

Tecnologias de Purificação

Para a Produção de Gases Renováveis



Patrick Bárcia
Vice-Presidente de Tecnologia





- **Founded in 2002 as Spin-off of University of Porto**
- **High specialization in gas separation processes**
- **Strong experience in several sectors of industry and provides turnkeys solutions for industrial gases generation**
- **World leader in VPSA technology portfolio**
- **+4000 PSA Systems installed worldwide | Present in +50 countries**

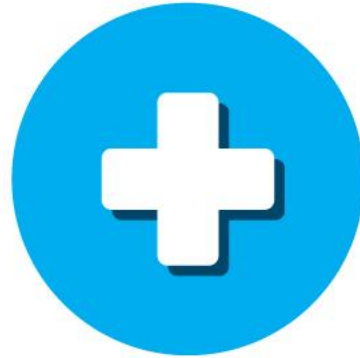
GLOBAL PRESENCE



ON-SITE GAS GENERATORS AND GAS PURIFIERS



INDUSTRIAL



MEDICAL



ENERGY

BIOGAS UPGRADING



METHAGEN^{AD}
Anaerobic Digestion



BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

RESEARCH & DEVELOPMENT | ENGINEERING & DESIGN | MANUFACTURE | SERVICE



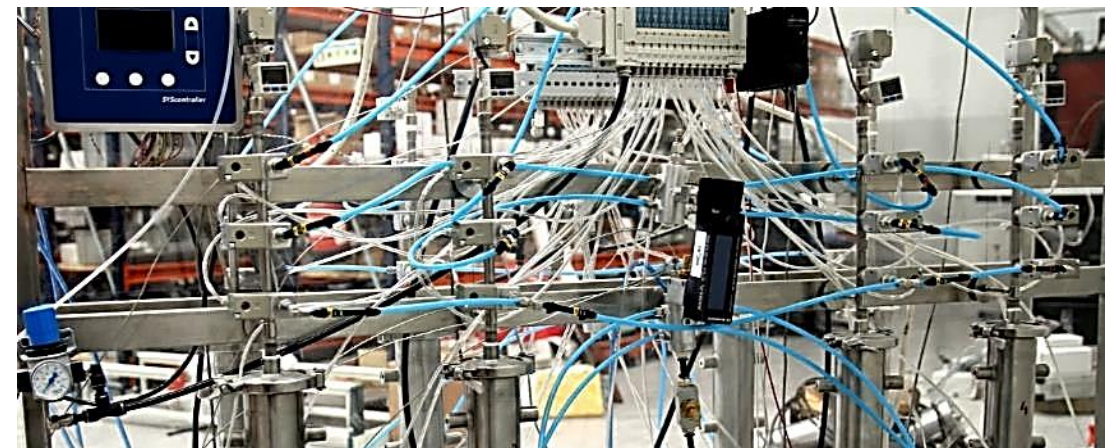
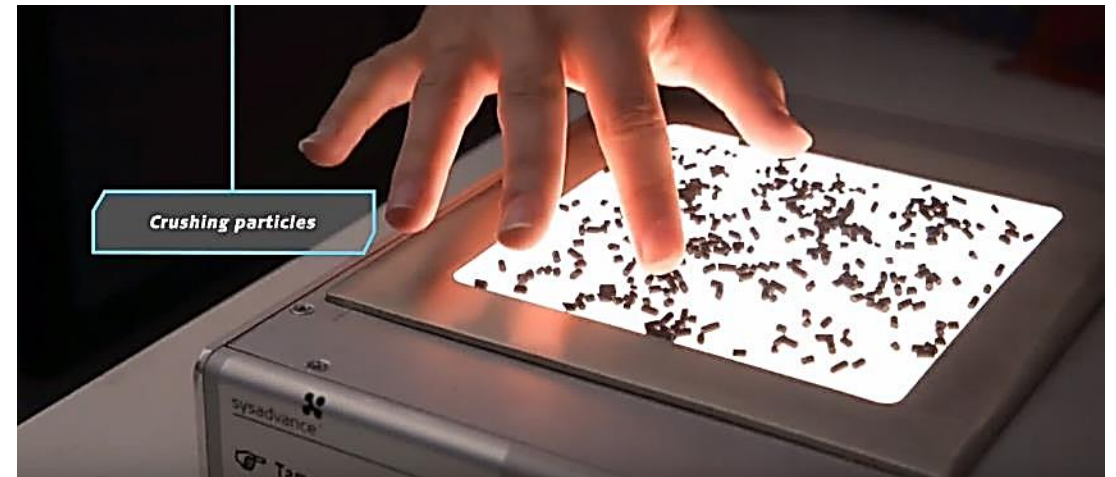


BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

R&D | LAB FACILITIES FOR ADSORBENT CHARACTERIZATION & CYCLE TESTING





BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

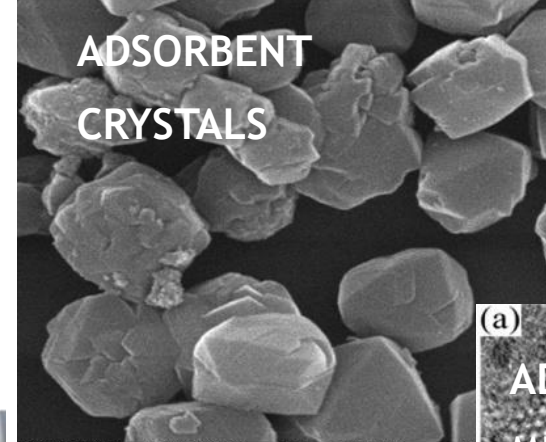
From Process to Micropores...



ADSORPTION PROCESS

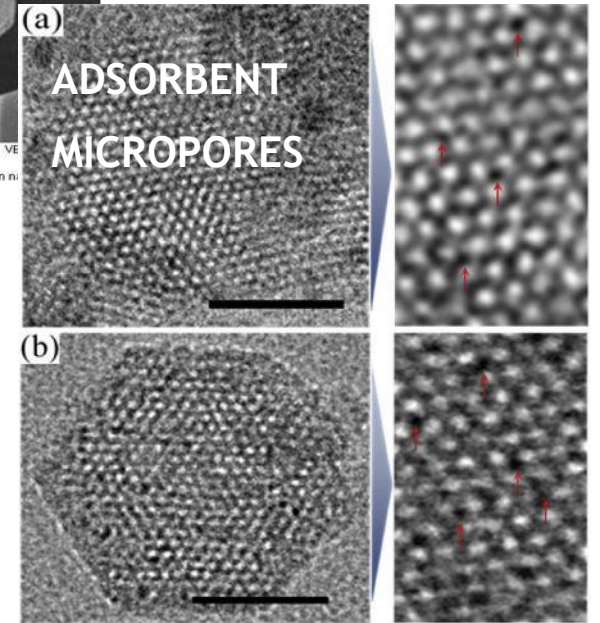


ADSORBENT PELLETS



ADSORBENT CRYSTALS

SEM HV: 30.00 kV WD: 7.3435 mm
SEM MAG: 30.00 kx Det: SE
View field: 4.816 µm PC: 15



(a) ADSORBENT MICROPORES

(b)

METHAGEN AD Anaerobic Digestion

- Low power consumption (0,22 kWh/Nm³ of biogas)
- High RNG quality (up to 99% CH₄)
- High methane recovery (up to 99.96%)
- Reduces N₂ (in addition to CO₂, O₂ & H₂O)
- Requires no water or chemicals
- Low long term consumable costs
- Reliable performance - avoid shut in
- Reliable operation - minimal downtime
- Modular and standardized design
- Easy to install
- Small footprint

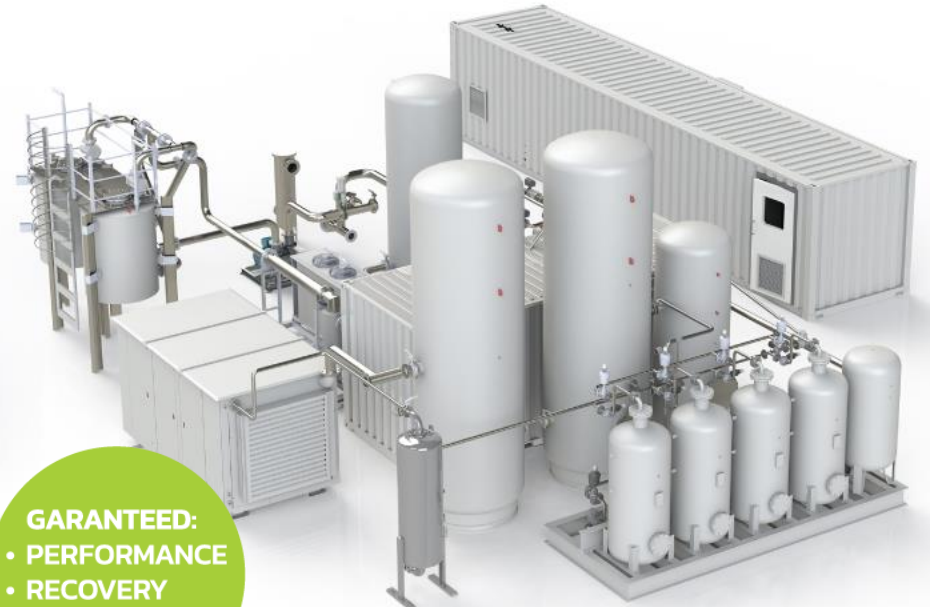


GARANTEED:

- PERFORMANCE
- RECOVERY
- UPTIME

METHAGEN LF Landfill Gas Upgrading

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GARANTEED:

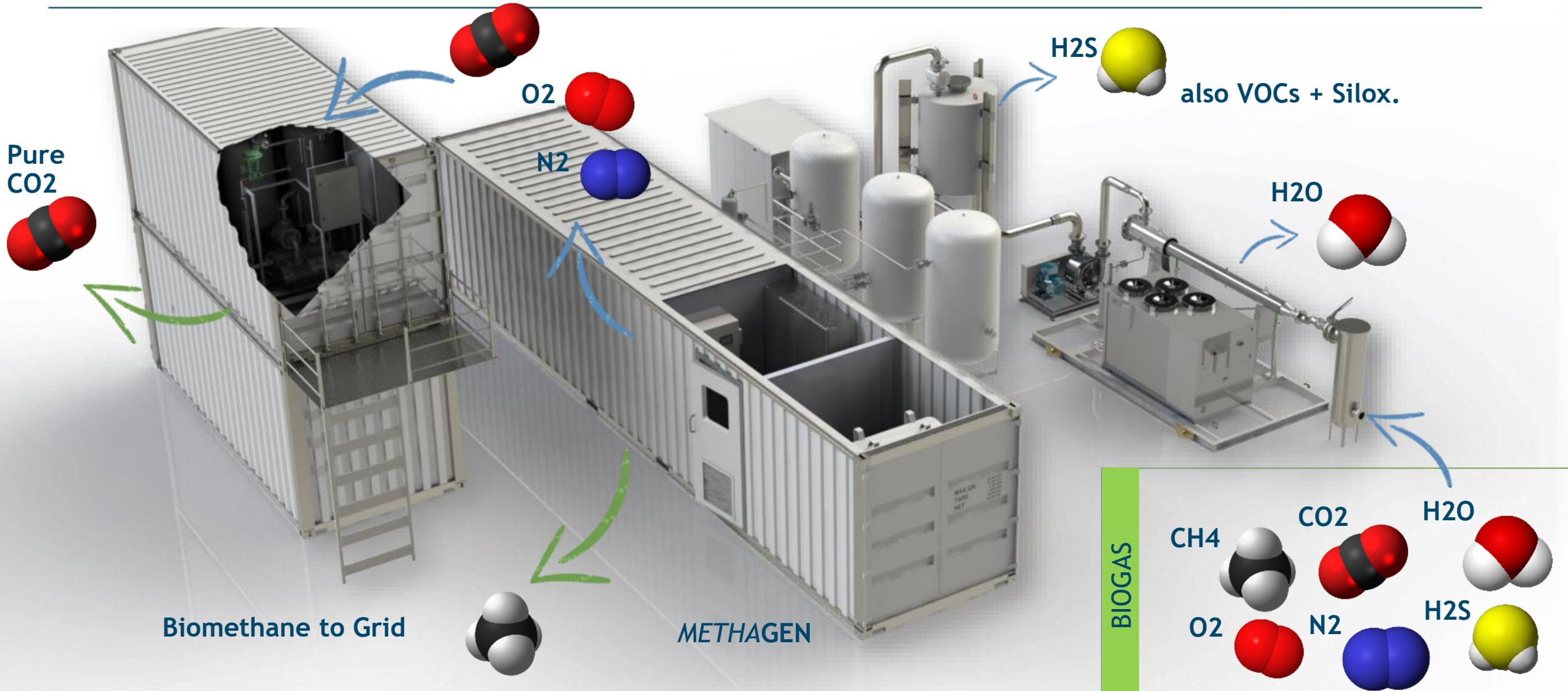
- PERFORMANCE
- RECOVERY
- UPTIME



BIOGAS UPGRADING

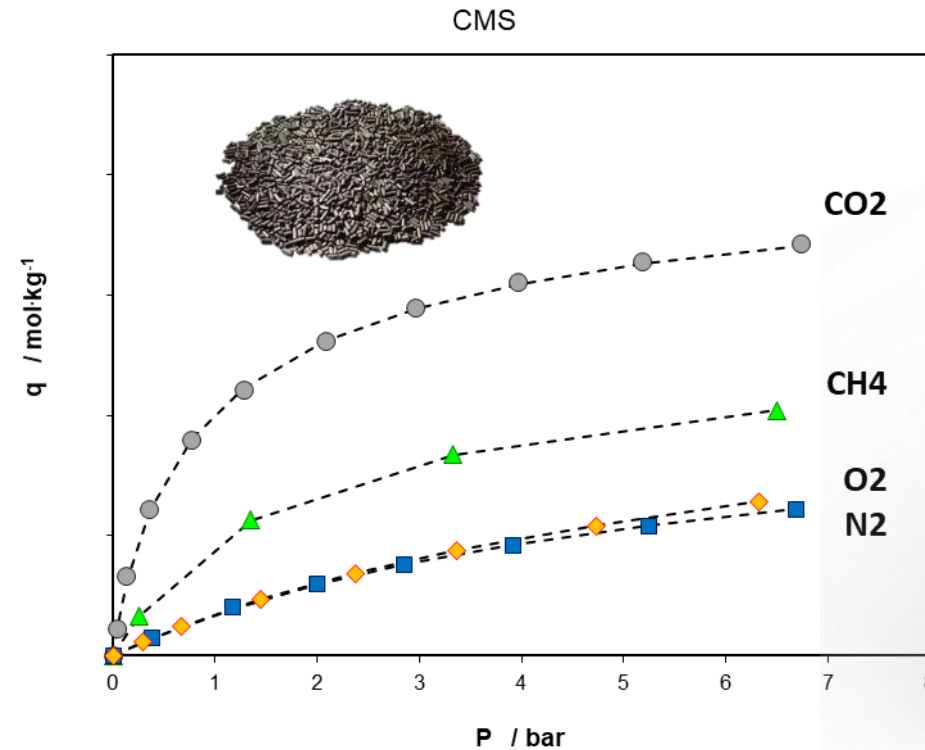
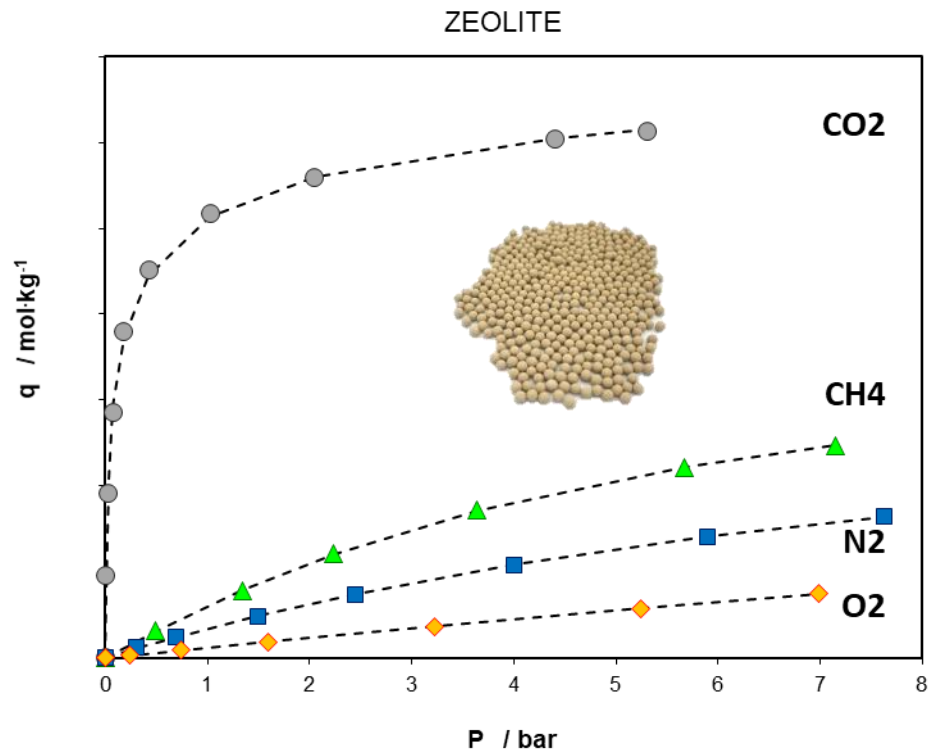
METHAGEN^{AD}

Anaerobic Digestion



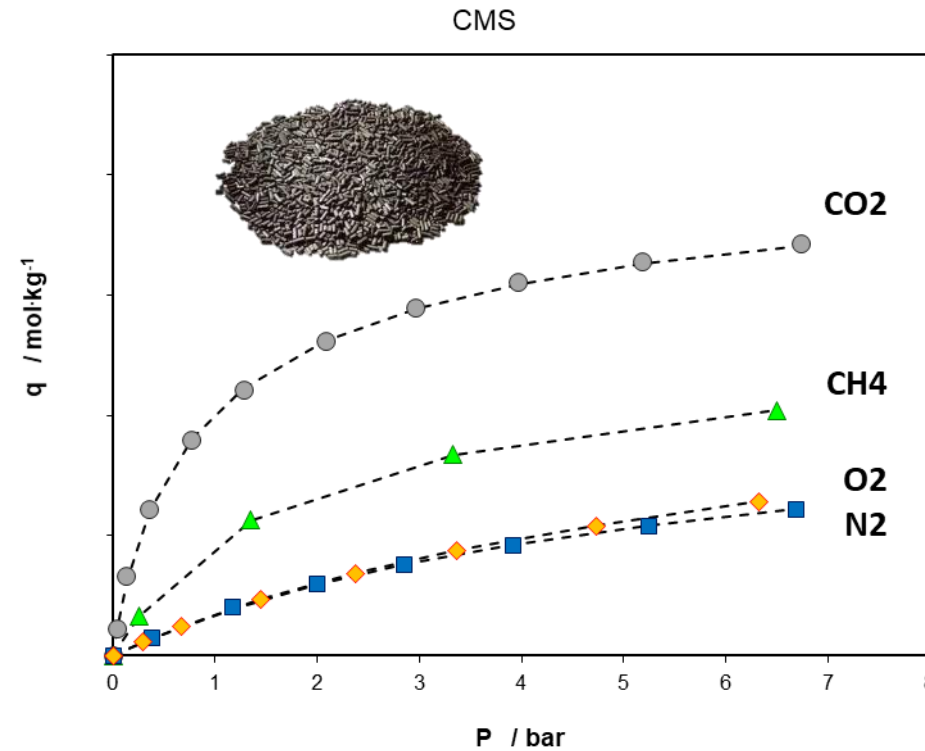
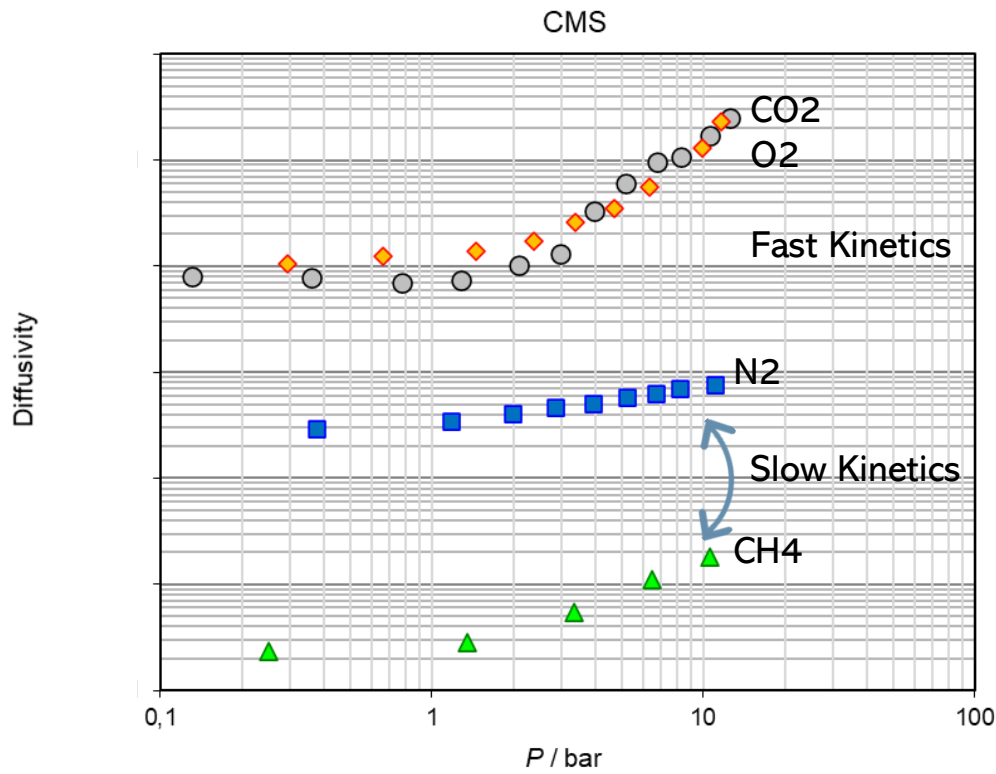


EQUILIBRIUM SEPARATION w/ MOLECULAR SIEVES





KINETIC SEPARATION w/ CARBON MOLECULAR SIEVE



BIOGAS UPGRADING



METHAGEN^{LF}
Landfill Gas Upgrading

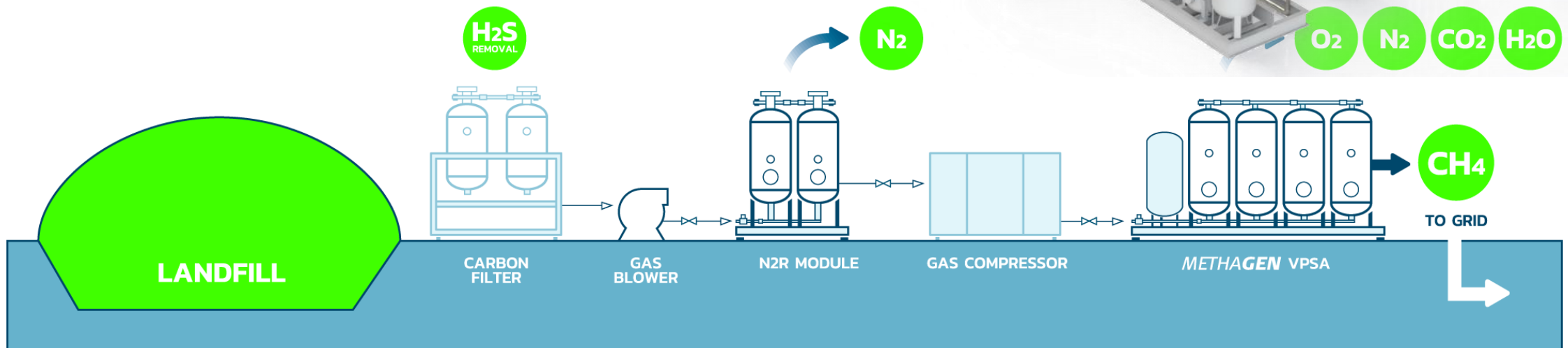


METHAGEN^{LF}

Landfill Gas Upgrading

Patented Process

Rejects up to 19% of Air from Landfill Gas





BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

REFERENCES

METHAGEN AD

- Feedstock: Municipal Organic Waste
- Offtake: Renewable CNG
- Location: Mirandela, Portugal
- Commissioned: 2016
- Capacity: 165 Nm³/h
- Awards: 1st RNG system in Portugal
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas



METHAGEN AD (2- Stage)

- Feedstock: Municipal Organic Waste + Green Waste
- Offtake: Pipeline Quality RNG (SoCalGas)
- Location: Perris, CA, USA
- Commissioned: 2017
- Capacity: 1000 Nm³/h
- Awards: 1st system to meet Rule 30
- Performance: < 2000 ppmv of O₂, High BTU (CH₄ >98,2%)
- Recovery: up to 98%
- OpEx: < 0,03 kWh/Nm³ of RNG





BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

REFERENCES

METHAGEN LF (2-Stage)

- Feedstock: Landfill Gas
- Offtake: Pipeline Quality RNG
- Location: Paris, France
- Commissioned: 2018
- Capacity: 500 Nm³/h
- Awards: 1st (non-cryogenic) pipeline RNG system in France.
- Patented technology
- Performance: > 96.7% CH₄
- Recovery: up to 98%
- OpEx: 0,32 kWh/Nm³ of Landfill Gas



METHAGEN LF (2-Stage) + CO₂ Recovery

- Feedstock: Wastewater sludge
- Offtake: Pipeline quality RNG
- Location: Portland, Oregon, USA
- Installed: 2019
- Capacity: 1500 Nm³/h
- Awards: 99,9% CH₄ recovery (w/ CCUS)
- Performance: > 98% CH₄, < 0.2% O₂
- Recovery: 99.96%
- OpEx: < 0,03 kWh/Nm³ of RNG





BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

REFERENCES

METHAGEN AD

- Feedstock: **Agricultural Waste**
- Offtake: **Pipeline Quality RNG**
- Location: **Prémery, France**
- Commissioned : 2020
- Capacity: 250 Nm³/h
- Awards: 1st of six plants same client
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas



METHAGEN LF (2-Stage)

- Feedstock: **Landfill Gas (with ≤20% Air)**
- Offtake: **Renewable CNG + Pipeline quality RNG**
- Location: **Granada, Spain**
- Commissioned: 2021
- Capacity: 500 Nm³/h
- Awards: 1st landfill project for CNG mobility in Spain
- Patented technology with highest N₂ reduction
- Performance: > 96% CH₄
- OpEx: 0,30 kWh/Nm³ of Landfill Gas





BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

REFERENCES

METHAGEN AD

- Feedstock: Wastewater Sludge
- Offtake: Renewable CNG
- Location: Boden, Sweden
- Commissioned: 2022
- Capacity: 500 Nm³/h
- Awards: Indoor Installation (60 miles from Artic circle)
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas



METHAGEN AD

- Feedstock: Wastewater Sludge
- Offtake: Renewable CNG Fueling
- Location: Lisbon, Portugal
- Commissioned: 2022
- Capacity: 500 Nm³/h
- Awards: 1st methanation plant in Portugal
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas





BIOGAS UPGRADING

METHAGEN AD
Anaerobic Digestion

REFERENCES

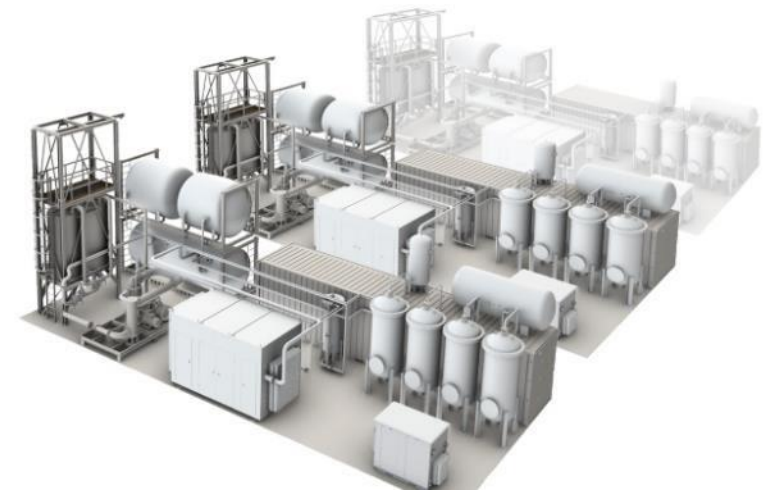
METHAGEN AD

- Feedstock: Potato Processing Waste
- Offtake: Factory Self Consumption
- Location: Turkey
- Commissioned : 2023
- Capacity: 360 Nm³/h
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas



METHAGEN AD

- Feedstock: Chicken Manure
- Offtake: Pipeline Quality RNG @ 17 barg
- Location: Latvia
- To be installed: 1st phase 2023, expansion 2024
- Capacity: 2000 Nm³/h + 1000 Nm³/h
- Awards: Largest Biogas Upgrading system in Latvia
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas





BIOGAS UPGRADING

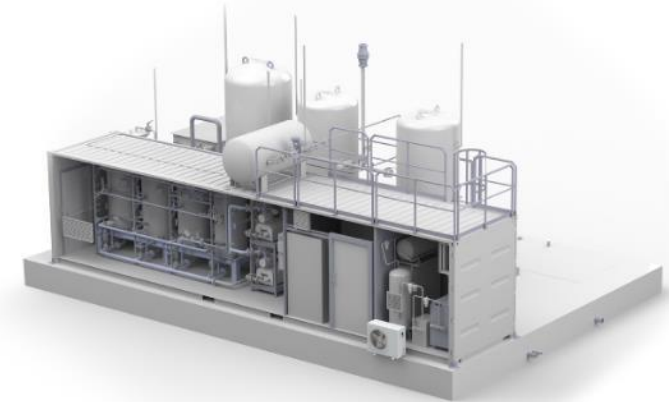
METHAGEN^{AD}

Anaerobic Digestion

REFERENCES

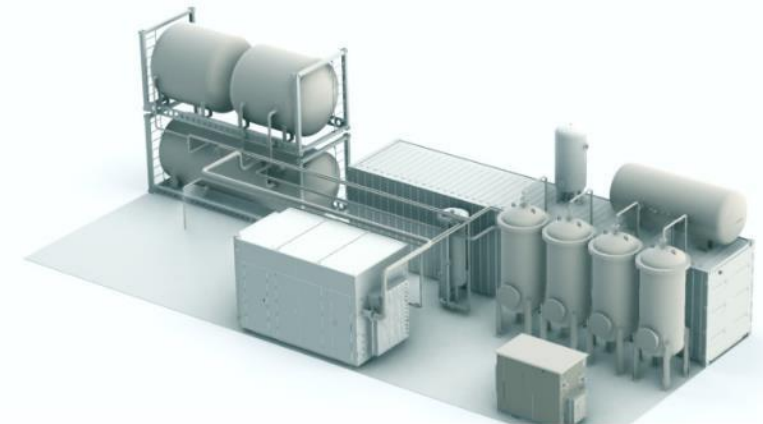
METHAGEN AD

- Feedstock: Dairy Manure
- Offtake: Pipeline Quality RNG
- Location: USA
- To be installed: 2023
- Capacity: 500 Nm³/h
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas



METHAGEN AD

- Feedstock: Dairy Manure
- Offtake: Pipeline Quality RNG
- Location: USA
- To be installed: 2023
- Capacity: 750 Nm³/h
- Performance: > 97% CH₄
- Recovery: > 99%
- OpEx: 0,22 kWh/Nm³ of biogas





BIOGAS UPGRADING

METHAGEN^{AD}

Anaerobic Digestion

Renewable Natural Gas Production w/ METHAGEN^{AD}
Key Performance Indicators

Cleantech

No water
No solvent
No waste

Compliance

Delivered dry
at NG grid pressure
> 6 barg

Sustainability

0,42 kWh/Nm³_{BM}
0,22 kWh/Nm³_{BG}

CH₄ Recovery

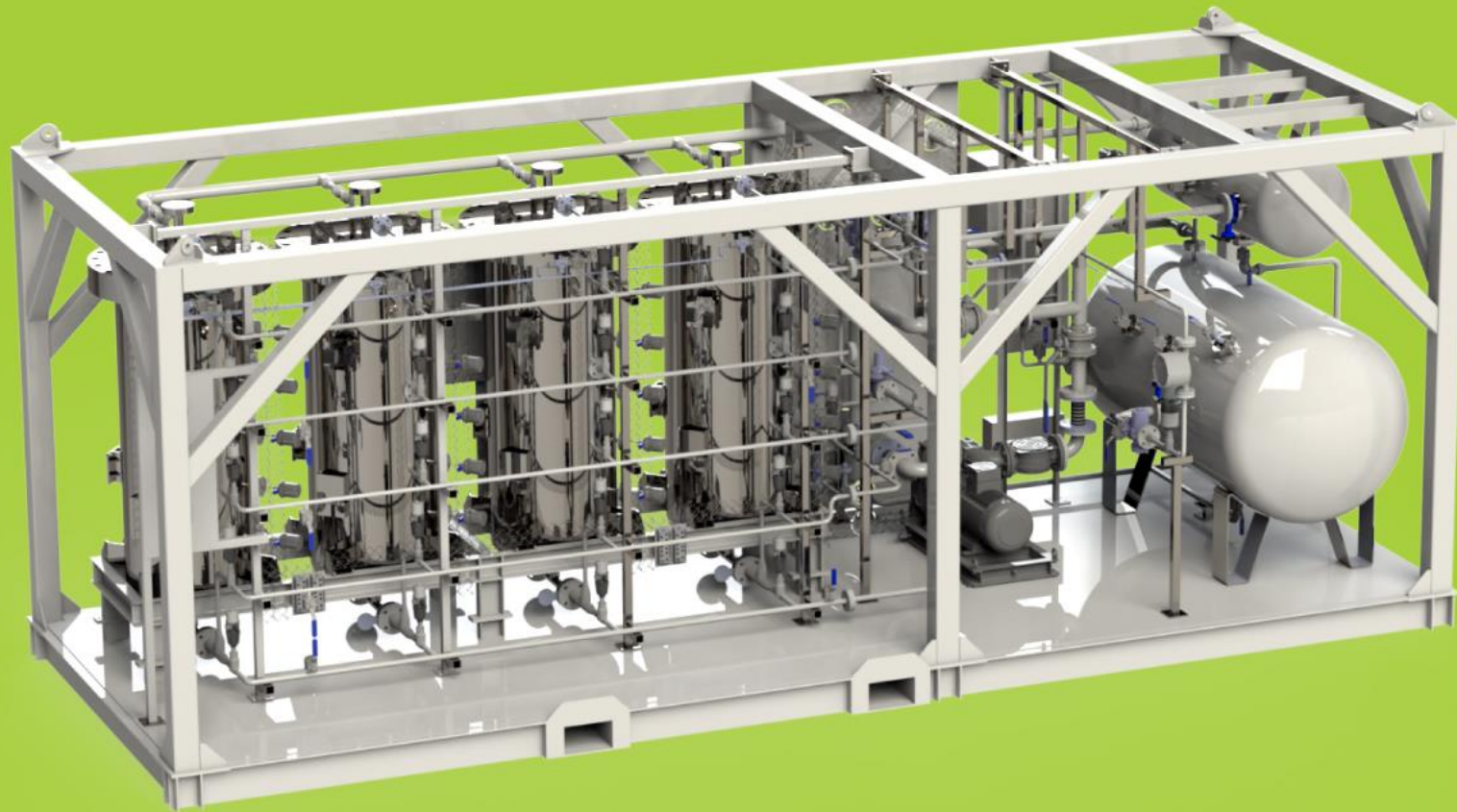
99.5% of CH₄
molecules
into the grid

High Heating Value

99 vol.% CH₄
NG Compatible



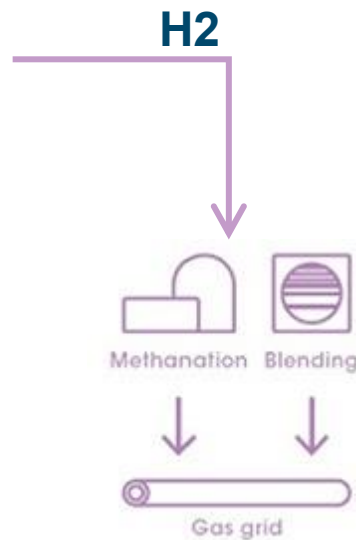
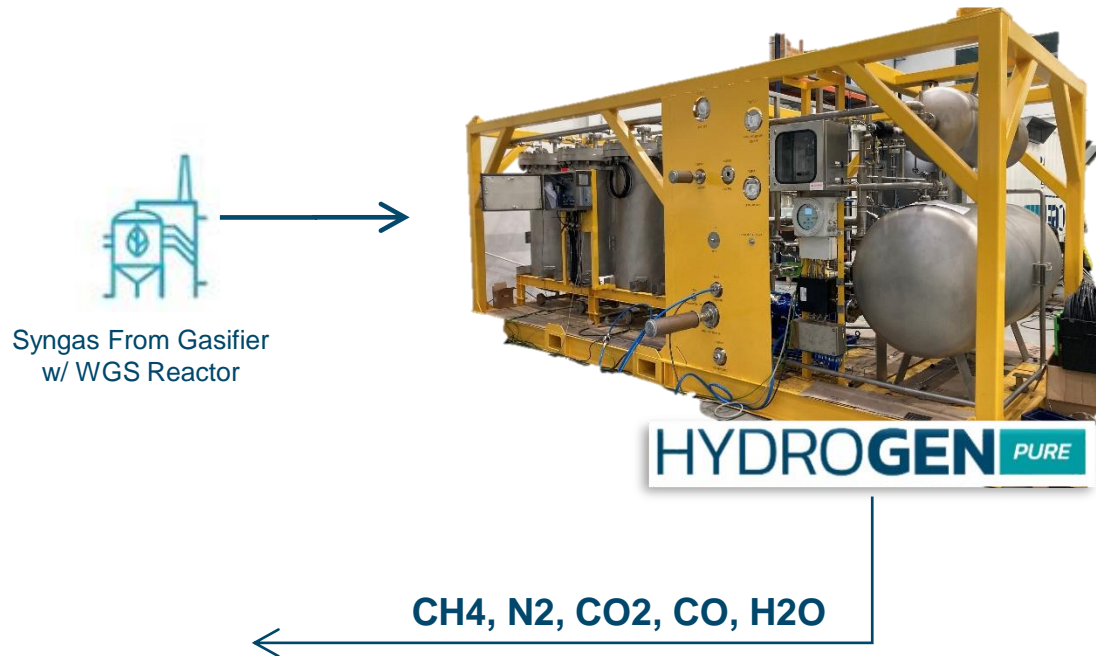
HYDROGEN PURIFICATION



HYDROGEN PURE



HYDROGEN **PURE**



VPSA adsorption unit

Purification of H₂ syngas from WGS reactor outlet deploying H₂ for industrial use:

Inlet: 200 Nm³/h @ 9 barg

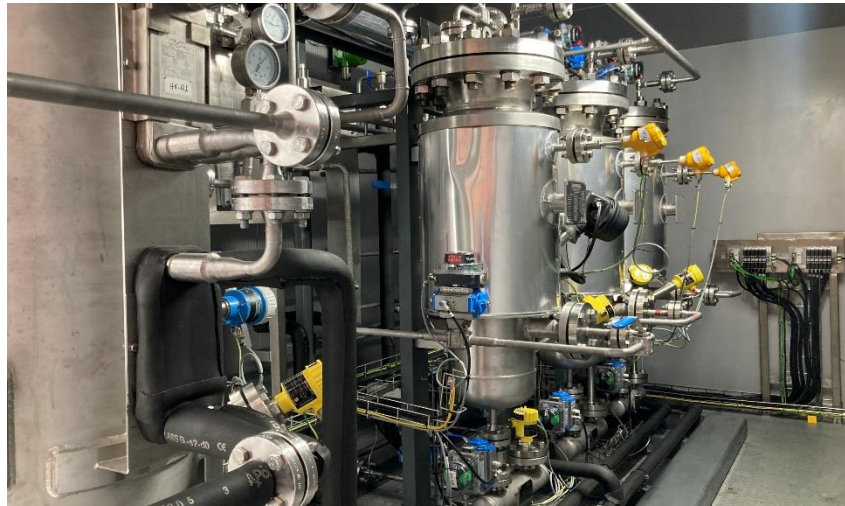
Product: H ₂	> 99.95 vol%
CH ₄	< 100 ppmv
N ₂	< 200 “
CO ₂	< 50 “
CO	< 5 “
H ₂ O	< 50 “

Consumption: < 0,05 kWh/Nm³ H₂

FC Grade: Requires a polishing catalytic step.



HYDROGEN PURE^C



Combined catalytic and adsorption unit
Purification of H₂ from electrolyzers or photo-electrolyzers deploying the highest purity H₂ suitable for fuel cells

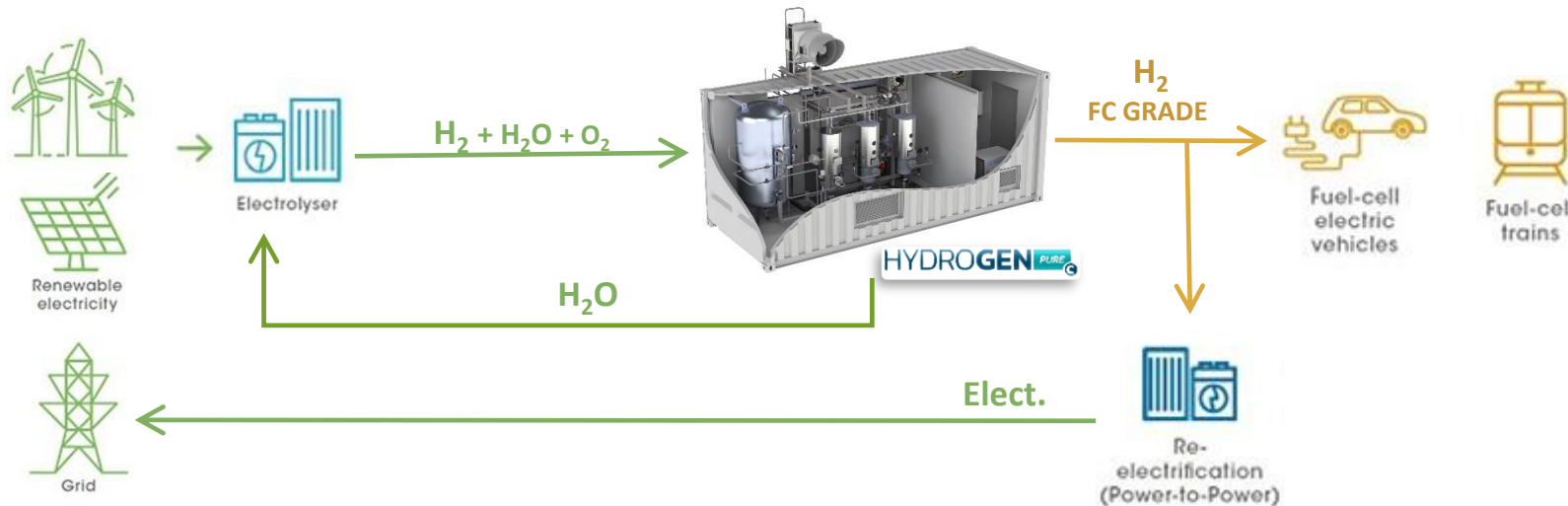
Inlet: 100-200 Nm³/h @ 40 barg
(0.3% O₂ + H₂O saturated @ 40°C)

Pressure: 10 to 40 bar(g)

Product: H₂ > 99.999 vol.%
O₂ ≤ 5 ppmv
H₂O ≤ 3 ppmv

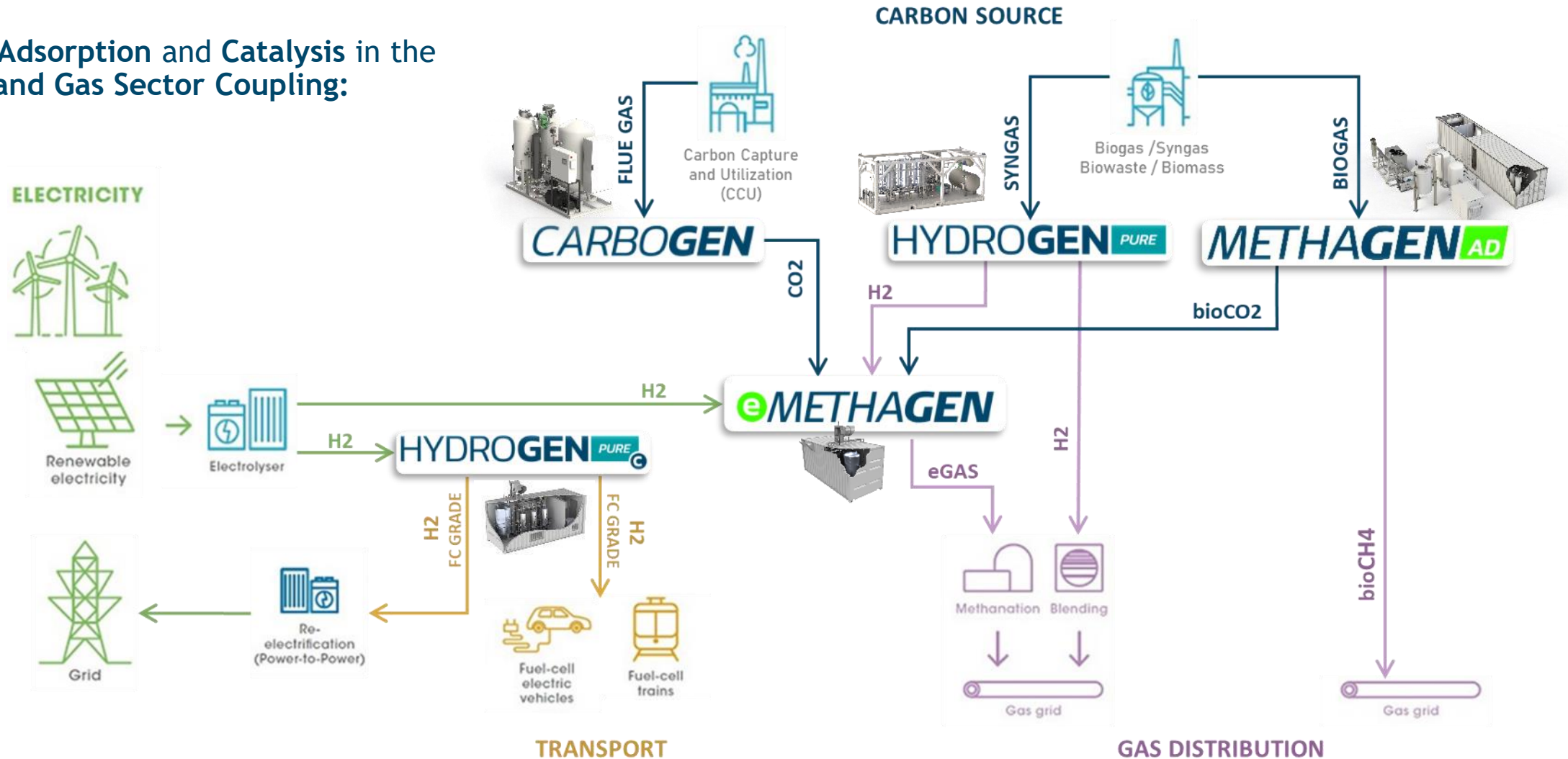
Consumption: < 0,05 kWh/Nm³

Option: Recycling of Condensate





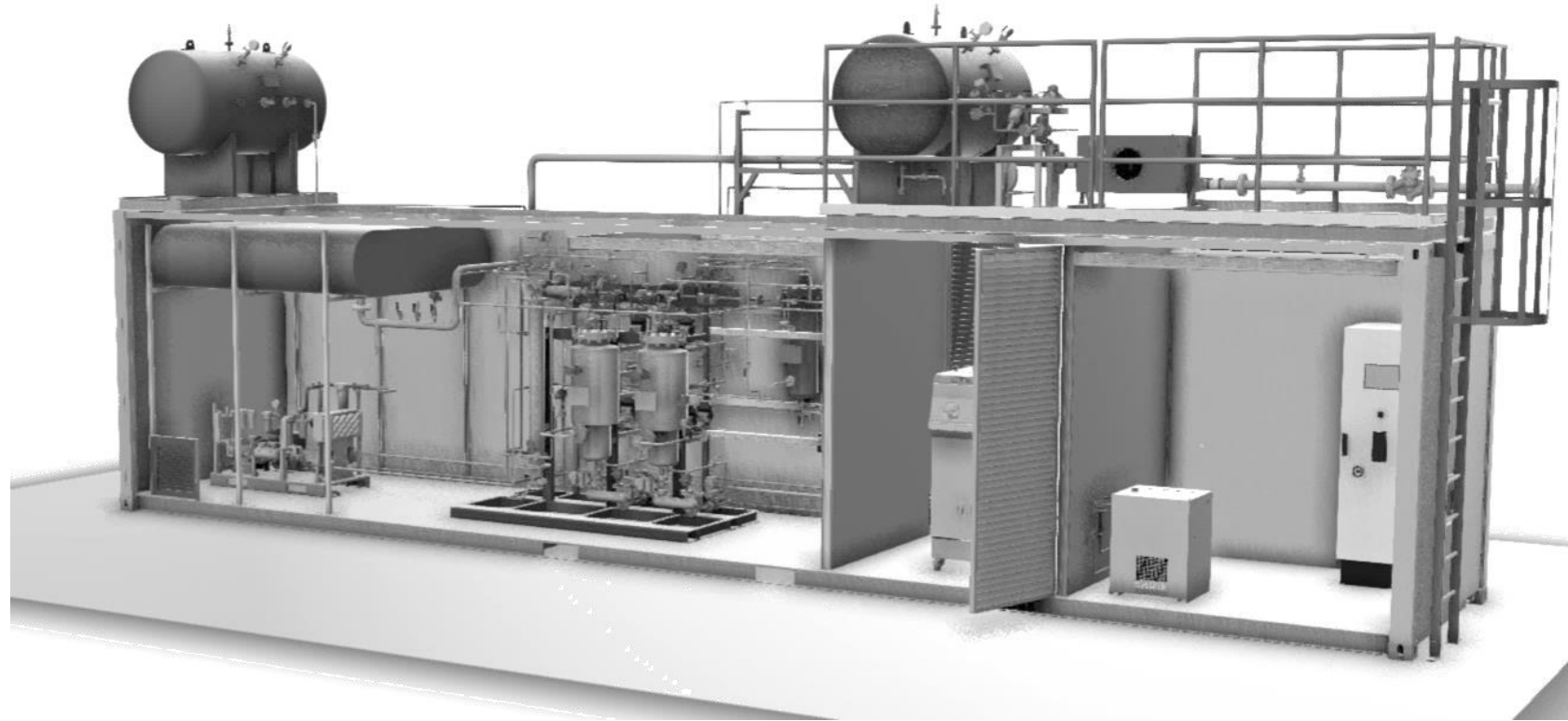
The role of Adsorption and Catalysis in the Electricity and Gas Sector Coupling:





eMETHAGEN

Research & Development:
Product Design Stage





www.sysadvance.com

patrick.barcia@sysadvance.com

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