

Opportunities with and for **Biogenic CO₂**

Overview

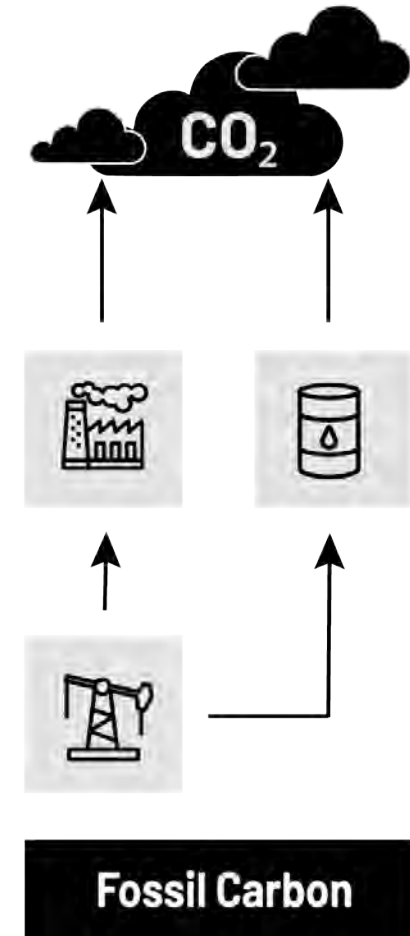
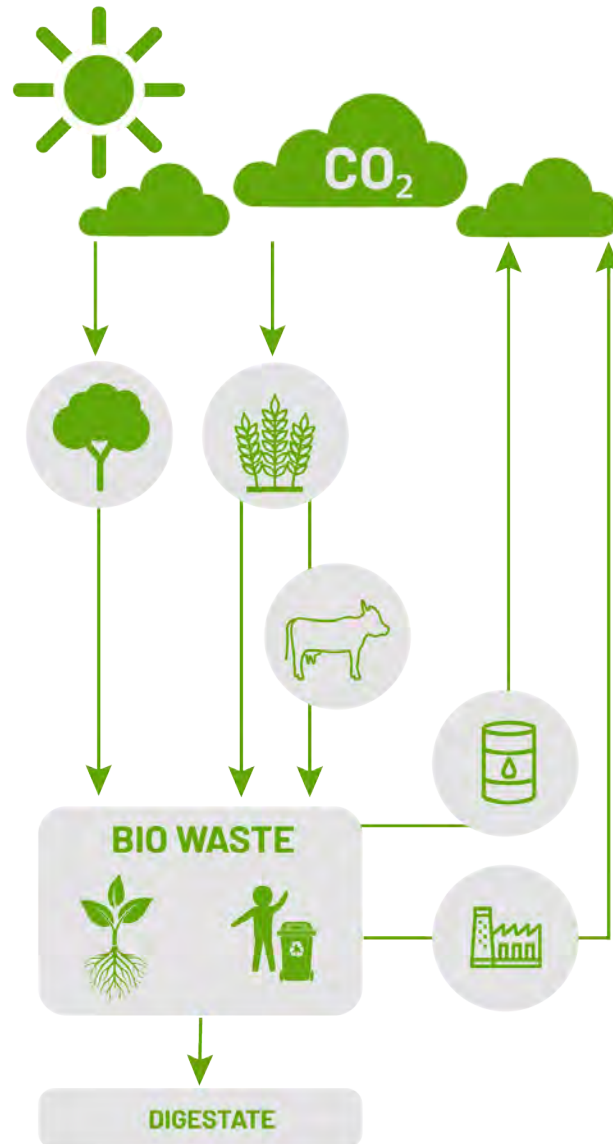
What to expect

- **What is Biogenic CO₂?**
- **Pentair SGS**
- **Technology**
- **Business case**
- **References**

What is Biogenic CO₂

The Natural Short Carbon Cycle

- Biogenic CO₂ refers to carbon dioxide that originates from biological sources.
- Unlike fossil-based CO₂, biogenic CO₂ is part of the natural short carbon cycle. ➡ No contribution to long-term atmospheric CO₂ accumulation.



Pentair At A Glance

A Global Leader in Smart, Sustainable Solutions

~9,750 employees
serving customers in

150+ countries

>\$4B[^] in revenue

[^]2024 full year results

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Pentair SGS

Sustainable Gas Solutions

 	 	 
Beverage: Breweries Soft drink bottlers Craft brewers Distilleries	Industrial Gases: Petrochemical Large industrial group Independent gas companies	Energy: Biogas plants Farmers Industrial Gases Landfill
CO ₂ fermentation and purification technologies for efficient and safe endproducts. An extensive product portfolio within quality and control components. Innovative solutions – also for craft brewers.	CO ₂ capture and recovery technologies for obtaining a safe endproduct even from a low purity source. The plants are delivering an end-product that exceeds the highest demands from ISBT and EIGA.	Recovery and upgrading plants for 'zero-methane' slip solutions. The upgrading plants are available with two different technologies, depending on need and plant size.



Sustainable Gas Solutions

Installed Base

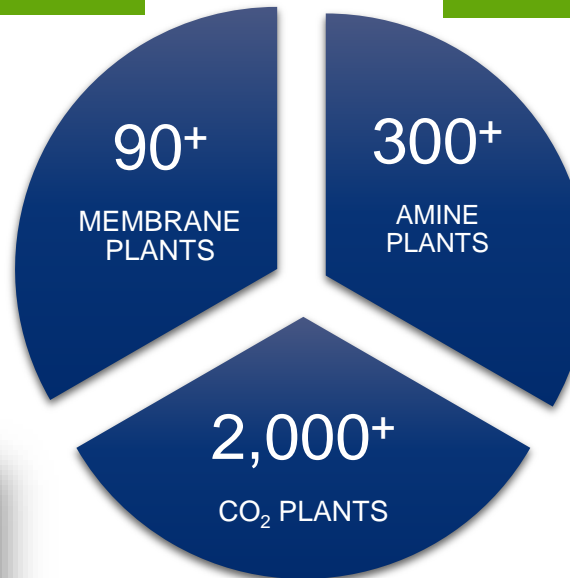
CO₂ & Methane Purification from Biogas

Multi-stage with CO₂
No Methane Slip



CO₂ Capture from Industrial Plants

500 kg/h to 15 t/h CO₂

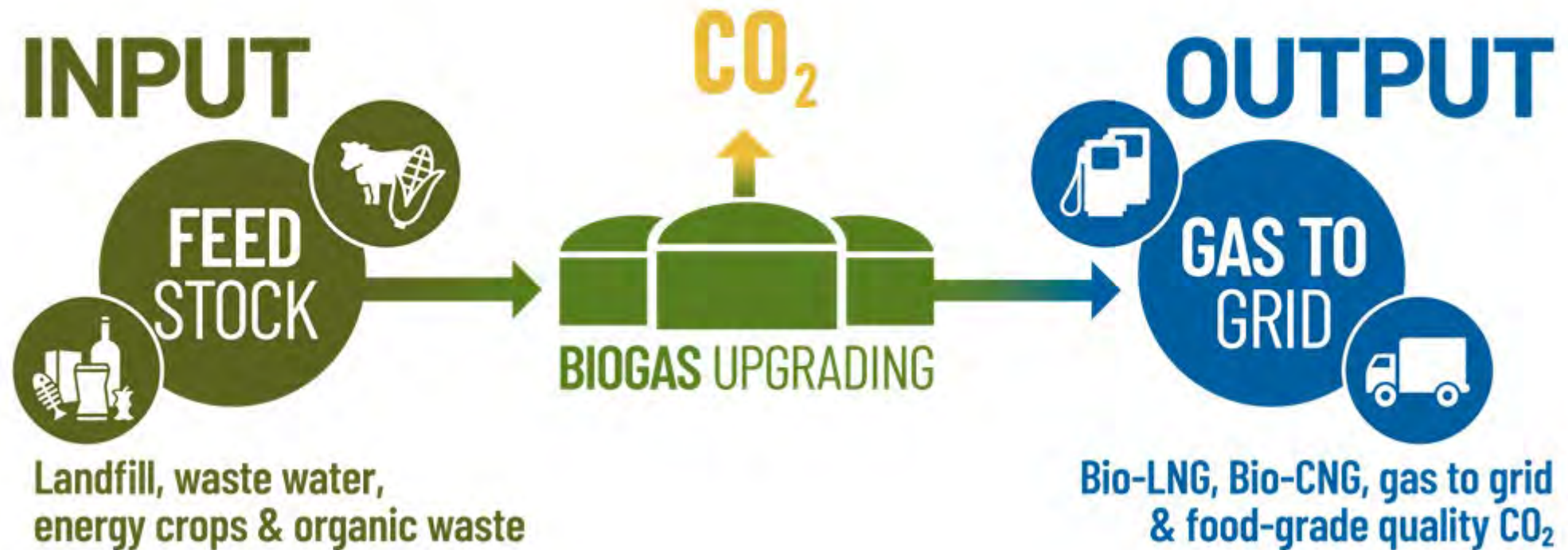


CO₂ Plants from Breweries

CO₂ Recovery in Breweries/Soft Drinks

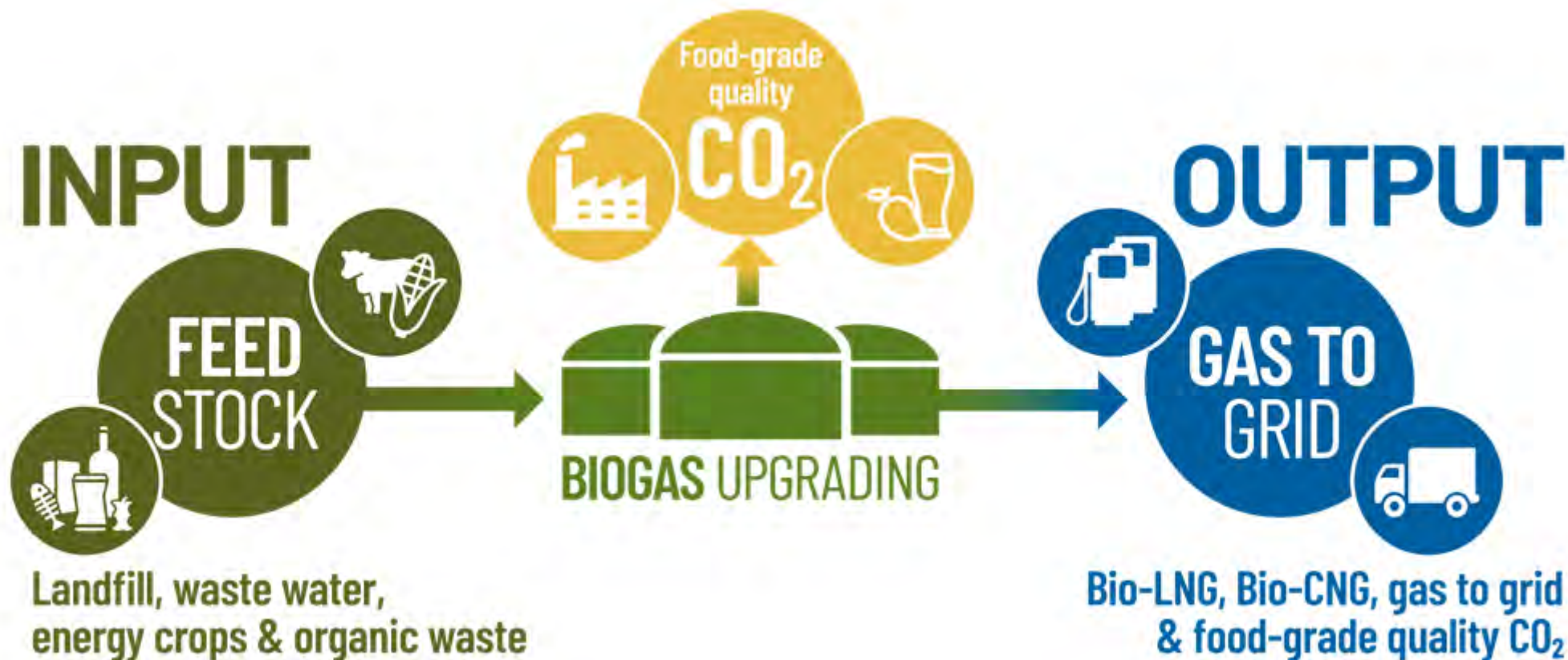
Biogas-to-Biomethane Upgrading

CO₂ to Free Air



Biogas-to-Biomethane Upgrading – Additional Value

CO₂ Capture and Utilization



Value with Biogenic CO₂ Recovery

The Bonus

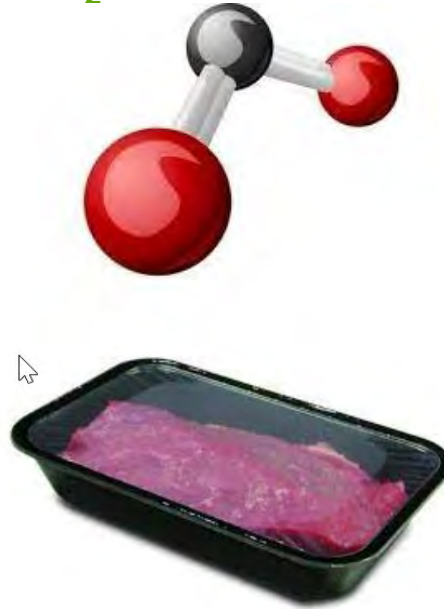
- Capability to recover food-grade quality CO₂.
- **EIGA** (European Industrial Gases Association), **ISBT** (International Society of Beverage Technologists).
- Possibility to meet specific regulations (experience with EC1935/2004, MOCA).
- Multi-line vessels and pumps facilitating transportation of the product.



Areas of Application

From Feedstock to Biogenic CO₂

- Industrial cleaning
→ Solvent-free on surfaces
- Welding industry
→ Arc Stabilization
- Dry ice
→ Non.mech. cooling source
- Power-to-X
→ Methanization out of H₂
- Working fluid
→ Thermodynamic cycles



- Agri production
→ Acc. growth in greenhouses
- Beverage
→ Carbonation and dispensing
- Food industry
→ Food preservation, freezing, packaging
- Refrigerated transport
→ Maintain the cold
- pH control
→ Water treatment
- Chemistry
→ Reactive agent



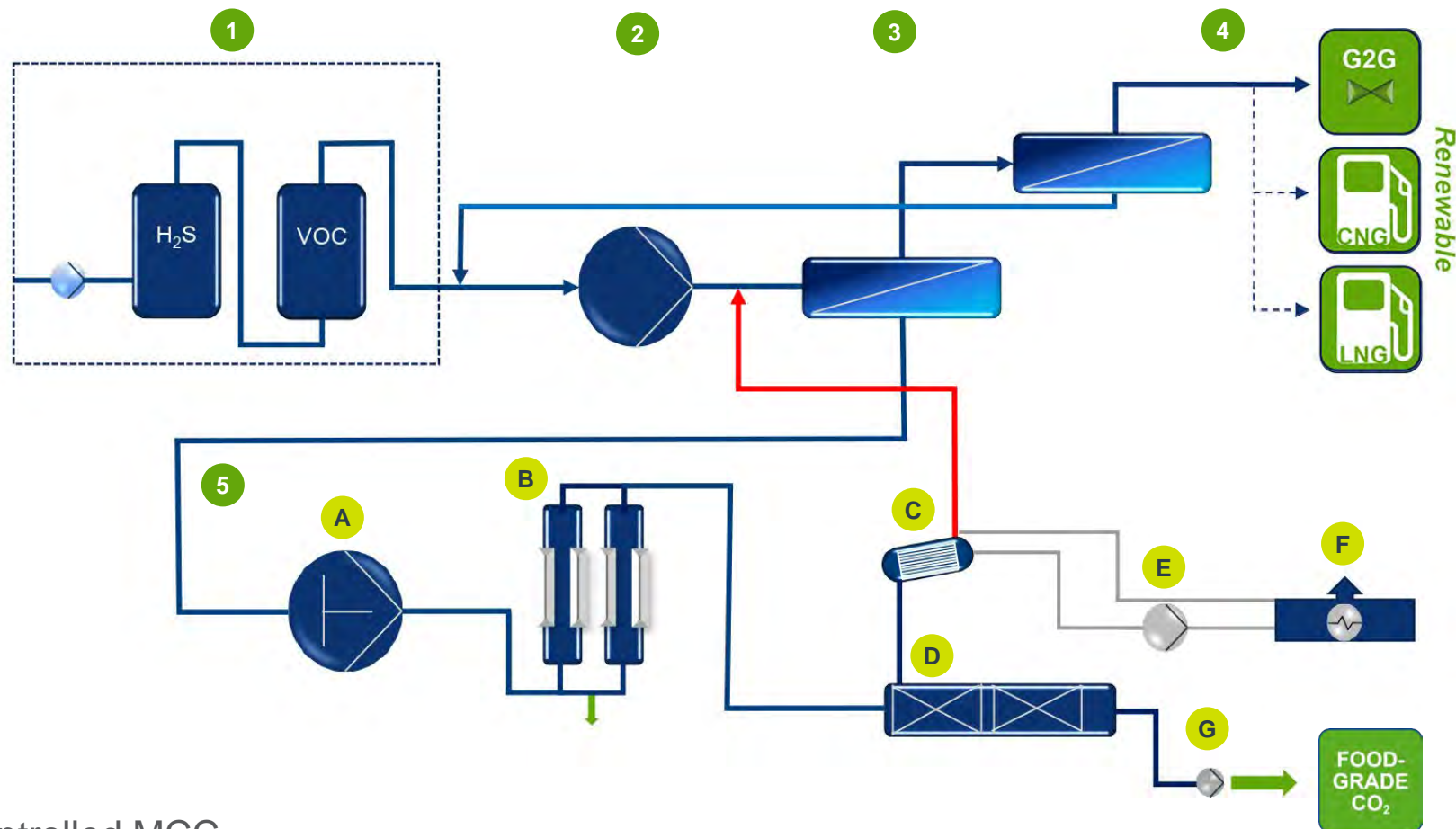
Biogas-to-Biomethane Upgrading & CO₂ Recovery

Our Solution

- 1 Pre-treatment biogas
- 2 Biogas compressor
- 3 2-stage membrane unit
- 4 Biogas outlet

- 5 CO₂ Recovery:
 - A CO₂ compressor
 - B Activated carbon filter/drier
 - C CO₂ condensor
 - D Stripper/reboiler
 - E Cooling compressor
 - F Dry cooler
 - G CO₂ pump

- > All parts skid mounted and controlled MCC

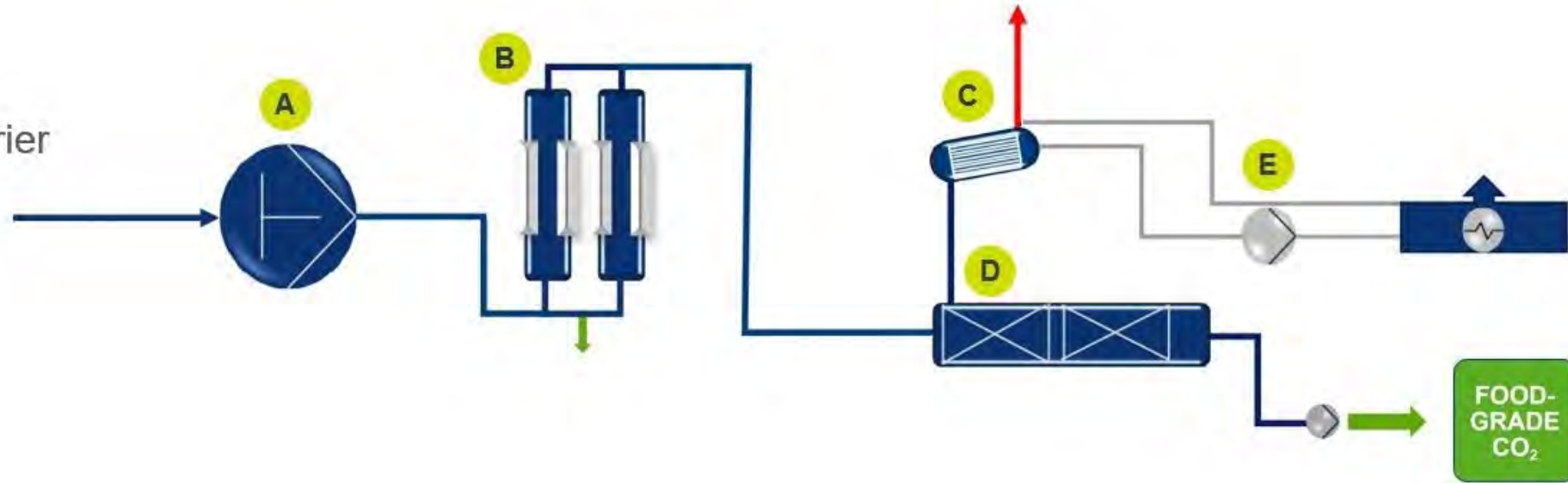


Pentair CO₂ Recovery

If You Already Have an Existing Biogas Upgrader

CO₂ Recovery:

- A** CO₂ compressor
- B** Activated carbon filter/drier
- C** CO₂ condenser
- D** Stripper/reboiler
- E** Cooling compressor



Biomethane Upgrading and Biogenic CO₂

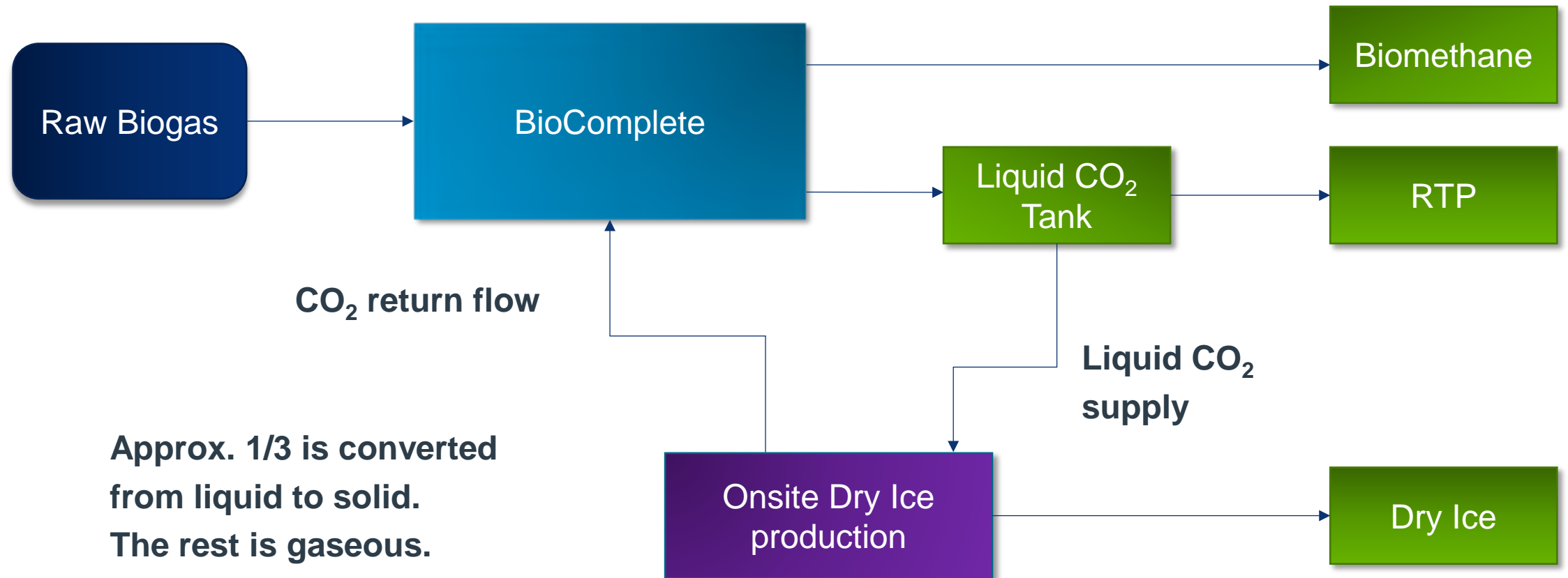
Business Case “Energiewerk Nieheim (DE)”

- Raw Biogas inlet 1100 Nm³/h
- Biomethane production 600 Nm³/h
- 22,000 t/a CO₂ production (food-grade quality)
- 9,000 t/a CO₂ used for dry-ice production
- Flexibility of local CCU or remote CCUS
- High CH₄ and CO₂ yield
- Energy consumption of 0.36 kWh/Nm³
- One truckload of dry ice holds as much CO₂ as 2.5 truckloads of liquid CO₂.



Biomethane Upgrading and Biogenic CO₂

Business Case “Energiewerk Nieheim (DE)”



Biomethane Upgrading and Biogenic CO₂

Business Case, Cambridge (UK)

- UK's first unsubsidized Biomethane plant.
- Upgrading 2,400 Nm³/Biogas/h.
- Producing up to 2 tonnes CO₂/h to EIGA specification quality.
- Biomethane sold directly to AstraZenica.
- Using 0.36 kwh to produce biomethane and CO₂.
- ~Zero Methane Slip.
- 40th UK Biogas upgrading/CO₂ plant.
- Commissioning Q2 2025.



First of its kind: Waste-to-Energy (WtE) Pilot Plant

Arc Waste-to-Energy Copenhagen (DK)

- Commissioned Q1 2024.
- Capable of capturing up to 4 tonnes of CO₂ per day.
- Helps with net-zero carbon capture targets.
- The energy needed to capture CO₂ is approx. 25% of the lower heat value in the waste.
- Main purpose is to test carbon capture technologies and optimize energy integration with the district heating network.
- The captured CO₂ is purified to beverage quality for further use in industry and merchant market.
- The Danish EUDP funds the project.



Segments and Customers

Industrial Gases



Beverages



Biogas



Biogenic CO₂ CCUS Business Case

CO₂ sales price CCU Market

- Depending on end user location
- Quantity of CO₂ required
- CCU Direct or via shipper
- CCU €100 – €140/tonne via shipper
- CCU €200 - €250/tonne directly to end user
- requires logistics and CO₂ end user storage tanks

Biogenic CO₂ Preference

- High purity and low cost to capture
- Green with carbon score benefits
- Locally sourced
- Strategically spread and provides supply resilience

CO₂ Sales price CCS Market

- Typically has additional logistics costs
- Access fees
- Difficult to get access to storage facilities
- Carbon trading required
- CCS €150 - 350/tonne

To Summarize

Biogas Upgrading Benefits

- Rely on a market leader in membrane technology & almost a century of CO₂ equipment & recovery system expertise.
- Energy and cost-efficient CO₂ & CH₄ separation & CO₂ recovery.
- Low OPEX with low-pressure membrane operation.
- Low Total Cost of Ownership (TCO).
- Flexibility to plug Pentair CO₂ recovery system onto Pentair or non-Pentair Biogas Upgrading System.
- High system uptime availability.
- Flexibility with plug & play installation.





THANK YOU FOR YOUR ATTENTION

For more info, please meet us at our stand

WWW.BIOGAS.PENTAIR.COM

