



**AMERICAN  
BIOGAS  
COUNCIL**

# Creating Efficiencies Through Measurement in Renewable Natural Gas Production

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ABC Sponsored Webinar  
August 29, 2023



# Quick Notes



You should be able to hear me talking now. If you can't, use the questions module to describe your issue.

Two Audio Options: Phone or Computer  
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Ask questions using the Questions Panel on the right side of your screen at any time.

The recording of the webinar and the slides will be available after the event. We will post them online and send you a link.

The screenshot shows the GoToWebinar interface. At the top, there's a menu with 'File', 'Options', 'View', and 'Help'. Below that, a yellow banner reads 'Attendees still on hold' with the instruction 'Press \*1 to Start the Broadcast for all attendees.' and a checked box for 'Record on start'. A sidebar on the left contains icons for navigation. The main content area is divided into two sections. The top section, labeled 'Audio', shows options for 'Computer audio' (unselected) and 'Phone call' (selected). It also displays the dial number '+1 (415) 655-0052', access code '147-638-497 #', and audio PIN '79 #'. Below this is a 'Questions' section with a table showing 'Show Answered Questions' checked. The table has columns for 'Question' and 'Asker'. At the bottom, there are options for 'Send Privately' and 'Send to All', and a 'Webinar Now' section with the ID '815-417-091' and the GoToWebinar logo.

Audio

Questions

# About the American Biogas Council



## The voice of the biogas industry in the US

### All sectors represented

- Project developers/owners
- Equipment retailers and dealers
- Waste management companies
- Waste water companies
- Farms
- Utilities
- Municipalities
- Consultants and EPCs
- Financiers, accountants, lawyers and engineers
- Non-profits, universities and government agencies

**400**  
**organizations**  
**5,000**  
**individuals**



# The US Biogas Market

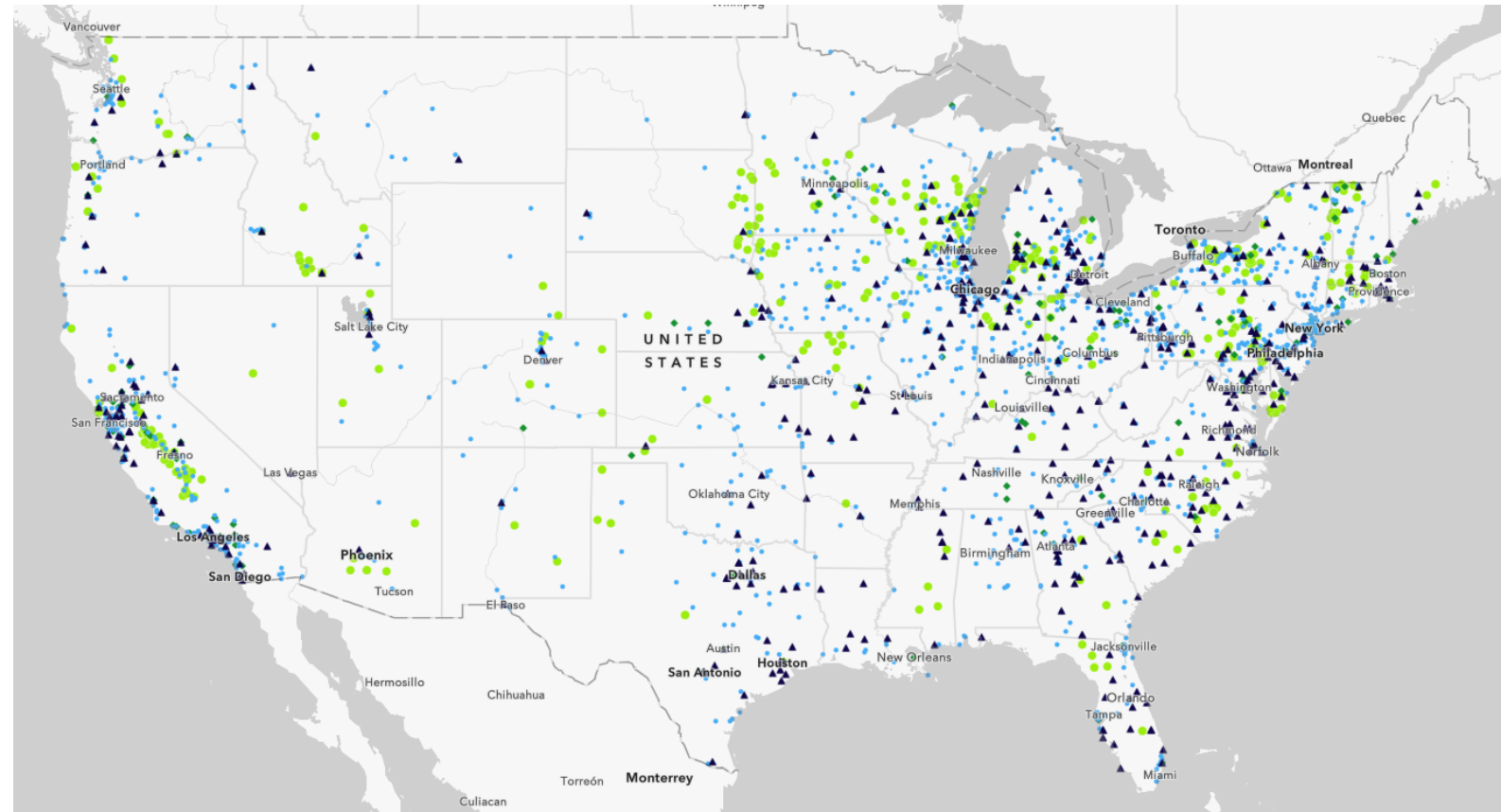


## Operational Biogas Systems: 2,405

- 304 RNG
- 2,101 Electricity
- 474 on Farm
- 1,269 Wastewater
- 102 Food Scrap
- 560 at Landfills

## Potential New Biogas Systems: 15,000

- 8,600 on Farm
- 4,000 Wastewater
- 2,000 Food Scrap
- 470 at Landfills





# Speakers



**Justin Walsh**  
*Business Development Manager*  
**Vaisala**



**Patrick Serfass (Moderator)**  
*Executive Director*  
**American Biogas Council**

The background of the slide is a photograph of an industrial facility, likely a natural gas processing plant. It features a complex network of pipes, valves, and large machinery. The scene is brightly lit, suggesting an outdoor or well-lit indoor environment. The overall color palette is dominated by light blues and greys, with some darker blue accents on the machinery.

# Creating Efficiencies Through Measurement in Renewable Natural Gas Production

Justin Walsh - Vaisala, Inc.

**VAISALA**



# Topics

- Monitoring benefits
- Measurement challenges
- Humidity measurement
- Vaisala solutions
- Lowering costs of monitoring

# We are Vaisala

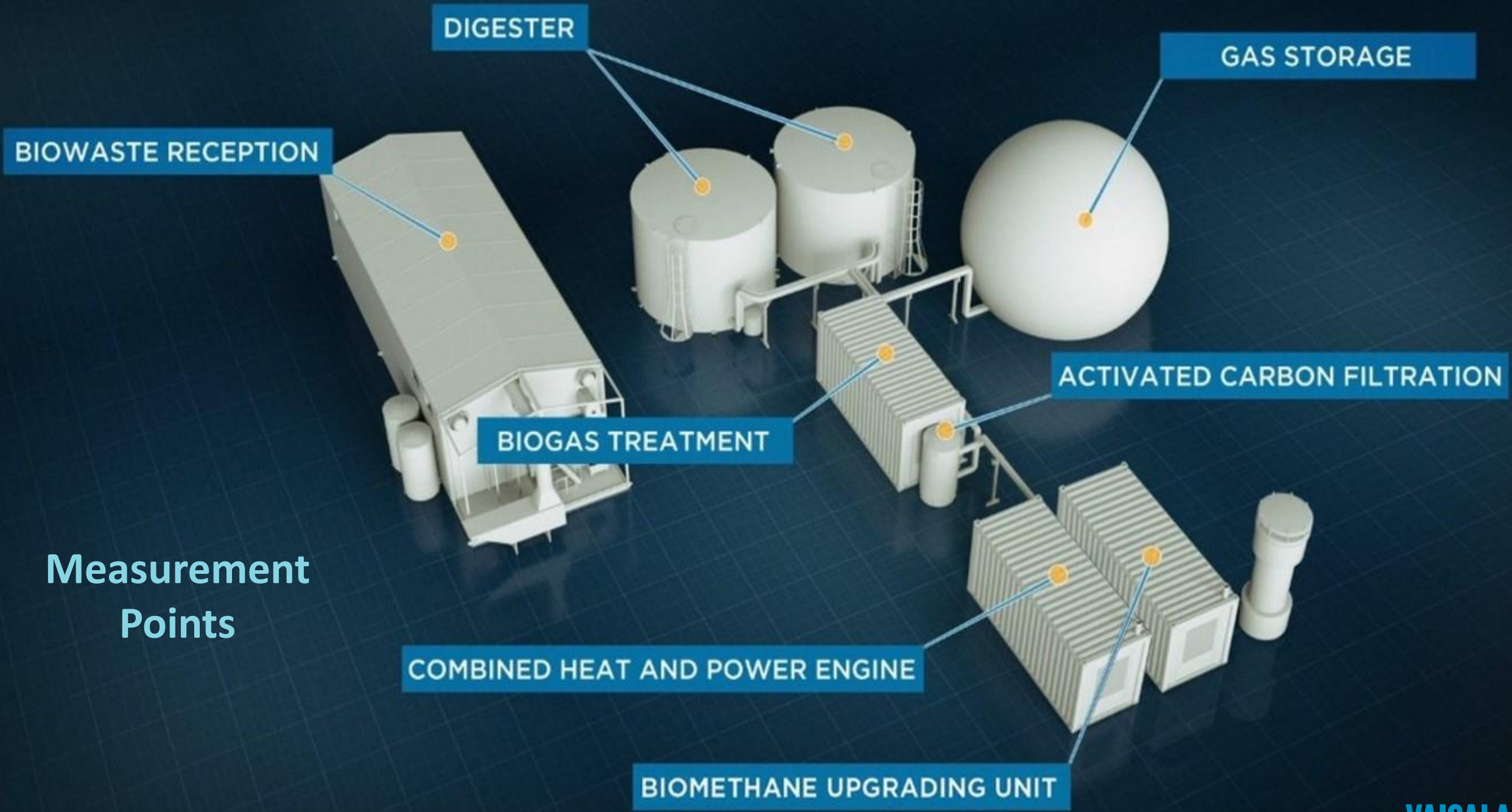
- We serve customers in Weather and Industrial markets
- **85+** years of experience providing a comprehensive range of innovative observation and measurement products and services
- Trusted supplier of instrumentation to protect sensitive processes and explore the unknown
- Various measurement solutions developed for industrial processes and controlled environments ensure, product quality, energy efficiency, and personal safety







# Operational benefits of online gas monitoring



## Measurement Points

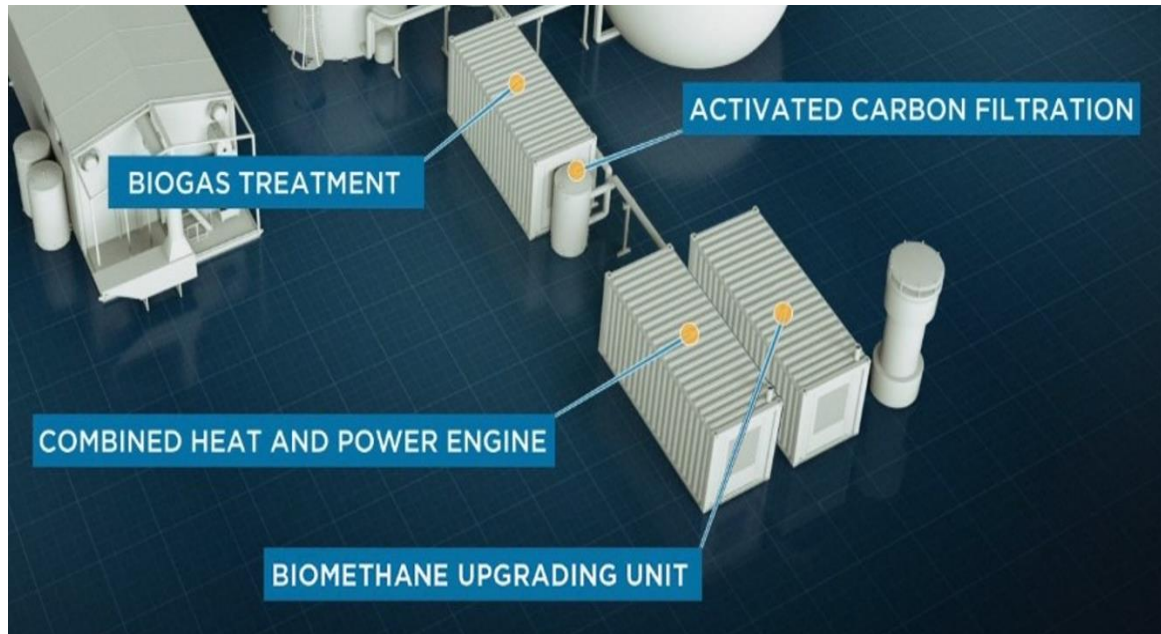
# Measurement at the digester

- Control heating, mixing, and feedstock additions by monitoring the  $\text{CH}_4/\text{CO}_2$  ratio
- Control the boiler used to produce heat for facility
- Report gas composition that is sent to the flare stack
- Even with identical digesters their outputs can vary, and measuring separately allows for better control





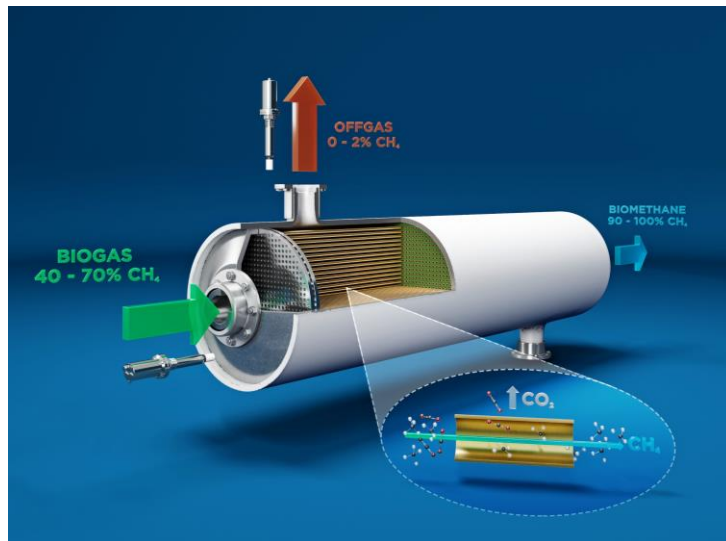
# Monitoring at inlet of upgrader



- Regardless of the upgrading technology, the incoming gas stream needs to be monitored for consistent gas quality
  - Lower methane content gas can be diverted to boiler, CHP engine or flare stack
  - Gas with high humidity should not be passed to upgrader, especially one with membrane
  - Having to start and stop the process causes low overall upgrading efficiency and increases methane slip

# Common upgrading methods

## MEMBRANE TECHNOLOGY



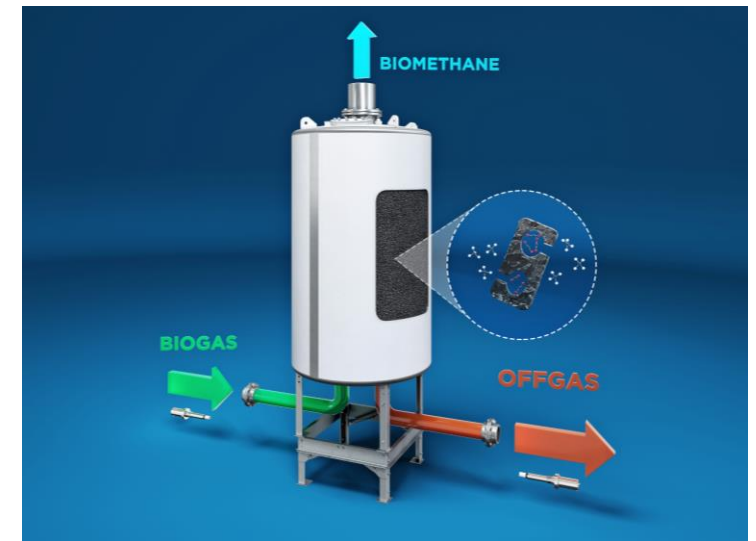
- Indications of efficiency and media lifespan
- Pressure and flow control
- Slip measurement

## WATER and AMINE WASH



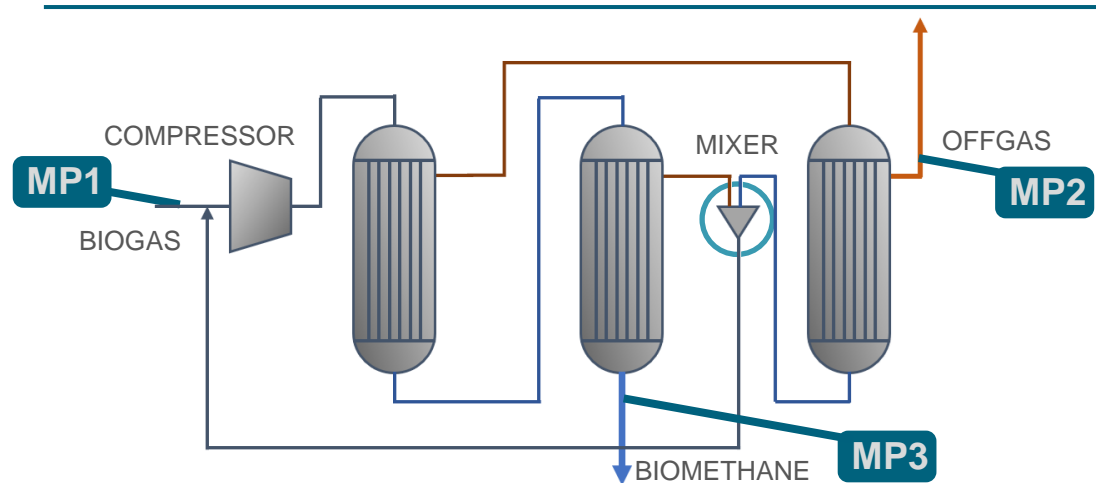
- Indications of efficiency
- Flow control
- Slip measurement

## PRESSURE SWING ADSORPTION (PSA)



- Indications of efficiency and media lifespan
- Pressure and flow control
- Slip measurement
- RTO feed measurement

# A closer look at membrane system monitoring



Optimize the upgrading process by adjusting the recirculation rate after second stage with the real time offgas and biomethane measurements

- **MP1**: raw gas before compressor,  
50...65 %CH<sub>4</sub> 30...40 %CO<sub>2</sub>
- **MP2**: methane slip in off-gas,  
0.5 ... 4 %CH<sub>4</sub> 90 ... 98 %CO<sub>2</sub>
- **MP3**: biomethane product,  
90 ... 98 %CH<sub>4</sub> 1...5 % CO<sub>2</sub>



# Continuous monitoring of the offgas stream

- Offgas contains a small amount of methane varying from ppm's to low vol-%
- This methane slip is lost production and measuring methane slip directly is the best way to monitor and control
- Methane slip has emission limits in regional legislation, and too high slip may require a Regenerative Thermal Oxidizer (RTO)

# Combined heat and power (CHP) engines

- Engines require certain methane concentrations to start and run reliably
- Engine can be tuned to run on the measured methane concentration
- Ensure gas meets specifications for operation, warranty, and service intervals
- Protect against condensate and water pass-through





# Measurement of landfill gas

- Landfill gas is commonly measured at a pumping station, where multiple well feeds are combined
- Measurement point is typically upstream of the flare gas branching point
- Based on gas quality measurement, decision is made to send the gas to the engine/upgrader or to the flare.



# Flare gas measurement

- Flare gas is generally measured when flare gas composition must be known for compliance with local regulations and for carbon credits
- Gas concentration in the flare stack is the same as the gas concentration upstream of the branching point to flare stack



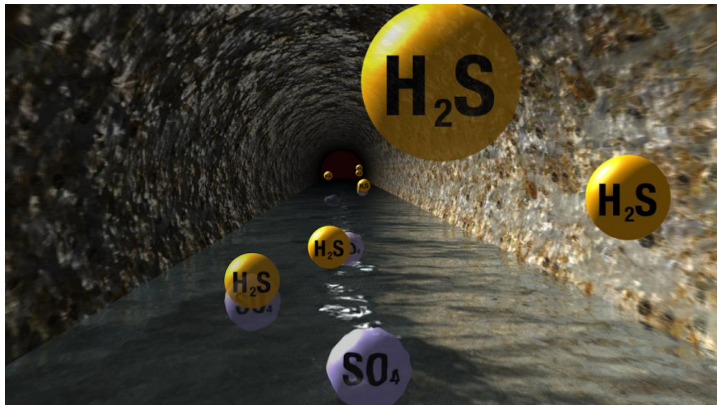
# Measurement Challenges



# Challenging locations and conditions

## High humidity

- Condensation
  - Saturated sampling lines
  - Water pass-through
- Corrosion
  - H<sub>2</sub>S
  - Line integrity



## Pressure and Flow

- High pressures
  - Require regulation
  - Leak prevention
  - Measurement compensation
- Low pressures
  - Sampling difficulties





# Extractive monitoring of the gas production process

Does your measurement system require:

- 1) Sampling lines
- 2) Pump
- 3) Moisture trap
- 4) Calibration gas bottles and valving?



How often is calibration and servicing required?

- Daily
- Monthly
- Quarterly

Are H<sub>2</sub>S and Humidity holding back measurement?



# Humidity Measurement



# Heat exchanger driers

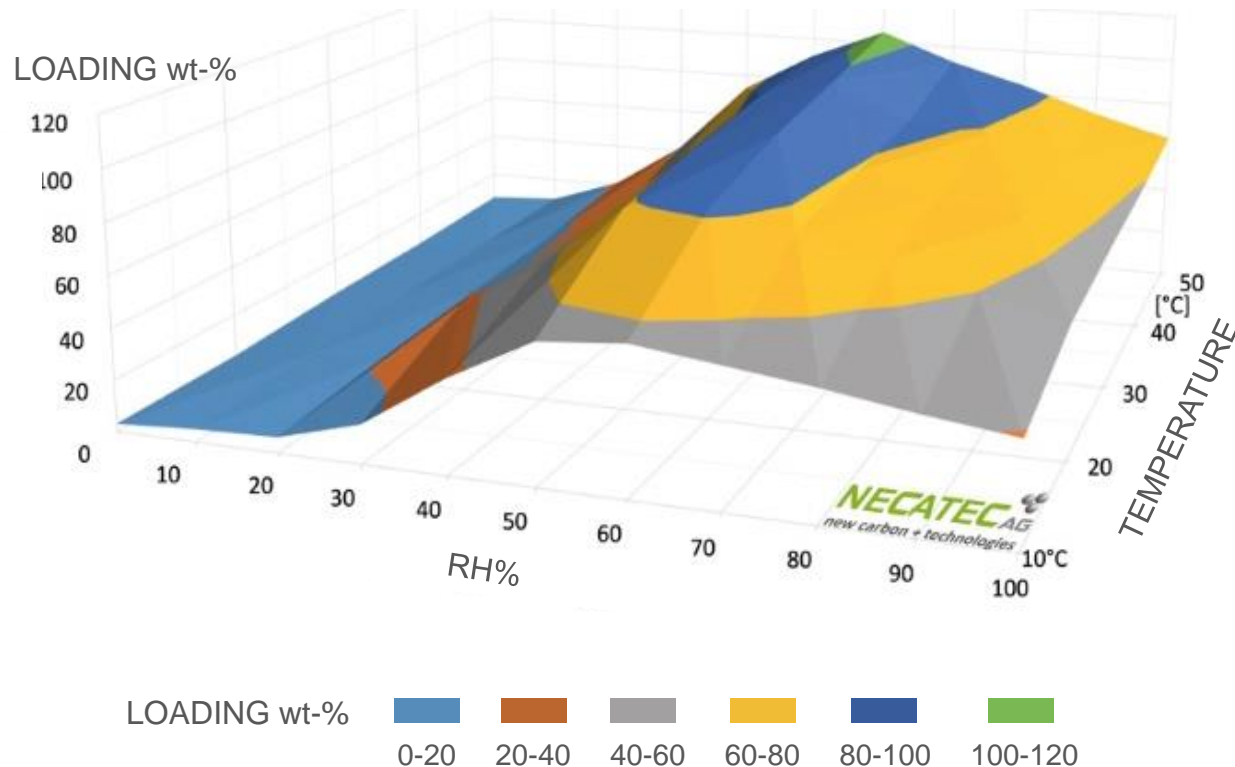
- The easiest way to remove excess humidity is to cool the gas to force condensation, followed by reheating the gas
- If gas is cooled down to say 5 °C temperature, the dew point temperature of gas drops to same value *if gas stays in cooler until it reaches equilibrium*
- In practice the gas comes out quicker and dew points higher than the cooler setpoint are observed
- Measuring the dewpoint after cooler is the only reliable way of knowing humidity content
- For some applications like biomethane/RNG the final product dewpoint must be even lower, and other methods for drying are used after heat exchanger



External insulated desulphurisation-unit (activated carbon) and cooling unit for dewatering



# Active carbon filtration efficiency and humidity



Laboratory test with 2400 ppm H<sub>2</sub>S in nitrogen with 0.5 vol-% oxygen  
Diagram courtesy of Negatec AG

- Filtration efficiency depends strongly on humidity
- Too high humidity is bad and condensation can ruin the filters completely → drying is needed
- Too low humidity drops efficiency significantly
- Best results in 50 ... 70 %RH range
- In dew point units this means maintaining dew point 8 ... 10 °C below gas temperature
- Aggressive drying before filters is actually bad for H<sub>2</sub>S removal

# Measuring at the carbon filter

- High humidity damages carbon filters
- Cost of one refill of activated carbon is typically in \$2000 – \$5000 range depending on filter type and size
- If humidity is not optimal and hydrogen sulfide etc. passes through, what is the cost of damage done to biogas engines and biomethane upgrading units?



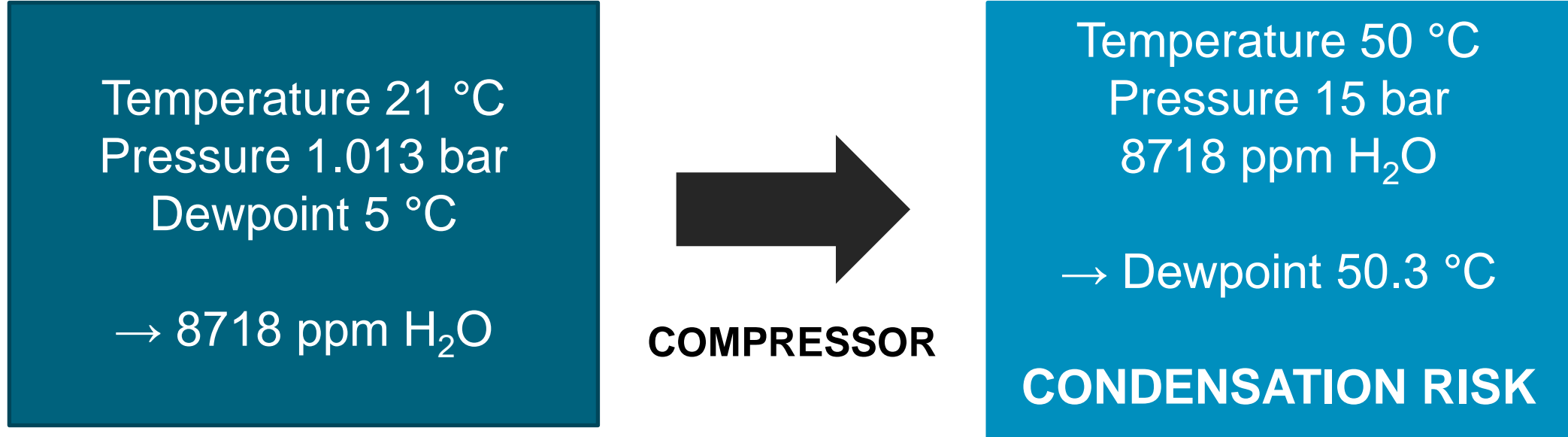
# Humidity concerns for CHP engines

- Condensed water in the engine can put engine out of commission
  - Loss of production in a medium size (1 MW) engine costs \$5000+ per day
- Ingress of condensation can lead to increased maintenance
  - The oil change interval can decrease to one half (1600 h → 800 h)
  - For a typical 1 MW size engine, the increase in maintenance costs could be about \$15,000+ per year
- If humidity reaches condensation at this point, then upstream gas treatment has a problem and water soluble impurities are probably also present





# Protect the membrane lifespan



- Upgrading with membranes requires a process pressure above 10 bar
- If the dew point of raw biogas is too high before compression, condensation will occur after compression even at high temperatures. Maintaining dew point at or below 0 °C is important for a trouble-free operation of the upgrading plant

# Vaisala MGP260 Series Multigas Probes



# MGP260 Product Series

## MGP261 – CH<sub>4</sub>, CO<sub>2</sub>, H<sub>2</sub>O

- Measured gases include
  - 0...100 vol-% Methane
  - 0...100 vol-% Carbon Dioxide
  - 0...25 vol-% Water Vapor

Property	Methane CH <sub>4</sub>	Carbon dioxide CO <sub>2</sub>	Water vapor H <sub>2</sub> O
<b>Accuracy specification at 25 °C (+77 °F) and 1013 mbar including non-linearity, calibration uncertainty, and repeatability; temperature and pressure compensated</b>			
Accuracy at +25 °C (+77 °F) and 1013 mbar <sup>1)</sup>	<ul style="list-style-type: none"> <li>0 ... 40 vol-%: ±2 vol-%</li> <li>40 ... 70 vol-%: ±1 vol-%</li> <li>70 ... 100 vol-%: ±2 vol-%</li> </ul>	<ul style="list-style-type: none"> <li>0 ... 30 vol-%: ±2 vol-%</li> <li>30 ... 50 vol-%: ±1 vol-%</li> <li>50 ... 100 vol-%: ±2 vol-%</li> </ul>	0 ... 25 vol-%: ±0.5 vol-%
Repeatability	±0.5 vol-% at 60 vol-%	±0.3 vol-% at 40 vol-%	±0.1 vol-% at 10 vol-%



## MGP262 – CH<sub>4</sub>, CO<sub>2</sub>

- Measured gases include
  - 0...5 vol-% Methane
  - 0...100 vol-% Carbon Dioxide

Property	Methane CH <sub>4</sub>	Carbon dioxide CO <sub>2</sub>
<b>Accuracy specification at 25 °C (+77 °F) and 1013 mbar including non-linearity, calibration uncertainty, and repeatability; temperature and pressure compensated <sup>1)</sup></b>		
Accuracy at +25 °C (+77 °F) and 1013 mbar	<ul style="list-style-type: none"> <li>0 ... 2 vol-%: ±0.1 vol-% CH<sub>4</sub></li> <li>2 ... 5 vol-%: ±5% of reading</li> </ul>	<ul style="list-style-type: none"> <li>90 ... 100 vol-%: ±1 vol-%</li> <li>0 ... 90 vol-%: ±2 vol-%</li> </ul>
Repeatability	< ±0.1 vol-% at 1% CH <sub>4</sub>	±0.4 vol-% at 95 vol-%



# The Key Difference

## World's First In Situ 3-in-1 Biogas Measurement Instrument MGP261

### Superior stability and accuracy

- Methane, carbon dioxide and the world's first optical humidity measurement device for biogas
- CARBOCAP® autocalibration
- Heated sensor head for avoiding condensation

### Low operating cost

- Real-time and in situ
- No sampling lines, pumps or moisture removal needed
- No calibration gases needed in routine use

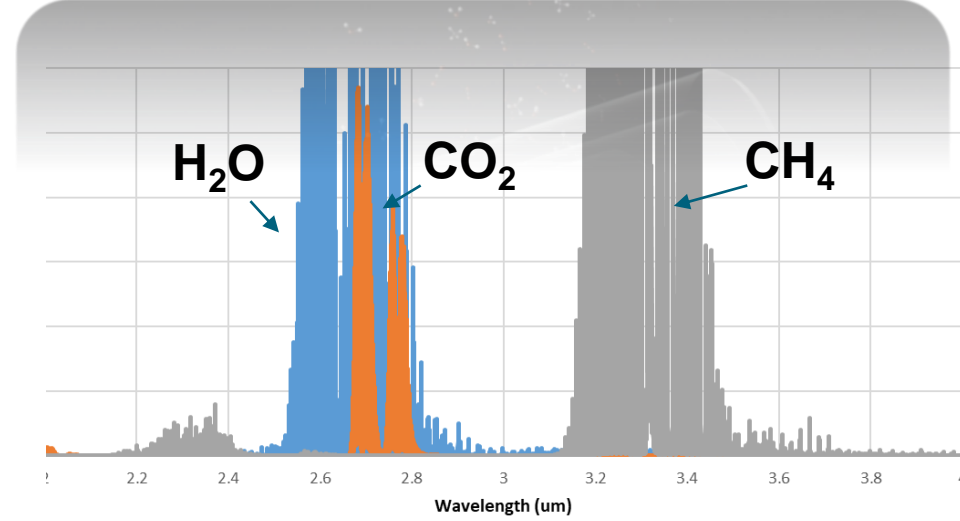
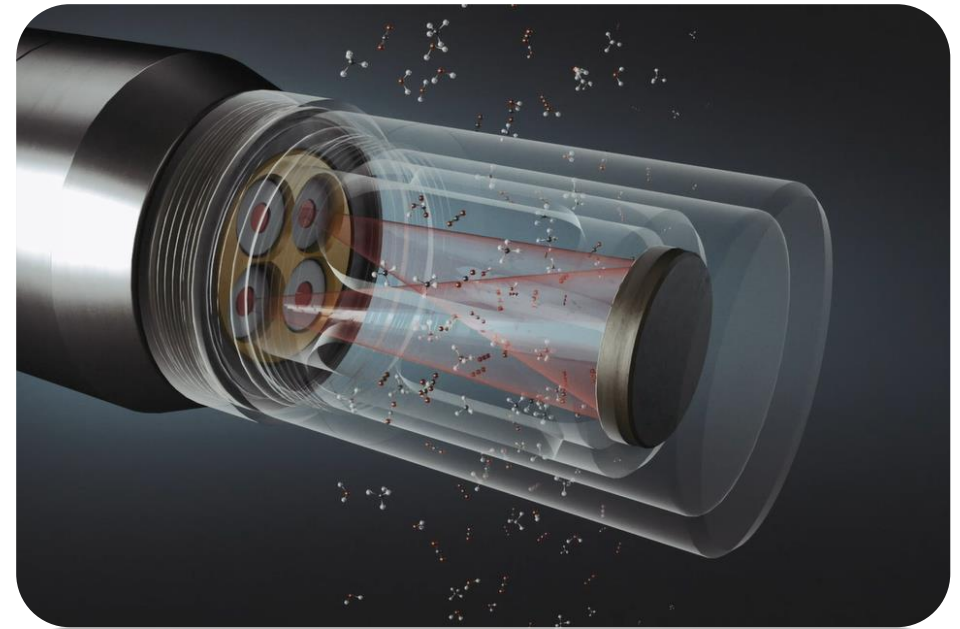
### Compact and robust

- Worldwide EX approvals to Zone 0/1, Class 1 Div 2
- IP66 rated, suitable for outdoor installation
- Corrosion resistance to 10,000+ ppm H<sub>2</sub>S



# Multigas measurements with CARBOCAP®

- For multi-gas capability, optical measurement channels are combined into a single probe
- Measurement accuracy is achieved with proprietary reference measurements
- Probe head is heated to prevent condensation
- Active components are protected from flammable gases ( $\text{CH}_4$ ) and corrosive gases ( $\text{H}_2\text{S}$ )
- Cross-interference is avoided by measuring humidity in combination



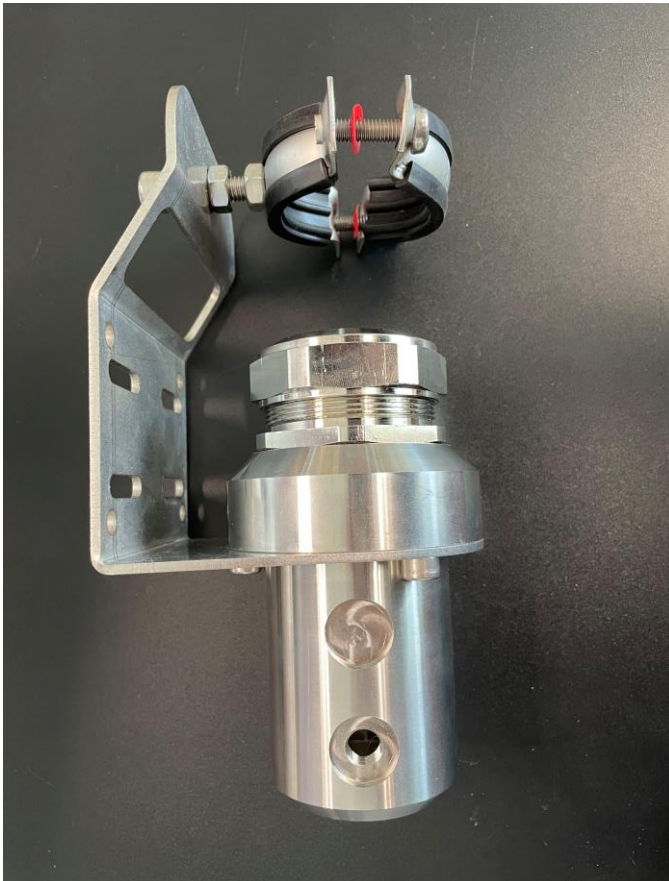
CH2



CH1

# Accessories

## Flow-Through Adapter



## Remote Display



## PC Comms Cable





# Insight PC Software



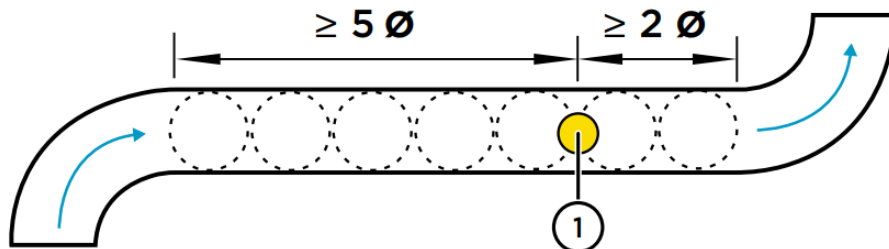
# Typical installation

- Horizontal orientation
- In area with continuous gas flow
- $-40\dots+60^{\circ}\text{C}$  ( $-40\dots +140^{\circ}\text{F}$ )
- Process pressure:  $\pm 500$  mbar(g),  $\pm 7.5$  psig

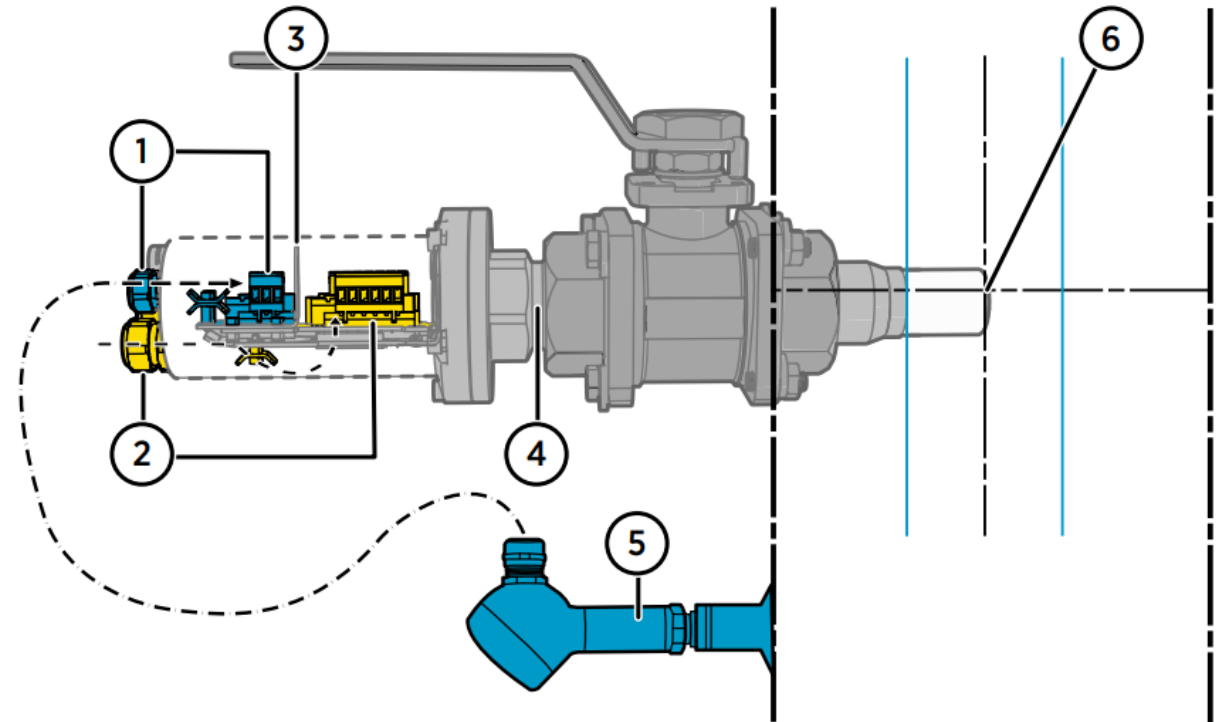


# Installation Best Practices

## Location and insertion depth



## Pressure compensation







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# Lowering the costs of monitoring

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# Monitoring cost drivers

- **Capital costs**
  - Instrumentation
  - Control systems
- **Energy use**
  - Electricity demand
- **Consumables**
  - Calibration gasses
  - Replacement sensors
- **Labor costs**
  - Skilled personnel
- **Calibration**
  - Field &/or Factory



# Lowring capital expenses for monitoring

## Conventional Analyzers

- Equipment components
  - Gas analyzer
  - Gas dryer assembly
  - Sampling pump
  - Tubing and Fittings
  - Heat tracing (optional)
  - Power supply
- Installation & commissioning
  - Additional vendor personnel

~ \$30...\$90+ kUSD

vs

## Vaisala MGP260 Series

- Equipment components
  - MGP260 Probe
  - USB Cable
  - Ball-valve (optional)
- Installation & commissioning
  - EPC or operational personnel

~ \$10+ kUSD





# Lowering operating expenses

## Stable measurement

- Annual or further calibration intervals
- Field calibration and adjustment
- Low-power device
- No consumables

## Protect the engine from wear and shutdowns



Customer feedback:  
Lost revenue if engine out of  
operation ~\$3,000–\$5,000  
/day

Customer feedback:  
Engine maintenance cost can  
be ~\$10,000

## Simple interface

- Free software
- If you can calibrate any other gas meter, you can calibrate the MGP260 series



## Prolong the refill interval of activated carbons



Customer feedback:  
Cost of activated carbon  
filters  
~\$2,000–5,000 / refill

*How often do you need to  
change the activated  
carbon filters?*

# What's in it for You?

**INCREASE CONTROL WITH METHANE  
MEASUREMENT**

**REDUCE COSTS WITH HUMIDITY MEASUREMENT**

**ENSURE PEAK PRODUCTION WITH OFFGAS  
MEASUREMENT**



## 1. Superior Stability and Accuracy

- Three-in-one: methane, carbon dioxide and humidity measurement in wet biogas
- CARBOCAP® autocalibration



## 2. World's 1st Optical Biogas Moisture Measurement

- Corrosion resistant measurement up to condensing conditions
- Hydrogen Sulfide H<sub>2</sub>S resistant



## 3. Install In Situ

- Real-time and Ex certified
- No sampling lines, pumps or moisture removal needed
- No calibration gases needed in routine use

# Thank You

# VAISALA

Engage us at [Vaisala.com](https://www.vaisala.com)

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# Questions and Answers



**Justin Walsh**

*Business Development Manager  
Vaisala*



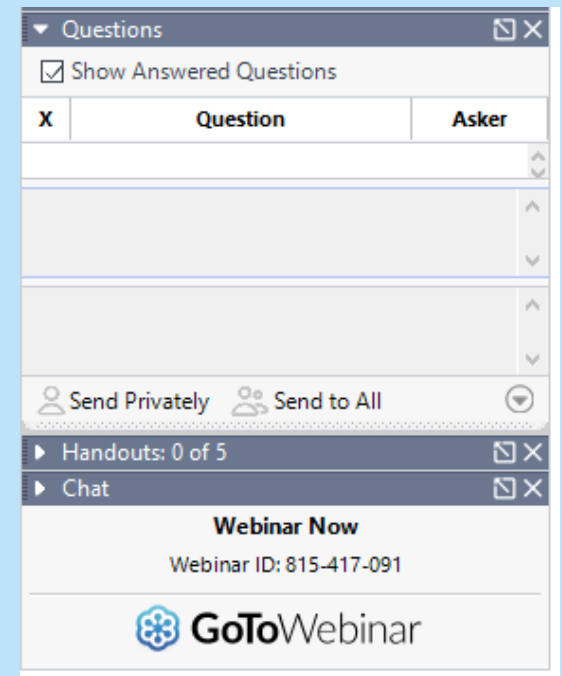
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A recording of the webinar and slides will be available to attendees within a few business days.



# Thank you!

Don't forget to fill out the **survey** after the webinar

## Become a member!

- Receive regulatory and policy intelligence
- Connect with other biogas and anaerobic digestion leaders
- Support the industry's growth and outreach

See you at BUSINESS OF BIOGAS in October!

Thanks for attending!