


5 steps toward a successful biogas upgrading project



Harmen Dekker
Manager Business Development
hdekker@dm-et.nl

Offices places strategically

To serve our customers globally, 24/7

- 
- **Gas treatment specialist** for over 30 years
 - More the 20 years in **water treatment**
 - **Innovative and product leader**
Carborex / Nutritec / Sulfurex /
Turbotec, Bio-LNG, LCO2, Bio-
Methanol
 - **Largest HP membrane**
biogas upgrader
in the world

Total Solutions Provider

Expertise in every step of the way to a successful upgrading project

Finance

Project
Development

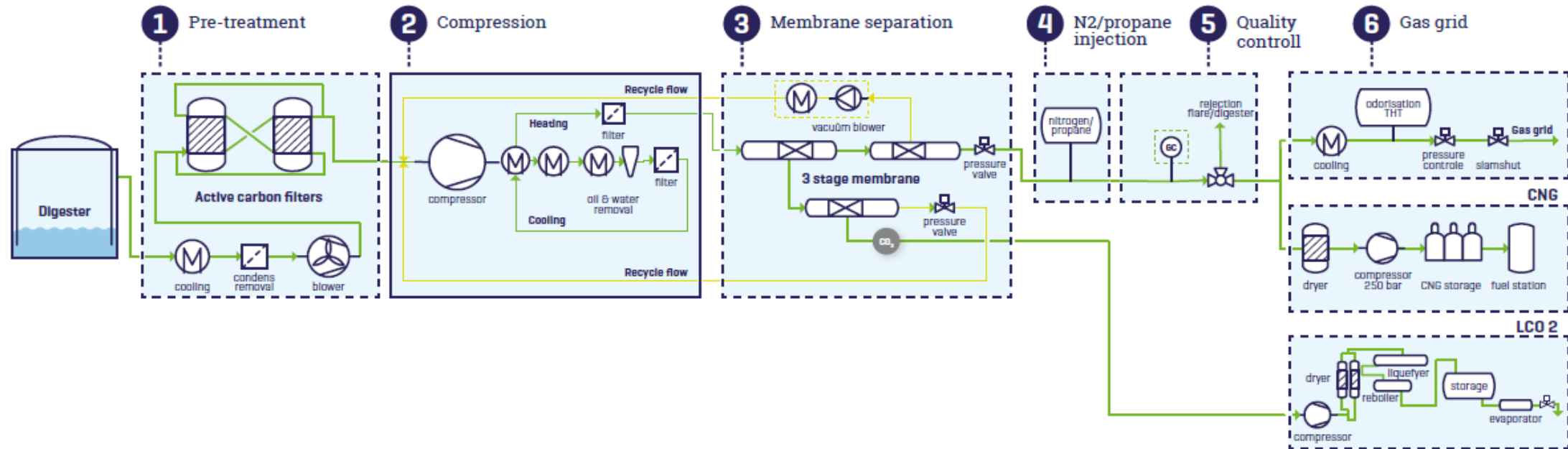
Asset
Management

Bio-Methane
Offtake

Integration

Effective production of Bio-CNG & Bio-LNG

How to make Bio-CNG – year in year out



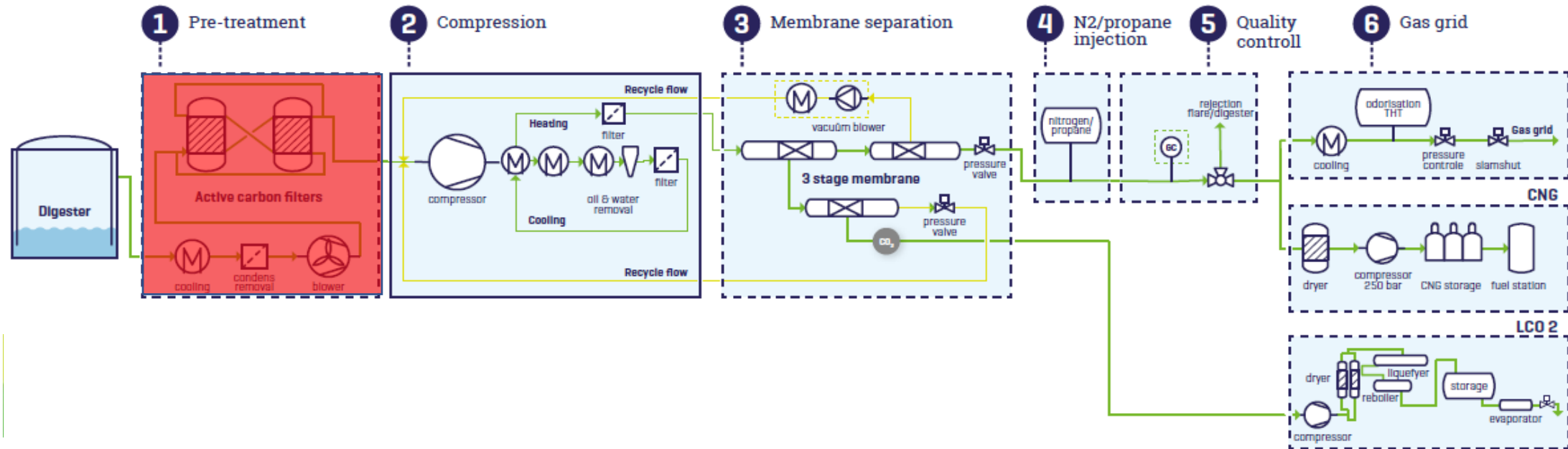
Step 1: maximizing your biogas output

- Quality control feedstock
- Optimizing operations (Asset Mngt)
- THP (Turbotec) for WWTP
- Enzyme addition
- Proper H₂S, NH₃ control



Step 2: know your biogas output

And the importance of pre-treatment



The effect of the gas quality

And the importance of pre-treatment

Biogas composition

Biogas plants	WWTP	Landfills	Agriculture
CH ₄ (%)	50-80	45-70	50-75
CO ₂ (%)	20-50	34-55	25-50
N ₂ (%)	0-3	0-20	0-3
H ₂ O (%)	<1	<1	<1
H ₂ S (ppm)	150-10000	50-900	100-10000
O ₂ (%)	<1	0-5	0-1
CO (%)	<1	<0,5	<1

ANALYSERAPPORT

Blad 3 van 3

Naam monster : Biogas na Gaskoelunit, 28-05-2018 12:25 uur
 Monsternummer : M52255
 Projectnummer : 18-0171 HKW

Resultaat analyses

Component	Concentratie in ppm
Methaan	: 64.6 Mol%
C2 KWS	: <0.001 Mol%
C3 KWS	: <0.001 Mol%
C4 KWS	: <0.001 Mol%
C5 KWS	: 1.3 ppm
C6 KWS	: 1.6 ppm
C7 KWS	: 1.2 ppm
C8 KWS	: 1.1 ppm
Aceton	: 1.4 ppm
Methylethylketon (MEK)	: 1.1 ppm
Benzeen	: 0.1 ppm
Tolueen	: 0.5 ppm
Pineen	: 10.2 ppm
3-Careen	: 1.9 ppm
Cymeen	: 705.2 ppm
D-Limoneen	: 93.5 ppm
Overige Terpenen / KWS	: 29.3 ppm

Bij C5-C8 KWS (koolwaterstoffen) is benzeen, tolueen, THT en MEK niet

Step 3: Choosing the right technology

Carborex[®] MS

Carborex[®] CNG

Carborex[®] LNG

Jevnaker Norway

Carborex[®] MS 400

Choosing the right technology

Let's compare

Strength

- Low heat demand
- No pre-treatment

Weaknesses

- Outsider conditions
- Water consumption
- Polluted water
- Compression of gas
- Operations

Strenght

- High methane recovery rate

Weaknesses

- Amine discharge cost
- High demand for regeneration
- Compression of gas

Strengths:

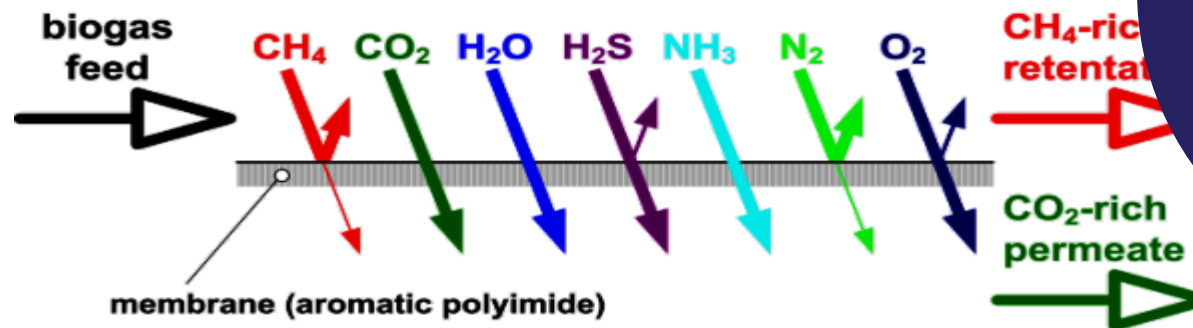
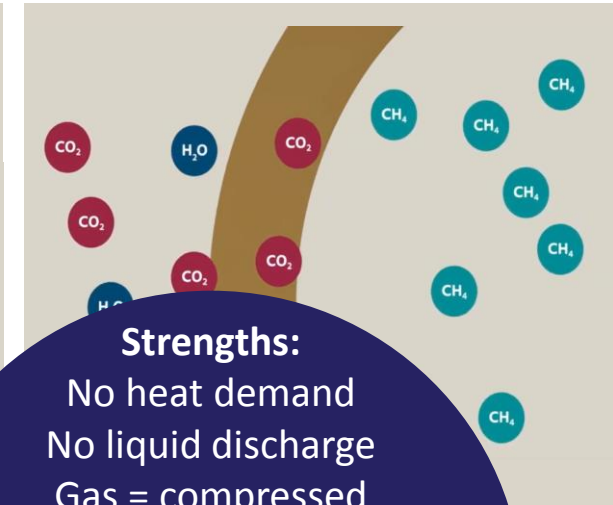
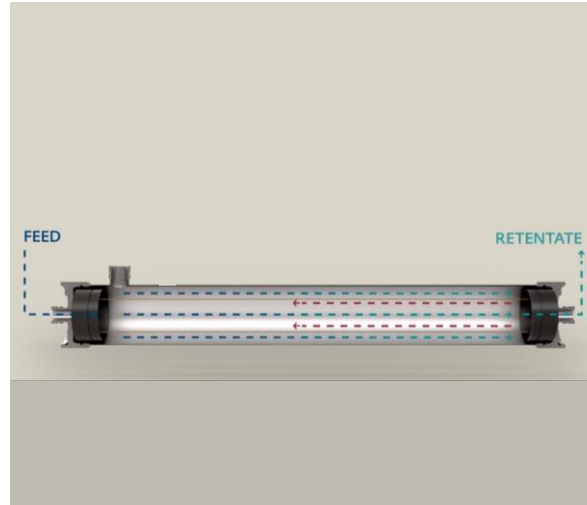
- High flowrate
- No liquid discharge
- Low heat demand

Weaknesses:

- Irreversible H₂S dam.
- High methane slip
- Compression of gas
- Pre-treatment
- Operations

Inside a membrane

Biogas upgrading



Strengths:

- No heat demand
- No liquid discharge
- Gas = compressed
- Easy operation

Weaknesses:

- Reliable pre-treatment
- Quality depends on N₂
- Min CH₄ off-gas 0.5 %

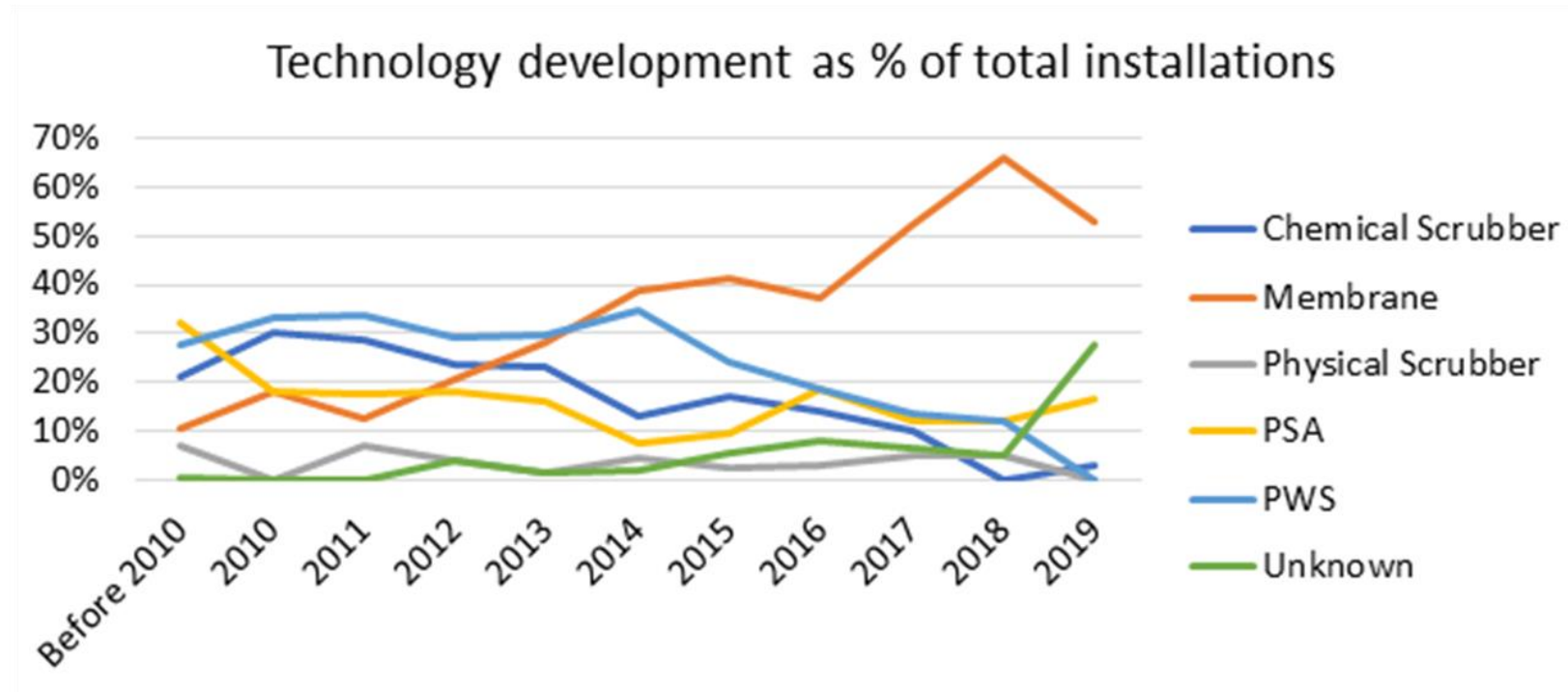
Membrane technology took a flight

Poundbury biogas upgrading – the opening by HRM Prins Charles



Effective production of Bio-CNG & Bio-LNG

Upgrading technologies



Feedstock and gas data					
Total tonnes	20.000	40.000	38.000	80.000	160.000
Feedstock methane percentage	55%	55%	55%	55%	55%
m3 biomethane produced per year	1.485.000	2.970.000	3.355.495	5.940.000	11.880.000
Plant capacity (accounts for load factor - see Plant assumptions)					
m3/ hr biomethane produced	188	377	426	753	1.507
m3/ hr biomethane injected (excludes propane)	154	313	353	633	1.281
Capital costs					
Development costs	£800.000	£1.000.000	£500.000	£1.200.000	£1.300.000
Civil works - digging, concrete	£600.000	£1.000.000	£750.000	£1.600.000	£1.900.000
Feedstock pre-treatment/ storage	£1.000.000	£1.800.000	£650.000	£2.500.000	£2.900.000
Digesters	£2.250.000	£4.000.000	£3.000.000	£7.500.000	£11.500.000
CHP capital cost for provision of electricity	£150.000	£300.000	£325.000	£500.000	£800.000
Biogas upgrading	£1.300.000	£1.500.000	£1.650.000	£2.300.000	£2.500.000
Supplementary food waste biogas upgrading (e.g. VOCs, H2S)	£400.000	£500.000		£750.000	£1.000.000
Propane injection equipment	£140.000	£150.000	£215.000	£160.000	£170.000
Gas measurement and metering	£310.000	£310.000	£320.000	£310.000	£310.000
Grid ROV and telemetry	£210.000	£210.000	£275.000	£210.000	£210.000
Grid connection/ pipework - mid-point/ average (site dependant)	£200.000	£250.000	£300.000	£300.000	£350.000
Land costs	£150.000	£250.000	£200.000	£350.000	£500.000
Digestate storage	£400.000	£600.000	£400.000	£900.000	£1.200.000
Opex required before plant commissioning	£50.000	£75.000	£450.000	£100.000	£150.000
TOTAL CAPEX	£7.960.000	£11.945.000	£9.035.000	£18.680.000	£24.790.000
Annual operating costs					
Insurance	£49.104	£58.668	£51.684	£74.832	£89.496
Propane net cost (after gas sales accounted for)	£25.589	£51.802	£58.526	£104.853	£212.202
Crop feedstocks	£210.000	£420.000	£980.210	£840.000	£1.680.000
Food waste feedstocks	-£100.000	-£200.000		-£400.000	-£800.000
Farm waste feedstocks	£20.000	£40.000	£49.970	£80.000	£160.000
Staff and maintenance annual average:	£800.000	£1.100.000	£425.000	£1.500.000	£2.200.000
Supplementary food waste biogas upgrading maintenance	£100.000	£150.000		£200.000	£250.000
Legal and professional fees	£20.000	£30.000	£30.000	£40.000	£50.000
Digestate handling/ disposal cost	£87.500	£175.000	£220.000	£350.000	£700.000
Landfill costs	£31.500	£63.000		£126.000	£252.000
Contingency	£98.414	£151.910	£136.154	£239.226	£400.627
TOTAL OPEX	£1.342.108	£2.040.380	£1.951.544	£3.154.911	£5.194.325
Results					
m3/ hr biomethane injected (excludes propane)	154	313	353	633	1.281
Project IRR (before tax)	15,8%	16%	17%	16%	16%
Equity IRR (following debt repayment and tax)	14%	14%	15%	14%	14%
RHI required	£182	£130	£97	£90	£63

Step 4: Economical operation

Economical aspects to a successful project

400000

Busting a Myth

Economical aspects to a successful project

350000

300000

250000

200000

150000

100000

50000

0

- CAPEX vs IRR
- Economic Lifetime analyses
- Biogas output

methane slib 0,5 - 2,5%

Specific power consumption 0.2 - 0.3 kWh/Nm3

Investment price 3-4 Mi \$

Gas to Grid time Gas to grid 85-98%



Step 5: Offtake & Integration



The enormous untapped potential



Agriculture



Municipal
Solid Waste



WWTP



Industry

What's next?

The development of the AD & biogas industry

- Green Gas increasingly important
- Trading
- Bio-LNG
- CO2 reduction and total foot print
- Methanol / DME / ... production
- Negative CO2 trading
- Fertilizer displacement



Our challenge is
to **create** the **clear** and **prosperous**
future

