



POSTER SESSION

Pentair (Union Engineering / HAFFMANS)

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15



UTILIZATION OF BIOGAS CO₂ ADDS ANOTHER LEVEL TO THE CIRCULAR ECONOMY

Biogas has really come to the fore in the struggle of replacing fossil fuels. Circular economy is crucial in the effort of obtaining a more sustainable energy composition - and the transition is in progress. Biogas can be playing an important role, and by continuously investing in the best technologies with a minimum or zero methane emission, the options for political support have also improved conditions.

How to become truly CO₂ neutral

After yet another summer with rising revenues of CO₂ for both food & beverage corporations and the industrial usage, the CO₂ from biogas is now seriously considered as a new 'hanging fruit'. Not all upgrading technologies are suitable for adding a CO₂ capture function. However, both wine and beer are good candidates.

The content of CO₂ in the raw biogas is approx. 40-60% and without a CO₂ separation unit, the CO₂ is vented to the atmosphere. A total cut-in rate in all cases through the addition of CO₂ from the biogas plant must be at a minimum one before it pays off. This must be evaluated case by case.

Biogas and food-grade CO₂

Utilization of the CO₂ from a gas production is always more or less possible, but making the methane suitable depends on several factors and the final product.

These gases can be produced from using crops such as maize from corn or wheat from wheat.

As the amount of the biogas gas is steadily increasing, the production of biogas is becoming an important factor in the production of food-grade CO₂.

Today, the CO₂ from biogas is used for the production of food-grade CO₂ in the Netherlands, Belgium, and other countries.

Figure 1: Utilizing CO₂ from biogas completes the circular economy loop

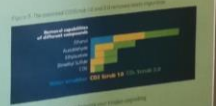


Figure 2: Biogas and food-grade CO₂



Patented technologies does the job

Great effort has been made to develop technologies in the CO₂ separation industry. The Pentair Union Engineering, which has developed the most advanced technology for the separation of CO₂ from biogas, is now leading the way in this industry. The CO₂ separation technology is used in the Netherlands and in other countries.



About Pentair Union Engineering

Pentair Union Engineering is a leading provider of CO₂ separation technologies. We have developed the most advanced technology for the separation of CO₂ from biogas. Our technologies are used in the Netherlands and in other countries.

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Pentair Union Engineering
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130 locations
In **34** countries

10,000
employees

United in our belief that the future
of water depends on us

Leading partner within CO₂ and biogas



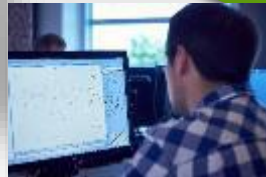
1400+
CO₂ PLANTS

20.000+
QC DEVICES



300+
AMINE
PLANTS

40+
BIOGAS
PLANTS



Combined product portfolio

Several issues influence the market changes

- CO2 crisis in Europe
- EU taxation/ penalties
- Ambitious Political projects
- Minimizing use of fossil fuels
- New sources (e.g. biogas) with useful by-products



IN 2025, COPENHAGEN WILL BE THE WORLD'S FIRST CARBON NEUTRAL CAPITAL AND THE CITY'S BUSINESSES AND UNIVERSITIES WILL BE SPEARHEADING THE DEVELOPMENT OF GREEN SOLUTIONS GENERATING EMPLOYMENT AND GREEN GROWTH.

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COPENHAGEN – A GREEN AND SMART CITY

1.1
THE ROAD TO CARBON NEUTRALITY IN 2025

DICE REPORTS'

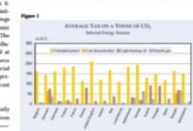
TAXING CO₂ IN EUROPE

The separation of greenhouse gases, especially carbon dioxide (CO₂) for the world climate has again highlighted in last year's World Climate Conference in the Hague. Whether nations will achieve the targeted reduction of the amount of these gases depends on how these pollutants are taxed.

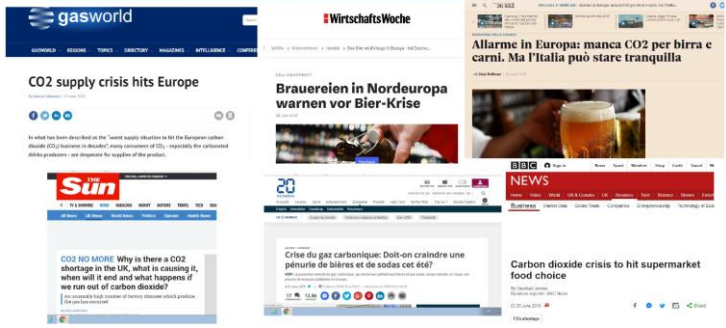
Global countries in Europe have the ambition of CO₂. All countries have a general consensus to use energy. In addition, several countries have agreed "energy" or "tax" means and to continue to work towards finding sources of energy, energy sources. All of these items on the consumption of energy are also reflected in the reduction that heating releases, heating CO₂. A few European countries have, in addition, introduced specific taxes on certain pollutants. This, Denmark, the Netherlands, France and Sweden place a direct tax on the CO₂ content of energy sources.

From an economic and ecological perspective, the tax burden on pollutants should not only be reduced but should also be zero. In other words, the tax on a source of CO₂ should be independent of the energy source that releases it. Only in the case of the carbon tax effects and savings effects go in the right economic and ecological direction. The consensus is that a tax on energy taxes is not generally aimed at saving sources, but to force companies to rethink the total cost of the product in the production process in their cost accounting.

CO₂ emissions differ greatly between countries and between DICE - Database of International Comparisons of Environmental Data



Dutch to introduce 'reasonable' corporate tax on carbon dioxide



Leading to new markets and technologies

Traditional sources vs. new reliable sources

Traditional Sources:

- Byproduct from Ammonia NH_3
- Fermentation
- Ethylene Oxide E/O
- Syngas
- Combustion
- Natural Wells

	CO ₂ %
Ammonia production	> 95
Fermentation	> 95
Bioethanol Fermentation	> 95
Ethylene Oxide	> 95
Natural Wells	> 95
Gas sweetening, MDEA	> 95
PSA Off Gas (Hydrogen Plant)	< 55
Flue Gas Amine Extraction	< 12
Self-generation, Combustion	< 12

New Reliable Sources:

- Fluegas from
 - Power plants
 - Process plants
- Tail Gas PSA
- MDEA
- Biogas
- (Bioethanol)
- Ambient Air
- Complex Gas compositions

(Steam Methane Reformer)

Complex technology > CAPEX

Reuse all the available sources

Biogas example:

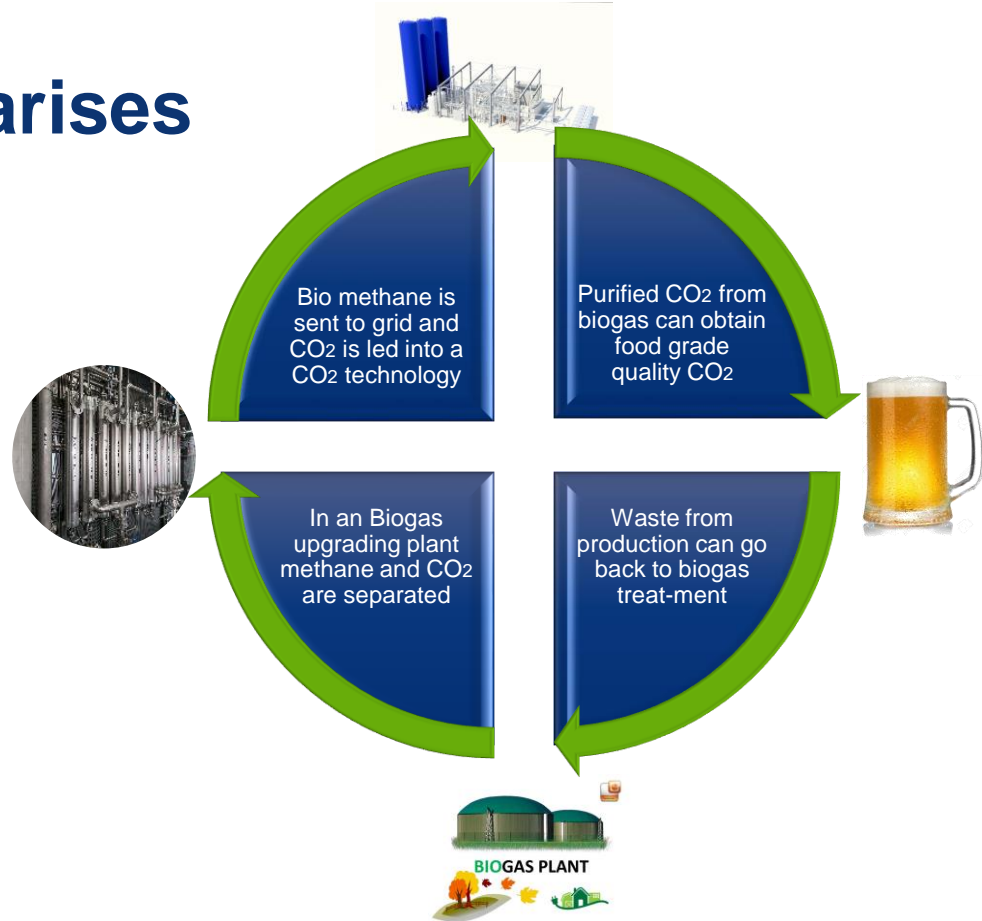
- a 1.000 Nm³ biogas plant
- Normal split: 60% Methane + 40 % CO₂
- 40% CO₂ = approx. 800 kg/h CO₂
- Petrol car emission factor 0,130 CO₂/km (<https://www.transportenvironment.org/what-we-do/cars-and-co2>)
- CO₂ Emission equal to a driving distance of some 6.150 km each and every hour

Biogas CO₂ is a low hanging fruit

New reliable sources arises

Biogas case: Strandmøllen/Korskro

- Biogas has been taken to next level
- 6,000 Nm³ biogas plant
- 48 tpd CO₂ recovery
- Upgrading both Methane and CO₂ is an environmental gain:
 - Methane can be utilized on gas grid
 - CO₂ can be utilized for different purposes:
 - Food grade
 - Green houses
 - Fire fighting
 - Welding
 - Dry Ice



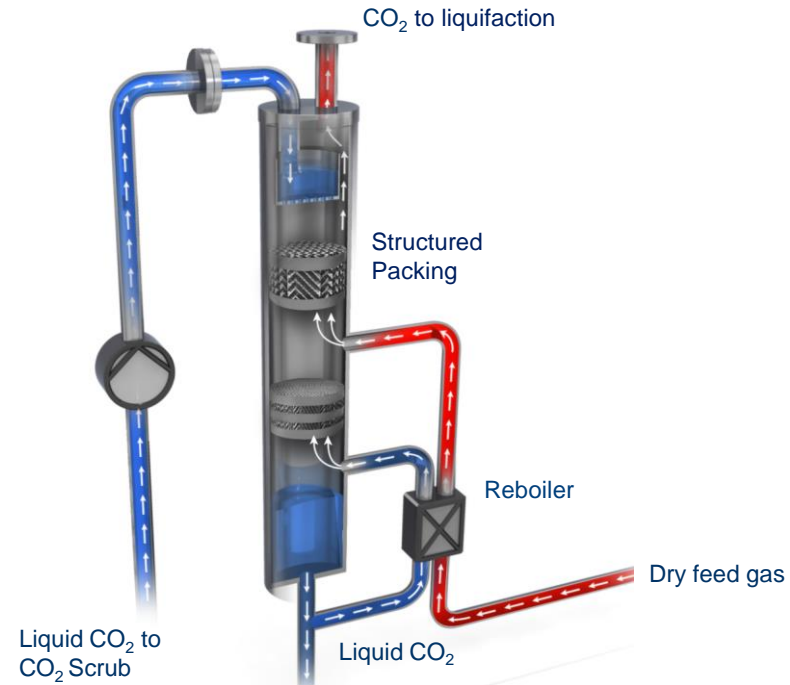
Biogas CO₂ is a low hanging fruit

Example of technology development

CO₂Scrub Version 1.0 is developed and launched by Union Engineering

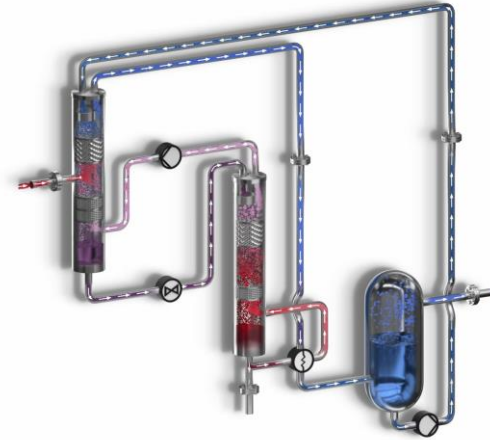
BENEFITS

- Excellent system for final CO₂ polishing
- Possible replacement of regenerable activated carbon beds
- Elimination of water scrubber
- Continuous replacement of absorbent - not needed.
- Tolerant for varying hydrocarbon content in raw gas
- No use of additional external sources is eliminating the risk of contamination
- Reduced amount of waste
- No use of water



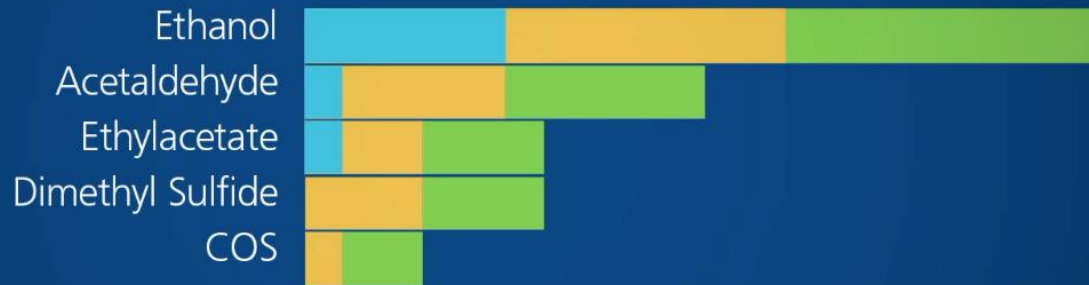
But more demanding raw gasses call for a new version

CO2Scrub Version 2.0



- > Minimizes need for carbon filters, water scrubbers and other purification steps
- > Efficient impurity removal including COS and DMS
- > Eliminates all impurities with a boiling point above -30°C
- > Energy optimised
- > With COS above 1 ppm there are no real alternatives

Removal capabilities of different compounds



Water scrubber **CO2 Scrub 1.0** **CO2 Scrub 2.0**

CO2 purification - BIOGAS

Operational benefits – CO2 Scrub:

- continuous operation (no manual controlled batch)

		BIOGAS	AC	CO2 Scrub / CO2 Scrub 2
Impurities of concern	BTEX	X		
	Methanol	X		
	Ethanol	X		
	Acet Aldehyde	X		
	Dimethyl sulfide [DMS]	X		
	Carbonyl sulfide [COS]	X		(2)
	Halogenated compounds	X		
	Ketoner	X		
	Terpener	X		
	Silotaner	X		

- By adding the CO2 Scrub solution, has CO2 from Beer fermentation been fully approved by all major soft drink companies

Clean and odorless CO2 =>

- CO2 > 99,9% (ISBT)
- Several of the above components has to be reduced to a few ppb (0,0000005%)



THANK YOU

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THANK YOU

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