set to replace natural gas.**

### **70% of heat is currently lost**

In current practice, combined heat and power is used to convert most of the biogas produced into electricity and heat. The electricity is supplied to the grid as green electricity. This is a great application if the heat produced can be used efficiently. However, that is only possible in a few cases, for example, for a local swimming pool. In most cases, 70% of the heat has to be dissipated without it being used. As a result, a large part of the energy content of the gas is lost, which is undesirable both in energetic and ecological terms.

### **Greater efficiency with green gas**

Most of the energy loss can be prevented by upgrading the biogas to natural gas quality. This process only requires a limited amount of energy, as a result of which the energy content of the biogas is almost entirely retained. Another benefit is that green gas can be supplied to the regional gas grid. Farmers have already started developing these installations at several locations in the Netherlands.

Accept the challenge as well and use energy more efficiently by producing green gas!



## Biogas upgrading in brief

### *Who can gain from the upgrading of biogas?*

- Farmers and market gardeners
- The food and luxury food industry
- Project developers and investors
- Authorities, especially provincial authorities

### *Where is biogas produced?*

- At co-fermentation plants in the agricultural sector (manure, crop waste, maize, etc.)
- At fermentation plants based on waste streams from the food and luxury food industry (organic waste, fatty waste-water streams, etc.)
- At water purification plants that use sludge fermentation
- Landfill gas (biogas is already being upgraded at the remaining landfill sites)

### *What are the benefits of upgrading biogas to green gas?*

- Optimum efficiency from biogas: no energy is lost in the form of heat, which is almost always the case when electricity is produced. The green gas (natural gas quality) is supplied to the gas grid.
- Sustainable and reliable: less fossil fuel required, further reduction of CO<sub>2</sub> emissions, security of supply (all of this using the existing gas infrastructure).

### *Which companies and institutes in the Netherlands offer the required technology?*

This list is not exhaustive. In this folder you can find information about the products offered by the suppliers marked with an asterisk:

- BTG: [www.btgworld.com](http://www.btgworld.com)
- Certified Energy: [www.certified-energy.nl](http://www.certified-energy.nl)\*
- Cirmac International: [www.cirmac.com](http://www.cirmac.com)\*
- Dahlman Filter Technology: [www.dahlman.nl](http://www.dahlman.nl)\*
- Dirkse Milieutechniek: [www.dirkse-milieutechniek.com](http://www.dirkse-milieutechniek.com)
- Gastreatment Services: [www.gastreatmentsservices.com](http://www.gastreatmentsservices.com)\*
- TNO Science and Industry: [www.tno.nl](http://www.tno.nl)\*
- Virage Milieu & Management: [www.virage.nl](http://www.virage.nl)
- Van der Wiel Stortgas bv: [www.vanderwiel.nl](http://www.vanderwiel.nl)\*

Further information: [www.energietransitie.nl](http://www.energietransitie.nl)

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This is a publication by Platform Nieuw Gas, one of the platforms where companies, knowledge institutes, civil-society organisations and authorities work together on the transition to a sustainable and reliable energy supply. The platforms are facilitated by SenterNovem, an agency of the Dutch Ministry of Economic Affairs.