

PENTAIR Haffmans

BIOGAS UPGRADING – best practice

PRESENTER: NIELS DEN HEIJER

DATE: APRIL 6, 2017

OUR CAPABILITIES SPAN THE GLOBE

19,000

EMPLOYEES

IN 40

COUNTRIES

ON SIX

CONTINENTS



WE PARTNER WITH OUR CUSTOMERS

WATER

**Water Quality
& Availability**

**Reduce, Recover, and Reuse Water,
While Requiring Less Energy**

**Food & Beverage
Processing**

**Increase Yield and Decrease Cost, Waste, Energy Use, and
Water Consumption – All While Maintaining Taste and Quality**

ELECTRICAL

Building Protection

**Protect Sensitive Equipment, Buildings, and Critical Processes
and Help Keep People Safe**

**Industrial Process
& Efficiency**

**Improve Utilization, Lower Costs, and Minimize Downtime for
Our Customers**

To Build a Safer, More Sustainable World

FOOD & BEVERAGE SITES

PENTAIR FLOW & FILTRATION Enschede, the Netherlands



PENTAIR SÜDMO, Riesbürg, Germany Hamilton, New Zealand



PENTAIR HAFFMANS Venlo, the Netherlands



UNION ENGINEERING Fredericia, Denmark



- Production of the **Beer Membrane Filter (BMF)** + cellar solutions
- Production of membranes and membrane modules using proprietary production equipment
- Solutions for process, wastewater treatment



- Production of valves, fittings and integrated valve systems
- Provides sustainable processing solutions to maximize production time and operational flexibility, from design through to the final commissioning of your process system.








- Production of quality control and process equipment for the brewing and beverage industries
- Production of CO₂ recovery and biogas upgrading solutions for the brewing / beverage, bio-ethanol and biogas industry



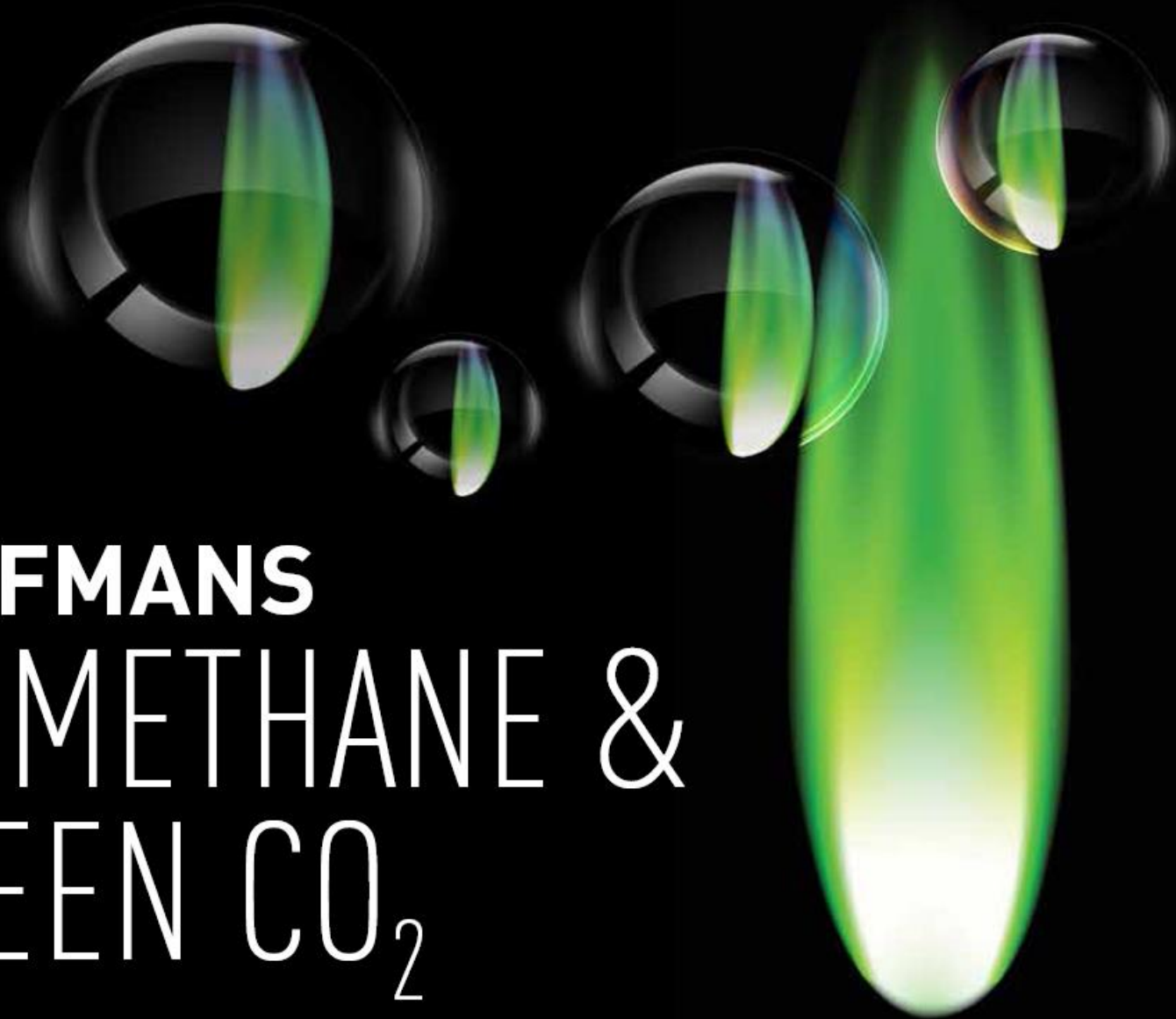
- Pentair acquired Union Engineering in early 2017
- Union Engineering's CO₂ technologies and service capabilities reinforce and expand Pentair's offerings within the Industrial Gas, Food & Beverage and Biogas Upgrading sectors.



INDUSTRIES WE WORK WITH

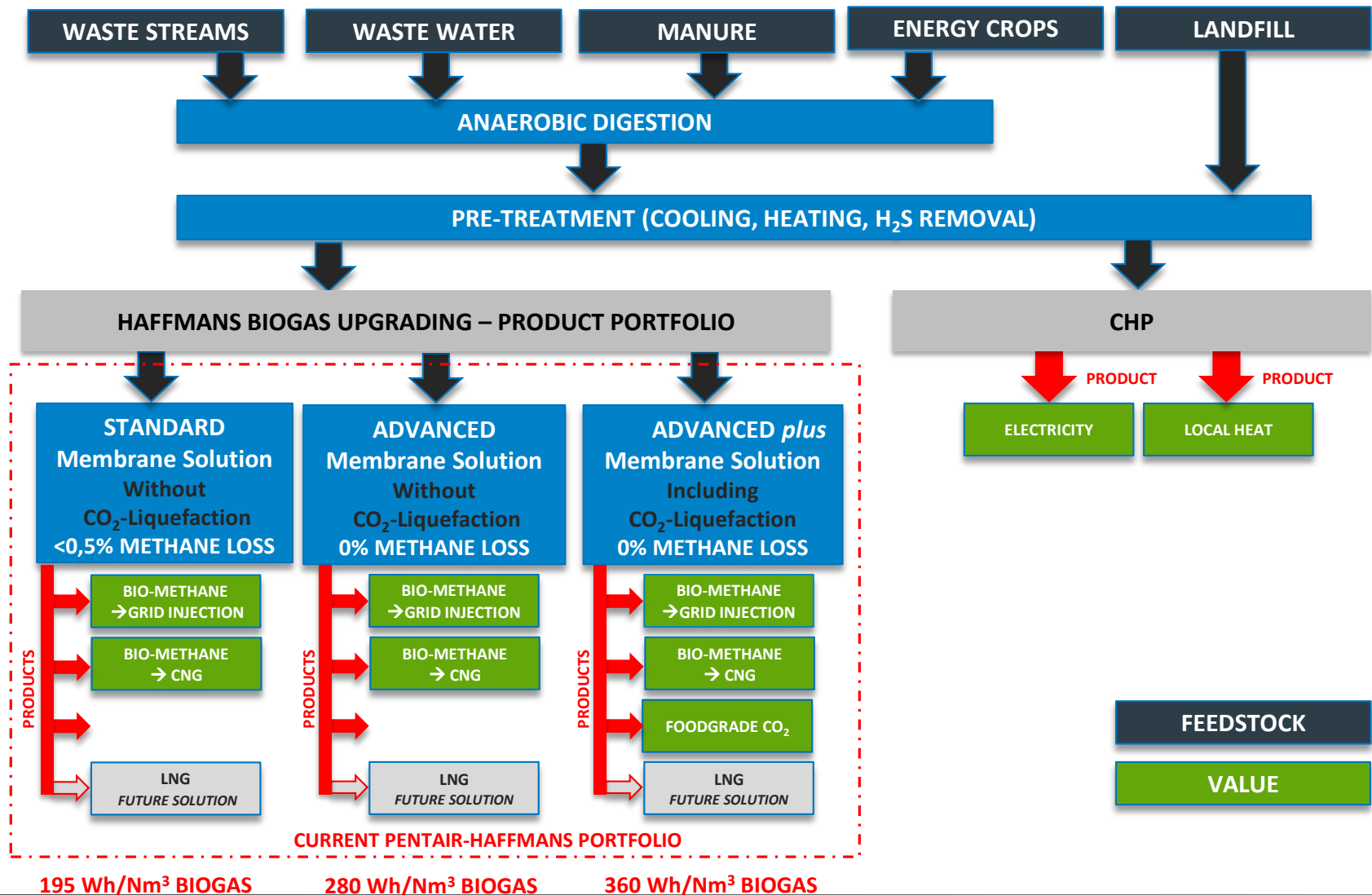
		Components	Systems	Services
	BREWING	✓	✓	✓
	BEVERAGE	✓	✓	✓
	DAIRY & FOOD	✓	✓	✓
	WINE & CIDER	✓	✓	✓
	BIOGAS, CO ₂ , BIOETHANOL	✓	✓	✓

BIOGAS UPGRADING

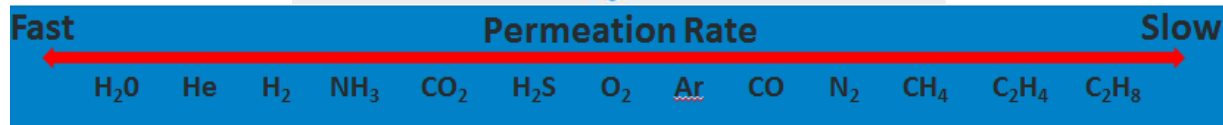
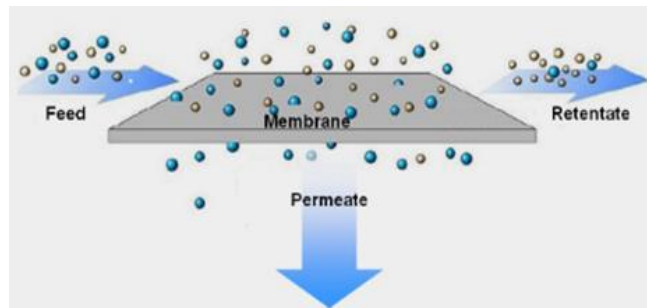
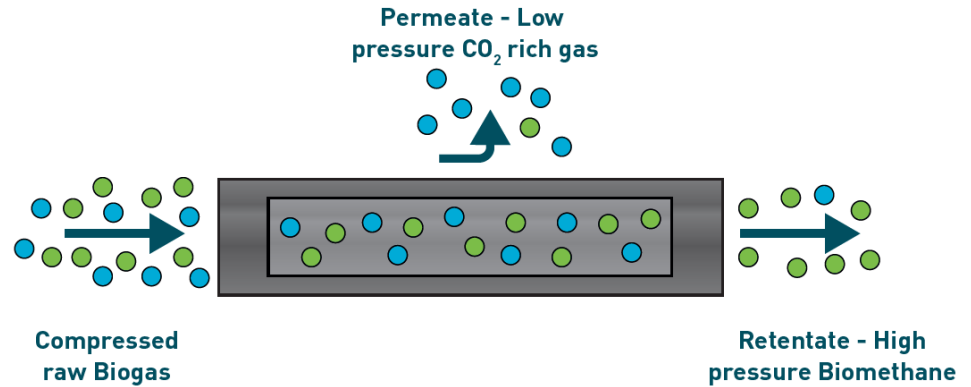


HAFFMANS
BIOMETHANE &
GREEN CO₂

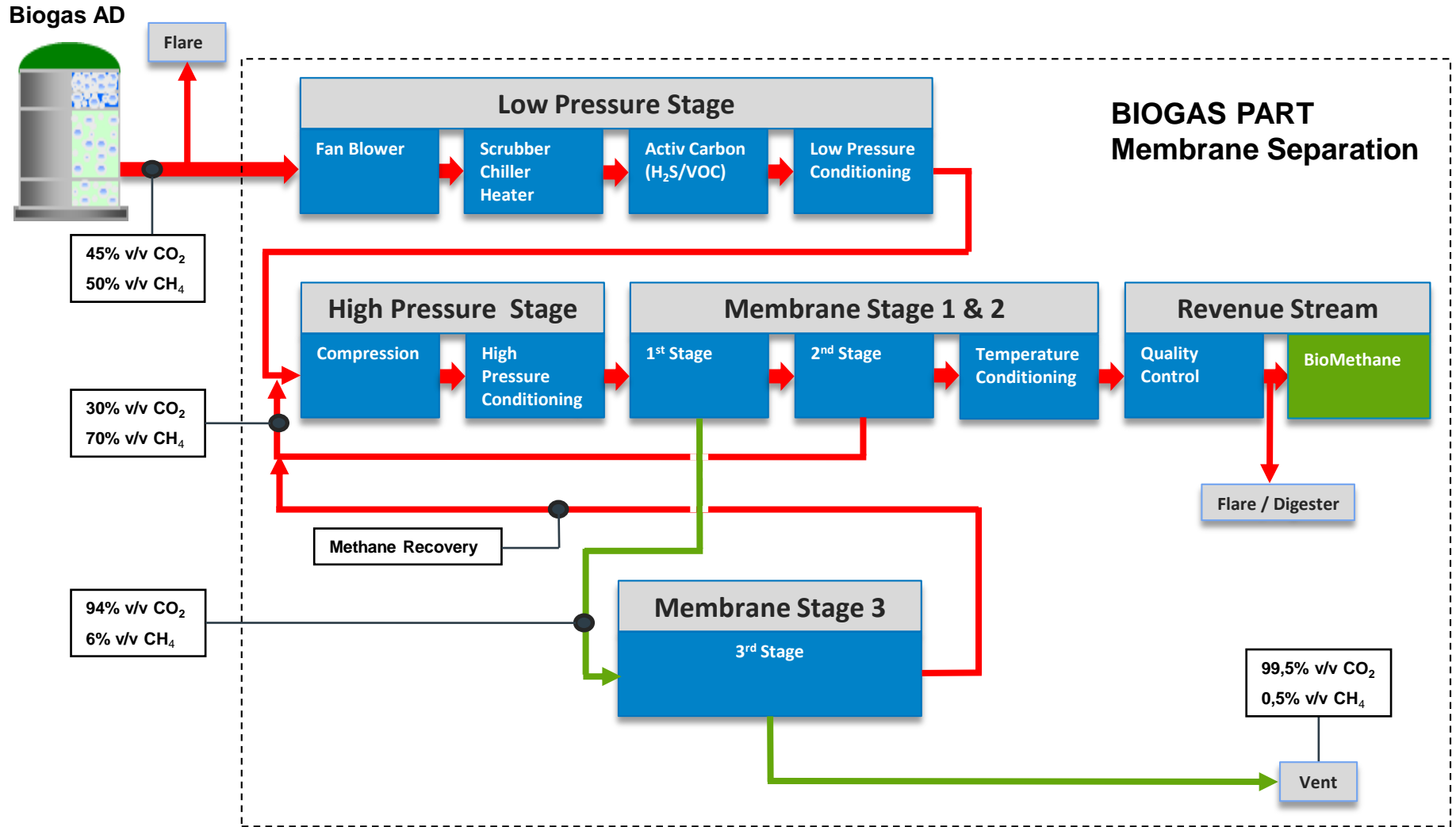
OVERVIEW – FROM FEEDSTOCK TO VALUE



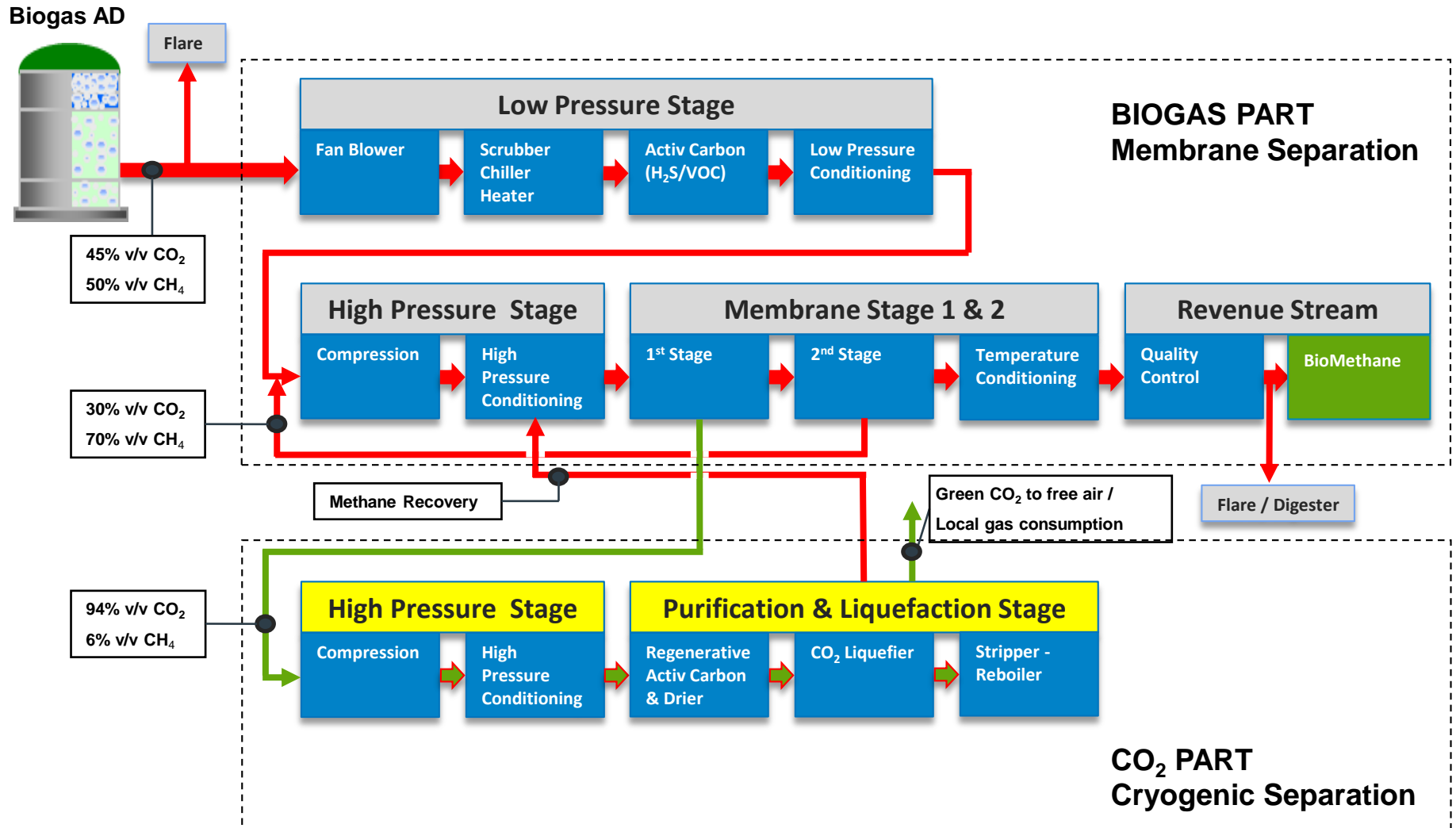
BIOGAS UPGRADING - MEMBRANE GAS SEPARATION



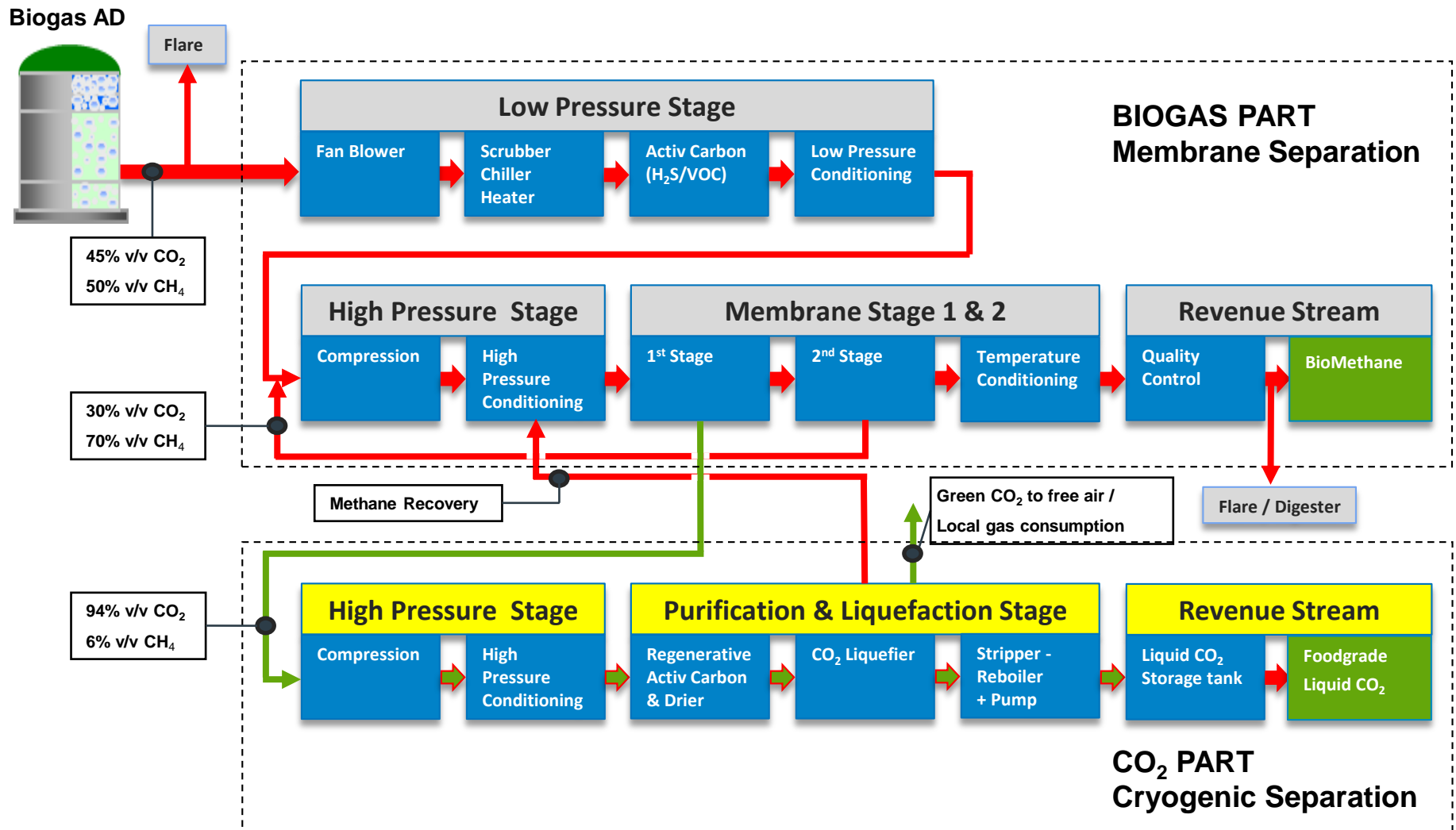
BIOGAS UPGRADING - STANDARD



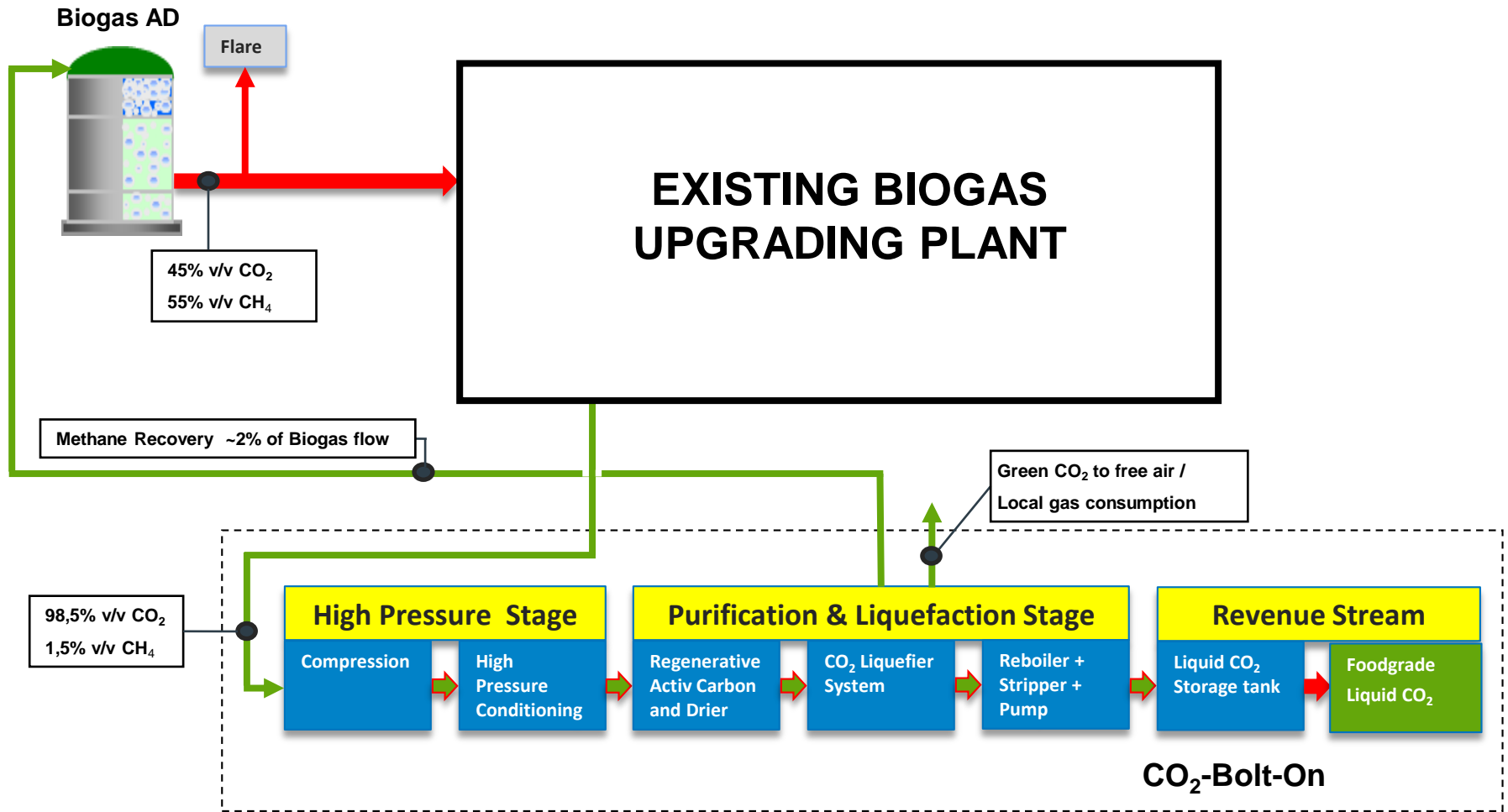
BIOGAS UPGRADING - **ADVANCED**



BIOGAS UPGRADING - *ADVANCED plus*



ADDITIONAL REVENUE WITH CO₂-BOLT-ON



- CO₂ purity acc EIGA Specs
- 440 Wh/Nm³ Raw CO₂

BIOMETHANE APPLICATIONS

- USE the CH₄ as fuel
- Bio-CNG (LNG) for:
 - Trucks
 - Buses
 - Cars



- USE the CH₄ for pipeline injection
- Biomethane for:
 - Transportation
 - Electricity
 - Heat



SECOND VALUE STREAM: CO₂ APPLICATIONS

→ CO₂ is used in different forms: gaseous, liquid, solid or super critical

Agri-production

- Accelerate plant growth in greenhouses



Beverages

- Carbonation and beverage dispensing



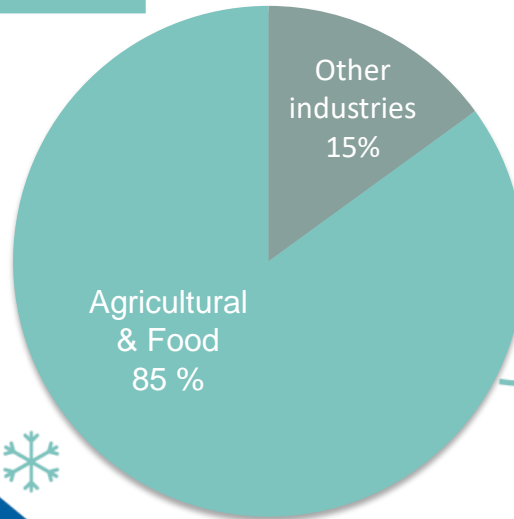
Food industries

- Food preservation, freezing, chilling, packaging, extraction



Refrigerated transport

- Maintain the cold chain for fresh and frozen products



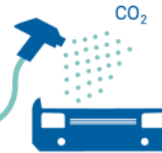
pH control

Water treatment



Chemistry

Reactive agent



Industrial cleaning

Solvent free cleaning for surfaces



Welding

Arc stabilisation in MAG welding

Many other applications : fire extinguishers, natural refrigerant, stunning of animals

4. Extra Product :CO₂ - QUALITY of CO₂



BIOGAS TO GRID & GREEN CO₂

EIGA DOC 70/17: FOOD-GRADE CO₂ FROM BIOGAS

Revised EIGA DOC 70 released in February 2017

Biogas from anaerobic digestion listed as carbon dioxide source

- Biogas from energy crop is handled similar to yeast-based fermentation (ethanol)
- Biogas from bio-waste digestion or co-digestion requires greater care in the evaluation
- [Biogas from landfills (landfill gas) with unlimited number of waste types requires extensive risk assessment]

Risk assessment process for AD plants for liquid CO₂ for food & beverages

- The food safety risk analysis (HACCP) includes the digester biogas process
- Final product carbon dioxide is always compliant with the Appendix A
- Complete on-line or complete batch analysis of carbon dioxide before supply to customer
- A food safety management system (e.g. ISO 22000) is strongly recommended for the carbon dioxide plant
- Compliance of the AD plant (and feedstock) with the EU regulations for animal by-products

CO₂ – QUALITY BY PENTAIR

Food Safety Risk Assessment with Industrial Gas Company

- Stricter quality criteria than for industrial CO₂
- FSRA completed before EIGA DOC 70 revision
- Since July 2015 hundreds of samples have been analysed according to the EIGA standard
- Inline analysis or complete batch analysis of carbon dioxide before supply to customer
- Initial deviations caused by:
 - H₂S
 - Moisture
 - Hydrocarbons (propane)

UK Experience

- Substrates:
 - Mainly energy crops and unprocessed vegetable matter
 - High quality -> low risk
- CO₂ goes via industrial gas companies to food, beverage and industrial applications
- CO₂ complies with food-grade requirements

NL Experience

- Substrates:
 - Mainly bio-waste, vegetable & food waste
 - Higher level of impurities -> process control
 - One reference with energy crops
- CO₂ goes via industrial gas companies and OCAP pipeline mainly to greenhouses
- CO₂ complies with food-grade requirements
- Test result: < 2 bacteria / dm³

SAFEGUARDING THE CO₂ QUALITY

Cleaning steps of raw biogas before membrane biogas upgrading:

Optional biological H₂S removal (bulk removal of H₂S):

- Reduction of H₂S levels from 1500 ppm to 30-50 ppm levels

Gas washer

Removal of ammonia/water solubles

Activated Carbon

Removal down to max. 1 ppm of all contaminations :

- H₂S
- VOC, MEK (methyl ethyl ketones), terpenes

Cleaning steps of raw CO₂ during liquefaction:

Compression to 18 bar (g)

-> Temperature increase to > 110 C -> sterilization of CO₂

Regenerative activated carbon

Removal of last ppm contaminations to ppb level

Liquefaction, strip column

Removal of all non-condensable gases: CH₄, N₂, H₂, O₂,

BIOGAS UPGRADING TRACK RECORD & REFERENCES

REFERENCES: MANURE

Customer : 2 Cattle Farms in The Netherlands (Tirns & Biddinghuizen)
1 Cattle Farm in France (Cucq)

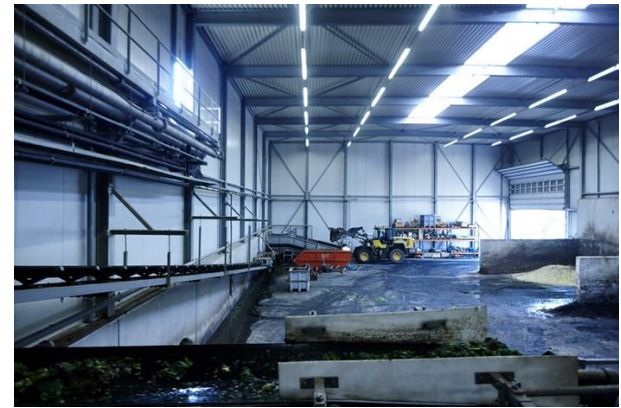
Market : Manure & agricultural waste products

Capacity : 220-350 Nm³/h biogas

Output : 135-220 Nm³/h biomethane



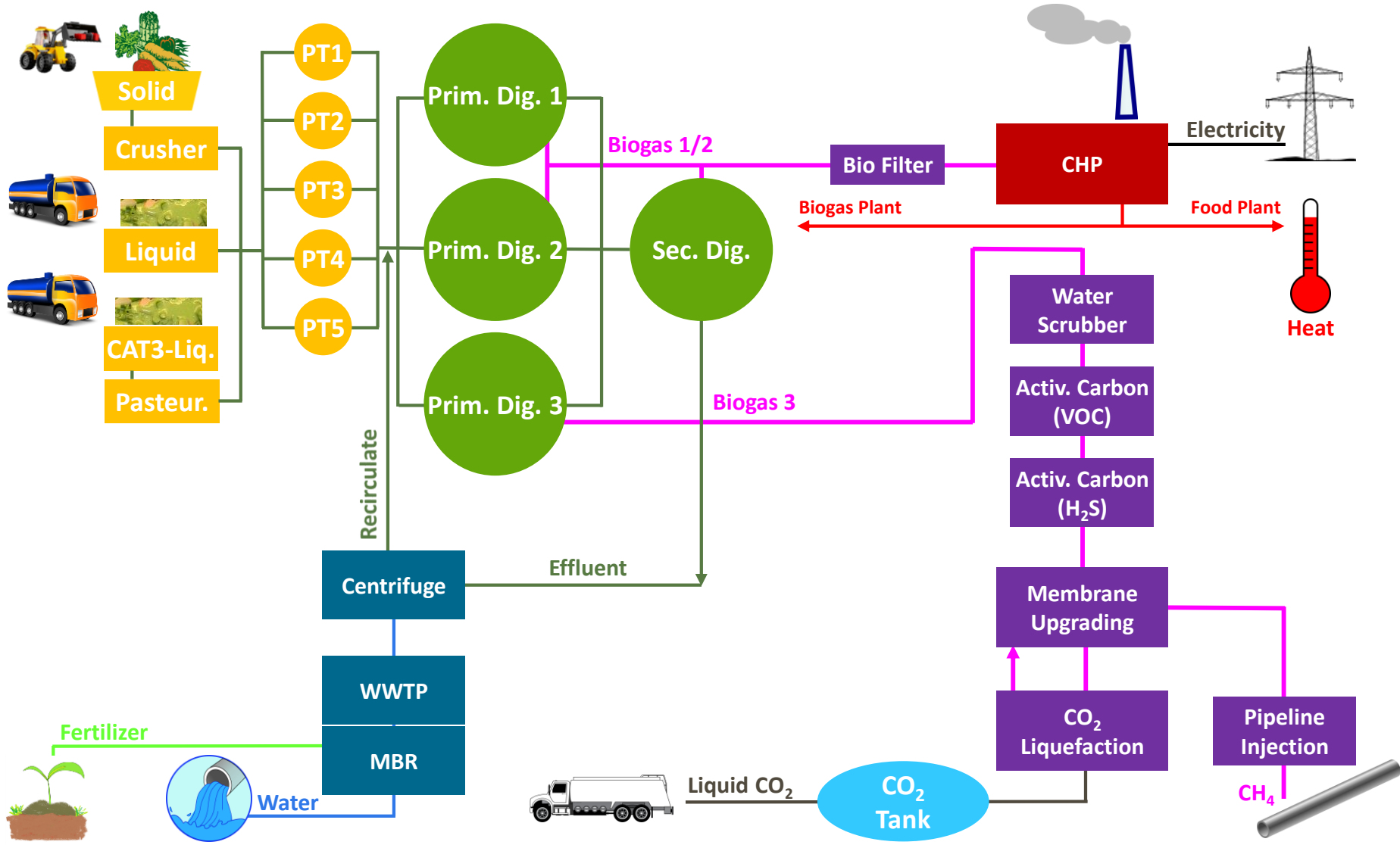
ECOFUELS – 450 Nm³/h BIOGAS TO GRID & GREEN CO₂



ECOFUELS – 450 Nm³/h BIOGAS TO GRID & GREEN CO₂



ECOFUELS: BLOCK DIAGRAM BIOGAS PLANT



BIOGAS UPGRADING



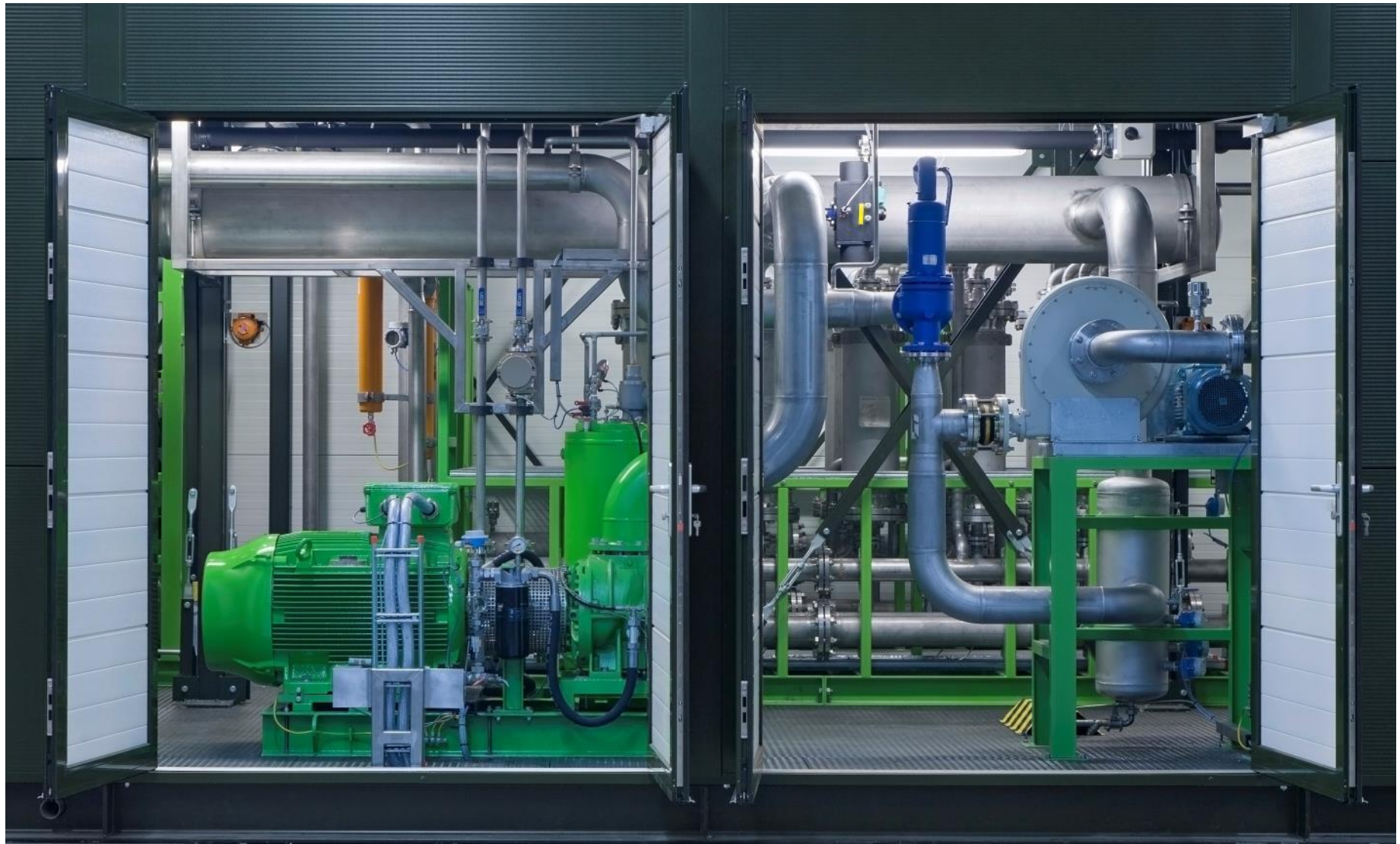
BIOGAS UPGRADING



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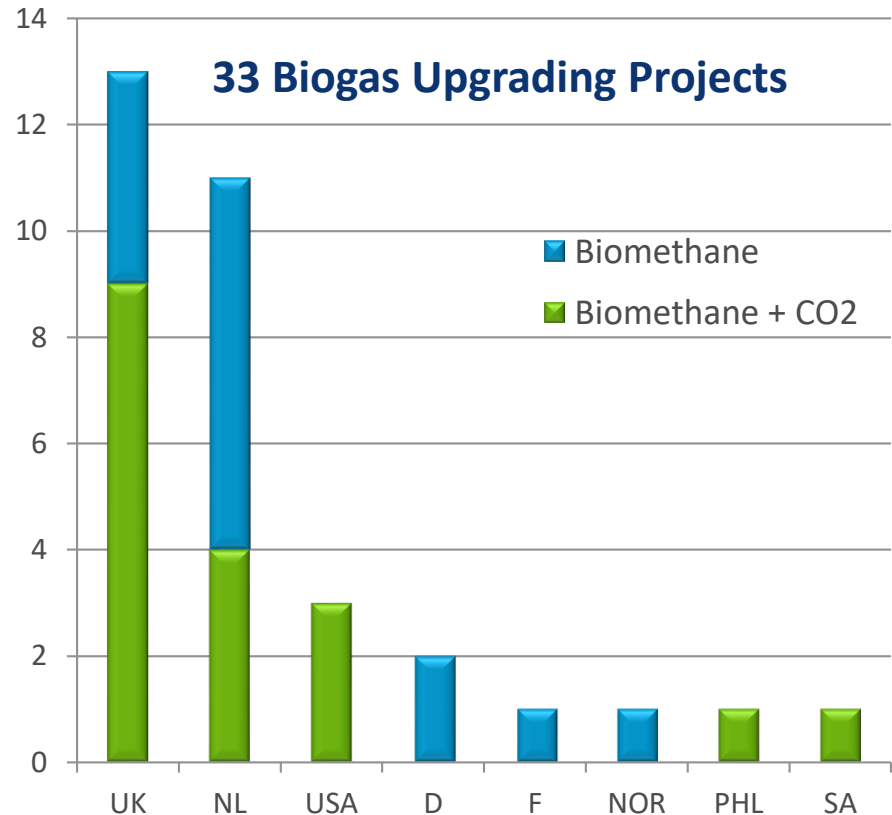
BIOGAS UPGRADING – COMPACT ENCLOSED SKID



BIOGAS UPGRADING – COMPACT ENCLOSED SKID



RELIABLE TECHNOLOGY PROVIDER



- Food Safety Risk Assessment (EIGA/ISBT) completed in cooperation with major gas company
- High CH₄ yield/ No CH₄ slip
- 24/7 Service desk / Own service team
- In-house design (incl. membranes) and production
- > 450 Haffmans CO₂ recovery plants world-wide
- > 1000 Union CO₂ plants world-wide
- > 1000 Process Installations in China
- 7+ years of service life experience with membranes
- Low membrane pressure and hence low energy Consumption

EIGA: European Industrial Gases Association – ISBT: International Society of Beverage Technologists

Thank you for your attention!

Niels den Heijer
Niels.denheijer@Pentair.com
+31 77 3232396
