



AD & BIOGAS WINNER 2016 BEST PROCESS OPTIMISATION



50 YEARS OF WINNING RIGHT



PRE-BASIC BIOGAS

MALMÖ SWEDEN

ROY SPEE

GENERATING BIOMETHANE & LIQUID CO₂
FROM FOOD & BEVERAGE WASTE

7 YEARS OF BIOGAS UPGRADING EXPERIENCE

WE ARE DRIVEN BY A PURPOSE

**DELIVERING SAFE
& SUSTAINABLE
ENERGY**



**MANAGING
WATER USE**



**MEETING THE
WORLD'S
INCREASING
DEMAND FOR FOOD**



**SUPPORTING,
MAINTAINING &
PROTECTING CRITICAL
PROCESSES**



OUR CAPABILITIES AND RESOURCES SPAN THE GLOBE

~30,000

EMPLOYEES

7

CONTINENTS

\$6.4 Billion

ANNUAL REVENUE
(2015)

~100

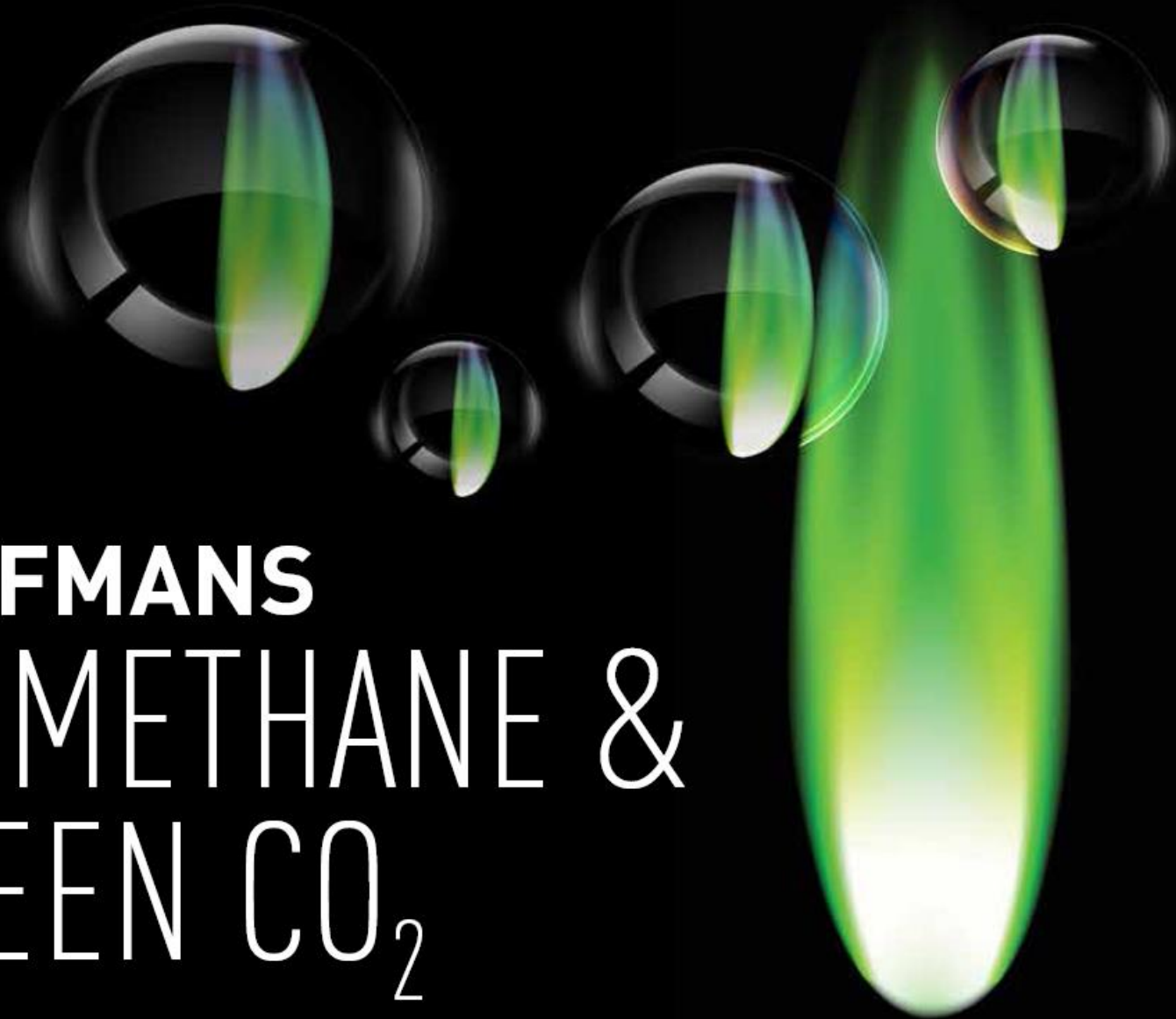
MANUFACTURING
FACILITIES

500+

PRODUCT
LINES

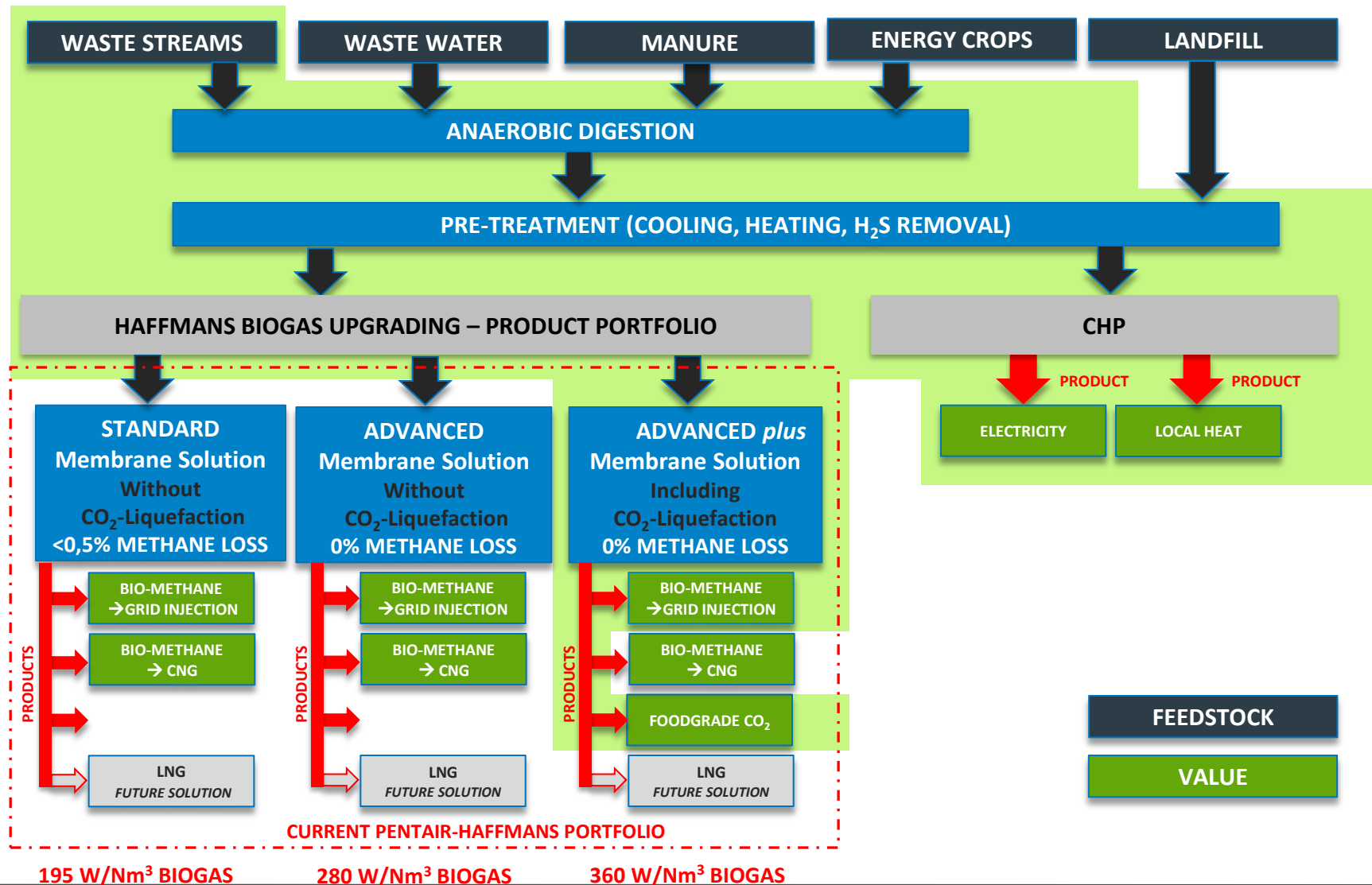
60+

SERVICE
CENTERS

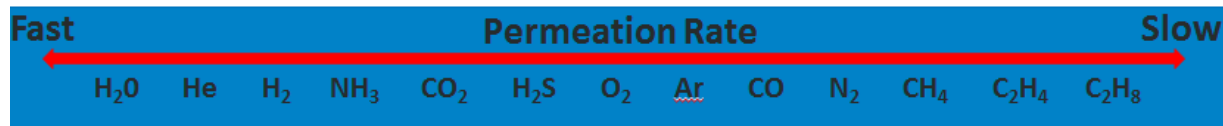
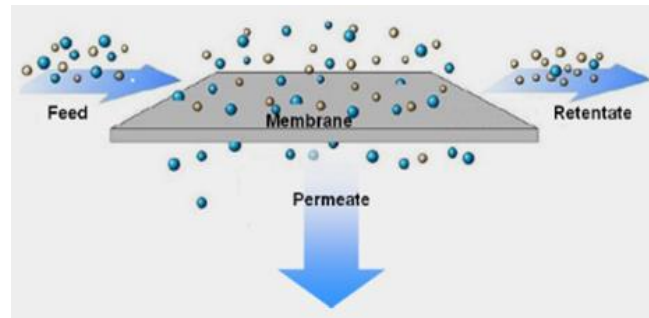
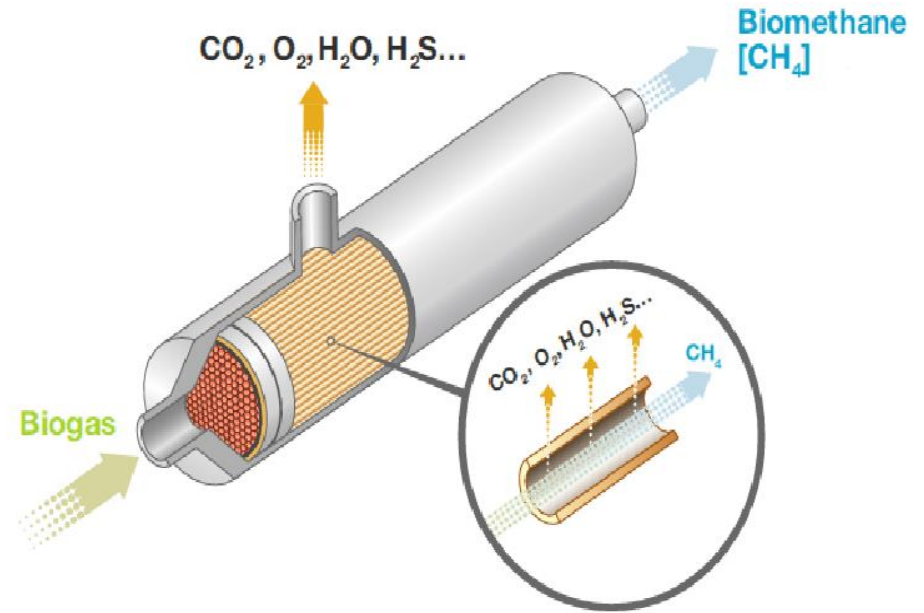


HAFFMANS
BIOMETHANE &
GREEN CO₂

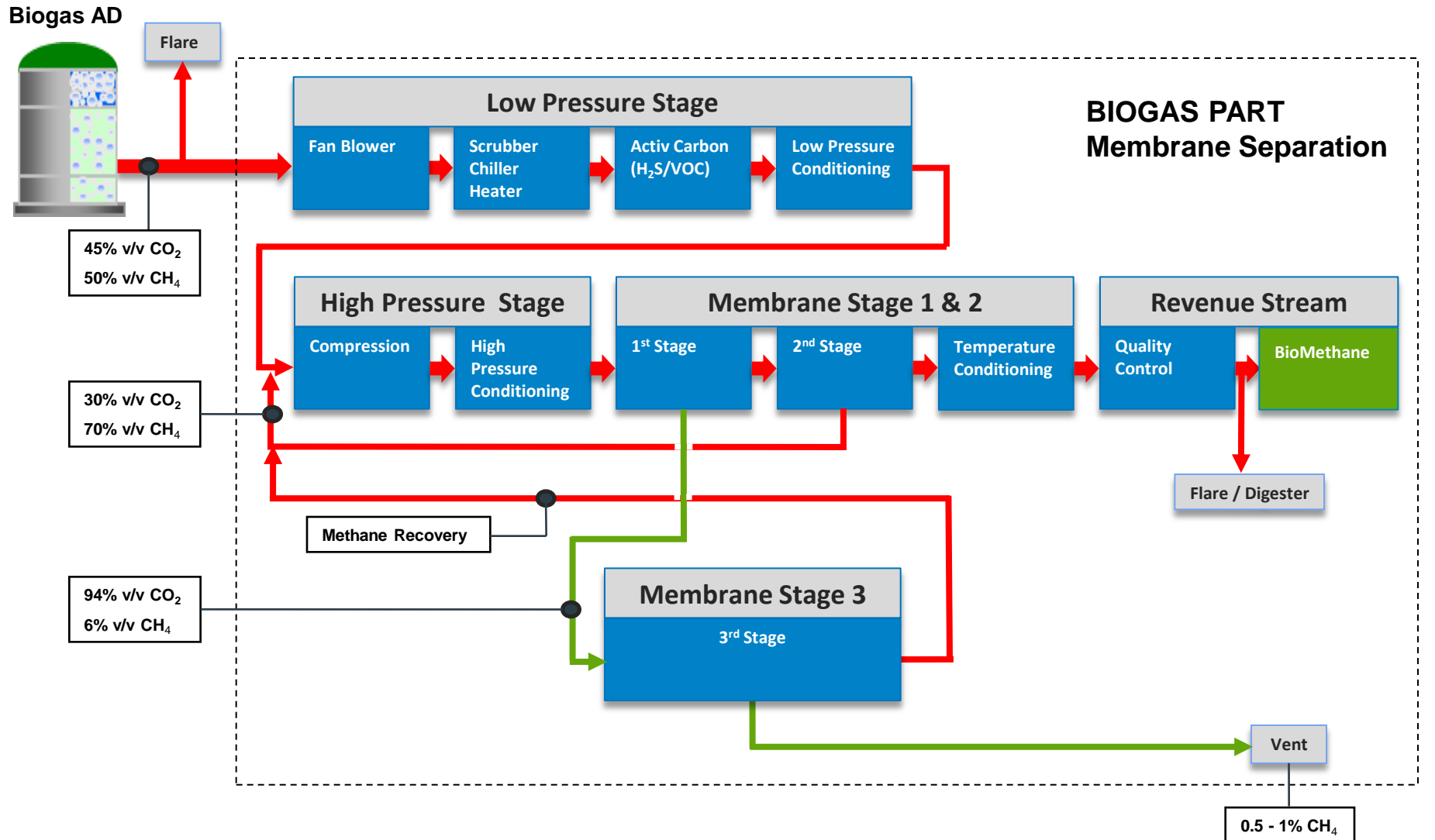
ARN: BIOGAS UPGRADING FROM BIOWASTE



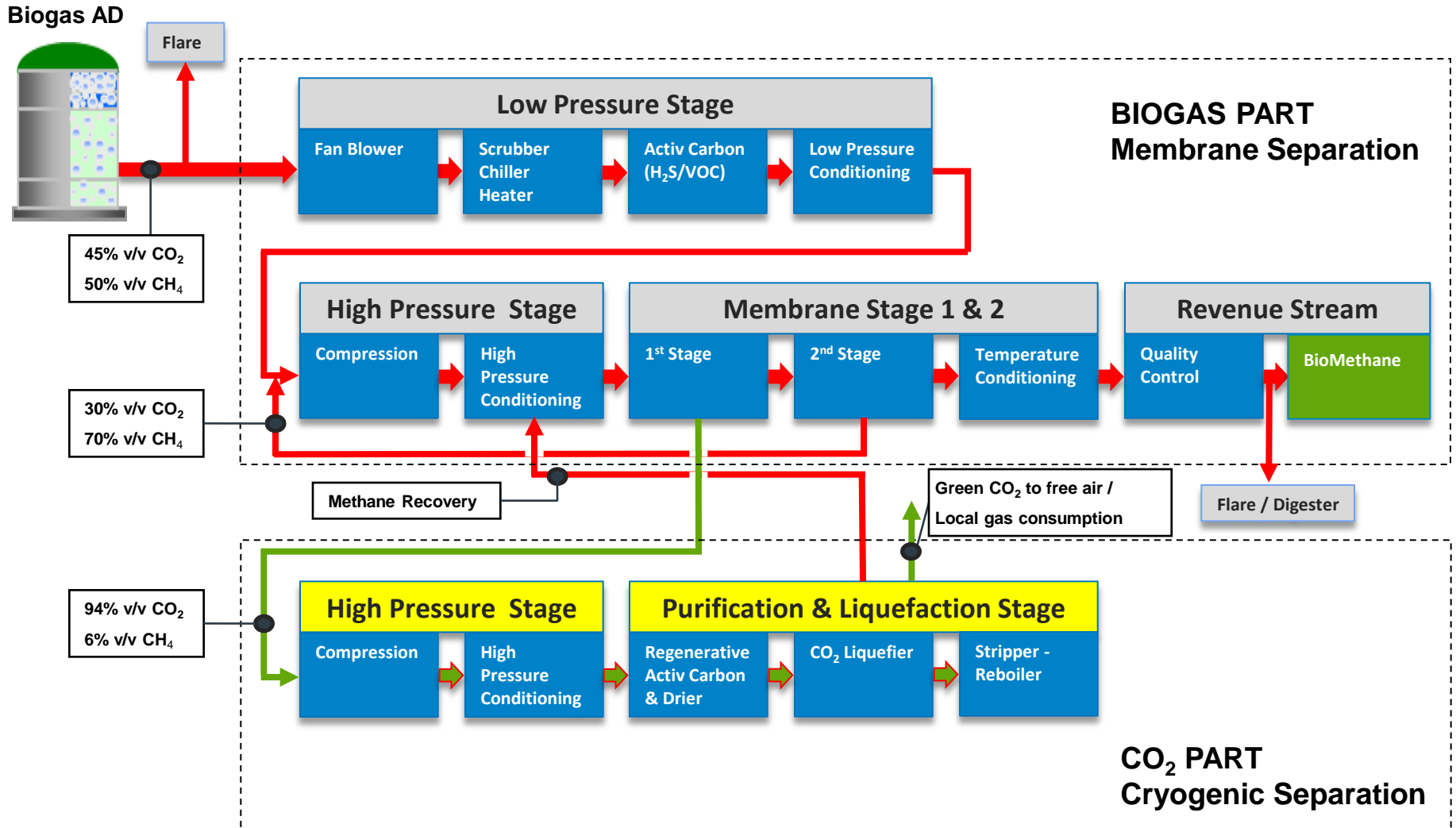
BIOGAS UPGRADING - MEMBRANE GAS SEPARATION



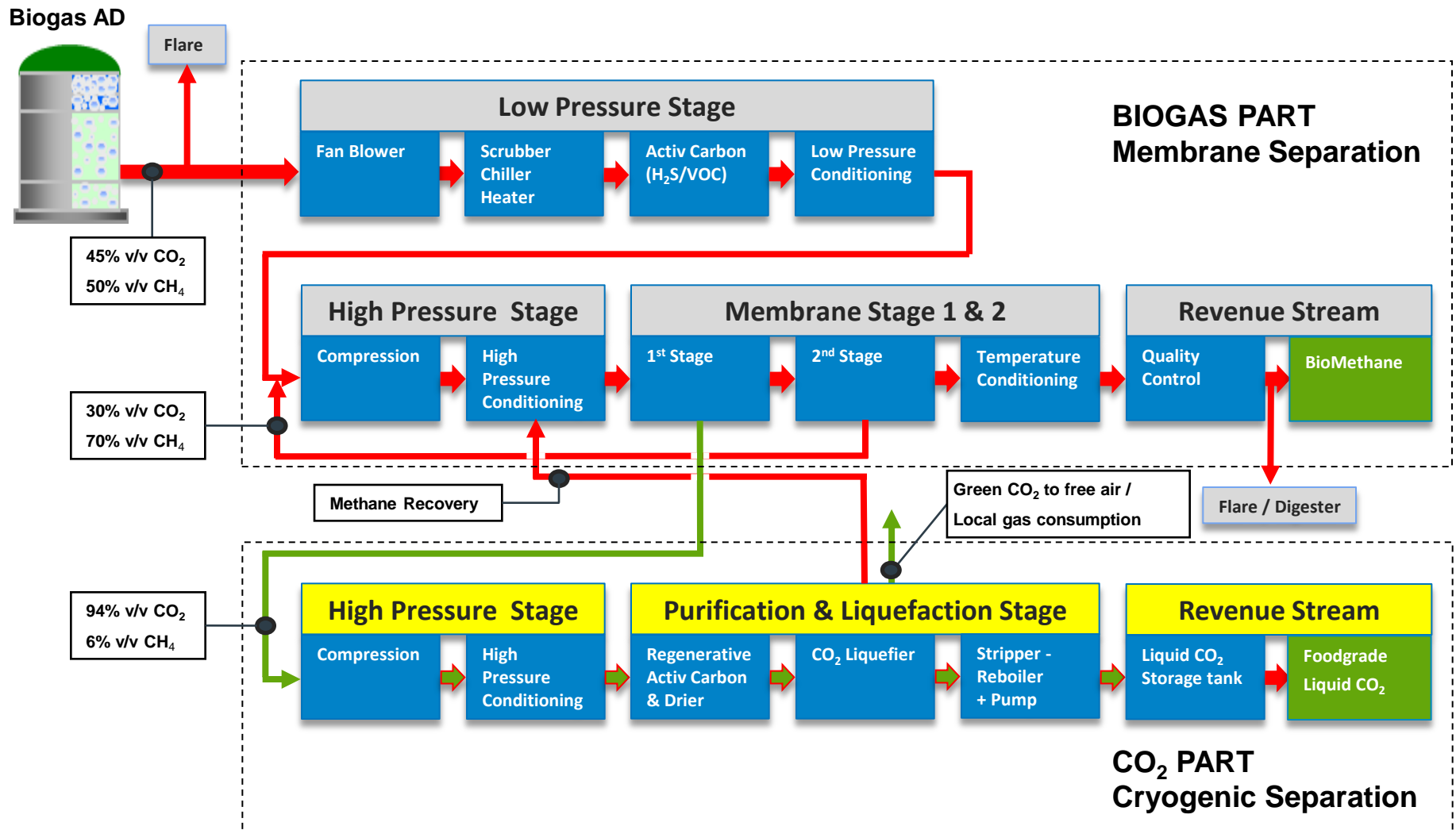
BIOGAS UPGRADING – STANDARD SYSTEM



BIOGAS UPGRADING – ADVANCED SYSTEM



BIOGAS UPGRADING - ADVANCED *plus* SYSTEM



APPLICATIONS FOR CO₂

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

Agri-production

- Accelerate plant growth in greenhouses



Beverages

- Carbonation and beverage dispensing



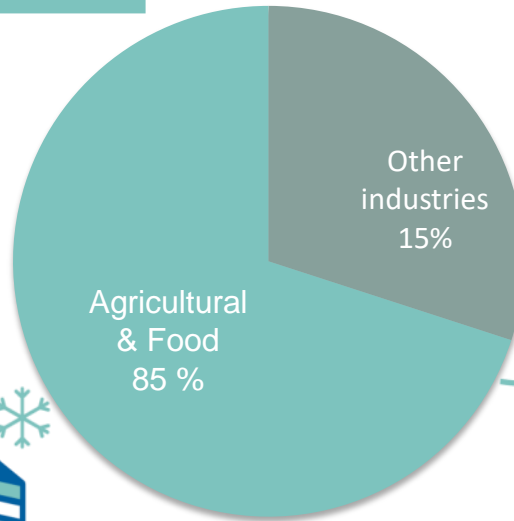
Food industries

- Food preservation, freezing, chilling, packaging



Refrigerated transport

- Maintain the cold chain for fresh and frozen products



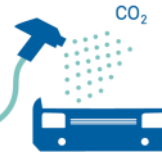
pH control

Water treatment



Chemistry

Reactive agent



Industrial cleaning

Solvent free cleaning for surfaces

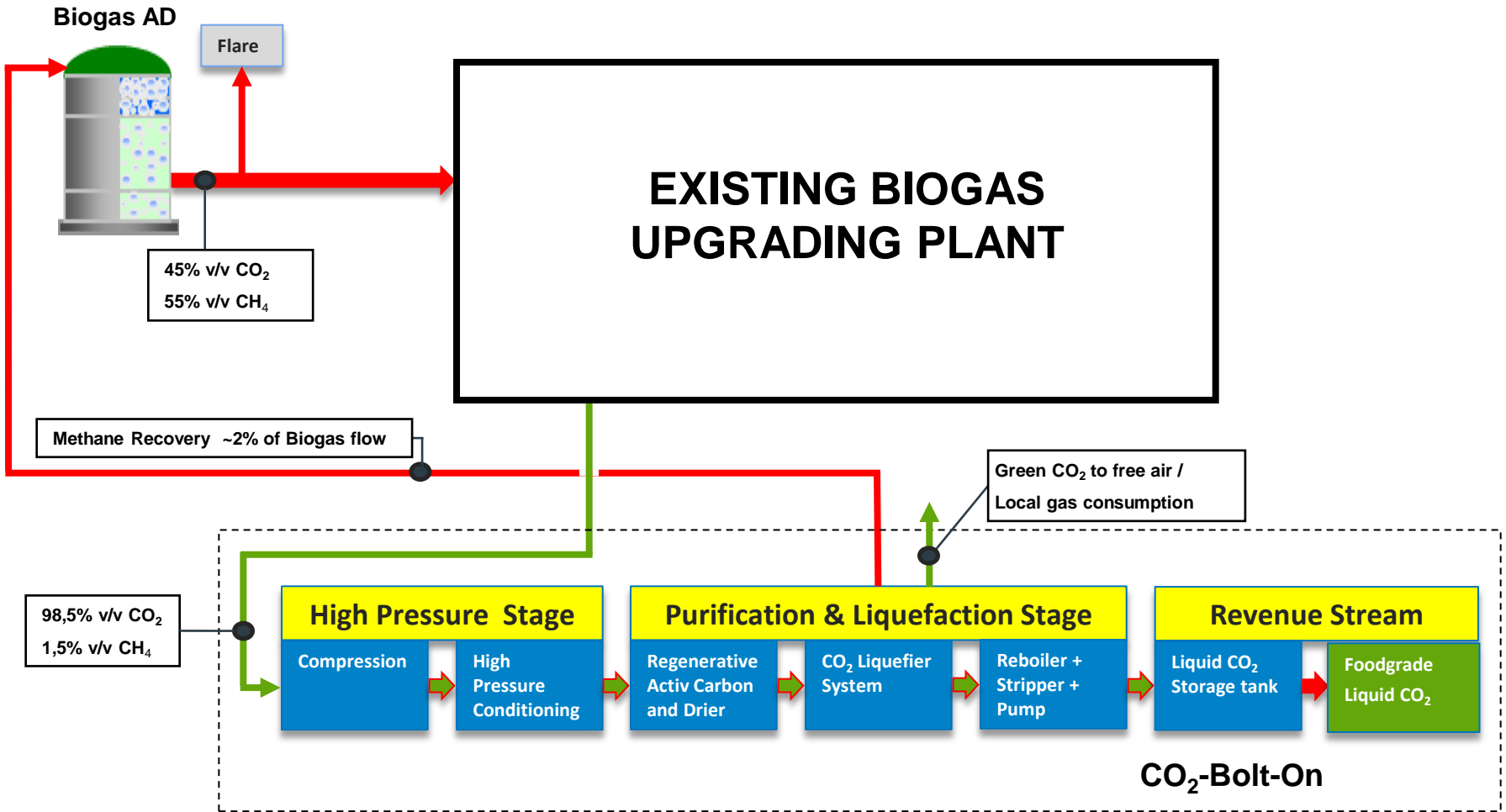


Welding

Arc stabilisation in MAG welding

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

ADDITIONAL REVENUE WITH CO₂ -BOLT-ON



**CO₂ purity acc EIGA Specs
440 W/Nm³ raw CO₂**

BIOGAS UPGRADING



BIOGAS UPGRADING



BIOGAS UPGRADING



REFERENCE VEGETABLE MATERIAL

Customer : ARN waste processing industry

Market : Compost Processing industry

Capacity : 530 Nm³/h biogas

CO₂ for greenhouses (via Linde)



ARN: BIOGAS UPGRADING CHALLENGES

CHALLENGES

- Decreasing capacity and separation efficiency
- Controlling the gas quality due to variance in biomass
- Plugging of membranes by VOCs (terpene, limonene and ketone)
 - Frequent replacement of activated carbon
 - Self-cleaning membranes
- Very strict regulations on CO₂ quality

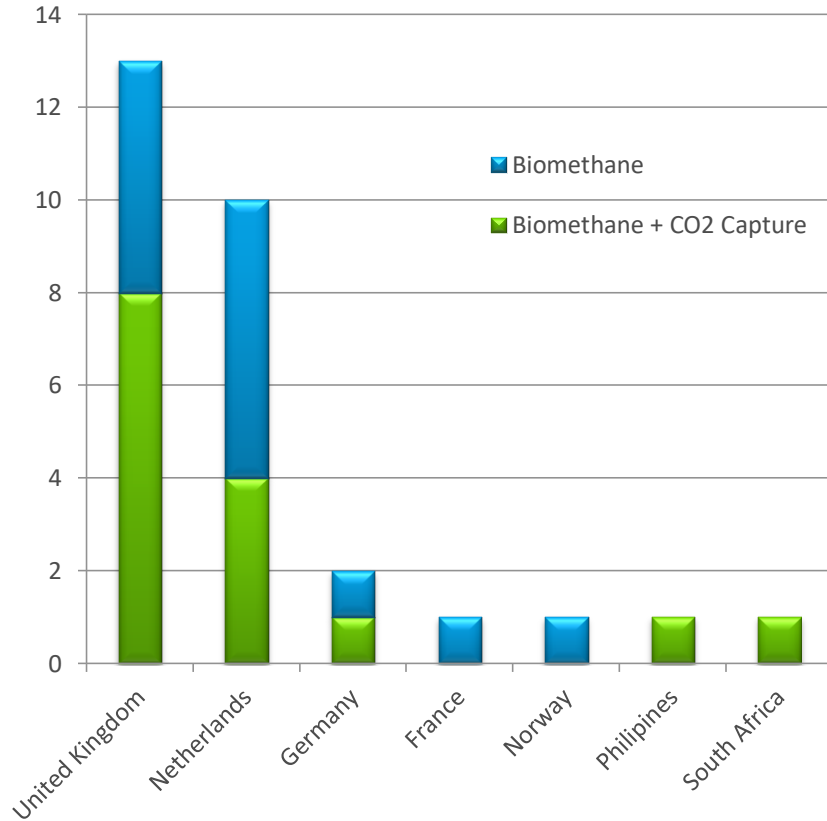


REFERENCE LIST PENTAIR HAFFMANS: BIO-WASTE

CUSTOMER	PRODUCT	COUNTRY	START-UP	CAPACITY	MARKET	OUTPUT
Fountain Civil Engineering, Cape Town	Advanced Plus	SA	Mar-17	1600 Nm ³ /h Biogas	Food & vegetable based waste	<ul style="list-style-type: none"> • 1010 Nm³/h Bio-methane • 1040 kg/h BioCO₂
UTS, Raynham Farms	Standard	UK	Jul-15	1000 Nm ³ /h Biogas	Organic Waste	<ul style="list-style-type: none"> • 565 Nm³/h Bio-methane
Indaver, Alphen a/d Rijn	Advanced Plus	NL	Jun-14	1050 Nm ³ /h Biogas	Garden & household organic waste	<ul style="list-style-type: none"> • 670 Nm³/h Bio-methane • 775 kg/h Bio CO₂
Abfallverwertung, Augsburg	Advanced	D	Oct-13	1000 Nm ³ /h Biogas	Garden & household organic waste	<ul style="list-style-type: none"> • 610 Nm³/h Bio-methane
ARN, Weurt	Advanced Plus	NL	Aug-12	530 Nm ³ /h Biogas	Garden & household organic waste	<ul style="list-style-type: none"> • 320 Nm³/h Bio-methane • 390 kg/h Bio CO₂
Ecofuels, Well	Advanced Plus	NL	Aug-11	450 Nm ³ /h Biogas	Vegetable-Fruit based waste	<ul style="list-style-type: none"> • 270 Nm³/h Bio-methane • 330 kg/h Bio CO₂

PENTAIR REFERENCES & ADVANTAGES

29 Biogas Upgrading Projects



PROVEN TECHNOLOGY PROVIDER

- In-house membrane & CO₂ systems design & production
- Low membrane pressure and power consumption
- 7+ years proven membrane service life
- No methane slip possible (increased revenue, clean lean gas)
- Liquid & gaseous CO₂ as 2nd value stream
- CO₂ end quality according to EIGA
- Food safety risk assessment completed in cooperation with major gas company
- Standardized skid modules in low-cost buildings for short delivery time and easy maintenance
- 24/7 service desk & own service team
- Globally 450+ CO₂ recovery plants in operation
- Award winner 2016: Best process optimization
- CH₄ to pipeline, CNG & LNG

EIGA: European Industrial Gas Association

Thank you for your attention!