Biomethane – technical and financial aspects

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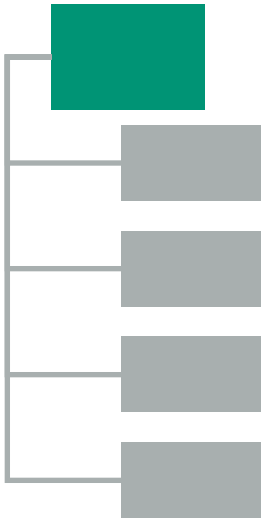
National info day Poland

8th of October 2013, Poznan

Proto type MEA-wash from Köhler & Ziegler in Schwandorf, Germany
Quelle: Schmack

Fraunhofer UMSICHT

Agenda



- FhG and Fraunhofer UMSICHT
- Status quo in Europe
- Overview on upgrading technologies
- Financial aspects
- Summary

Fraunhofer-Gesellschaft

- One of the leading research organizations in Europe
- 60 institutes at 40 locations in Germany
- Offices in USA, Japan, China, Korea etc.
- Fraunhofer UMSICHT in Oberhausen
  - Research fields in environmental technology, material technology, process technology and renewable energy
  - founded in 1990
  - Approx. 25 mio€ turnover in 2012
  - approx. 450 employees

Fraunhofer UMSICHT
Portfolio in Biogas Technology

- Research topics
  - Process monitoring and optimisation of fermentation
  - Public acceptance of biogas plants / renewable energy sources
  - Biogas purification and upgrading
  - Feed-in of biogas into natural gas grids
  - Biomethanation – power to gas
- Feasibility studies and expertises (substrate supply, economic efficiency, climate balance etc.)
- Analysis of substrates and products of fermentation
- Realisation of continuous laboratory scale fermentation processes
- Design and construction from laboratory scale to pilot and demonstration plants

Biogas and biomethane production

Status quo in European countries

Country	Biomethane plants	Biomethane plants feeding the grid	Biogas plants total (incl. LFG, sewage, agricult.)	Agricultural	Biowaste (incl. organic MSW)	Sewage	LFG
Austria	**10**	7	**503**	approx. 300	55	134	14
Croatia	**-**	-	**12**	9	-	2	1
France	**3**	1	**269**	40	98	60	71
Germany	**132**	130	**9.500**	approx. 7.700	100	1.700	
Hungary	**1**	-	**58**	36	-	14	8
Italy	**-**	2	**1.300**	approx. 1000	32	60	220
Netherlands	**15**	15	**130**				
Poland	**-**	-	**219**	30	2	approx. 200	
Slovakia	**-**	-	**57**	34	4	10	9
UK	**2**	2	**360**	60		100	> 200
Sweden	**47**	11	**242**	26	26	135	55
Switzerland	**17**	15	**600**	140		460	
TOTAL	**227**	**183**	**13.250**				

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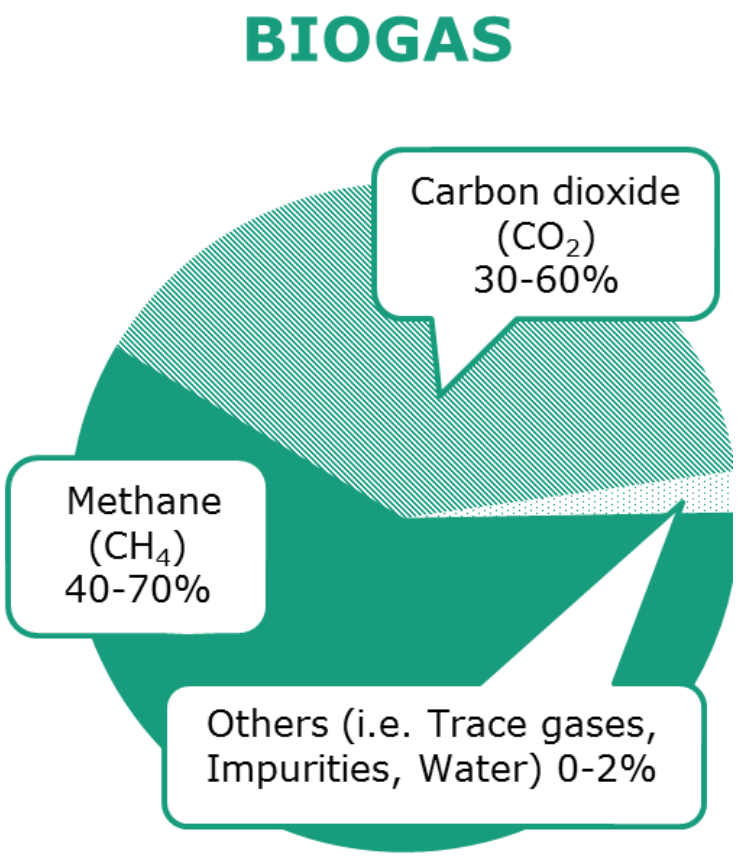
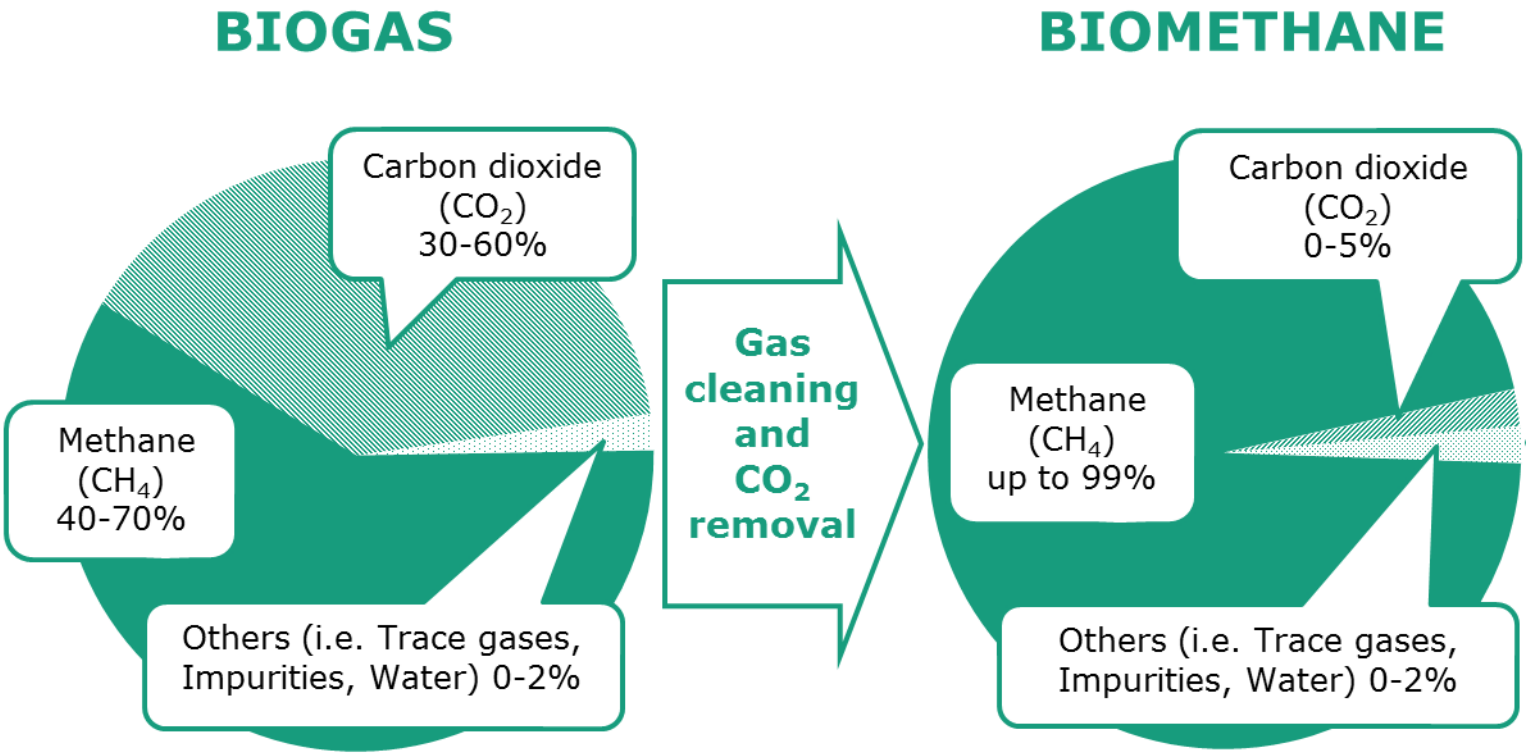
Overview on upgrading technologies
From Biogas to Biomethane



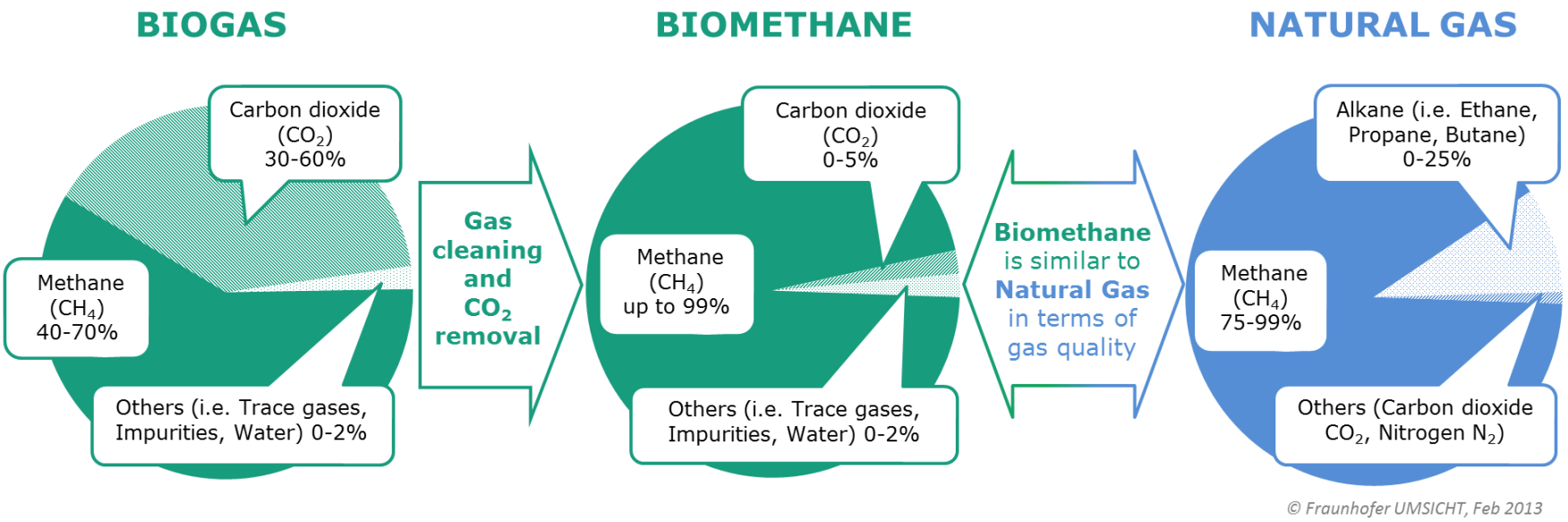
Overview on upgrading technologies

From Biogas to Biomethane

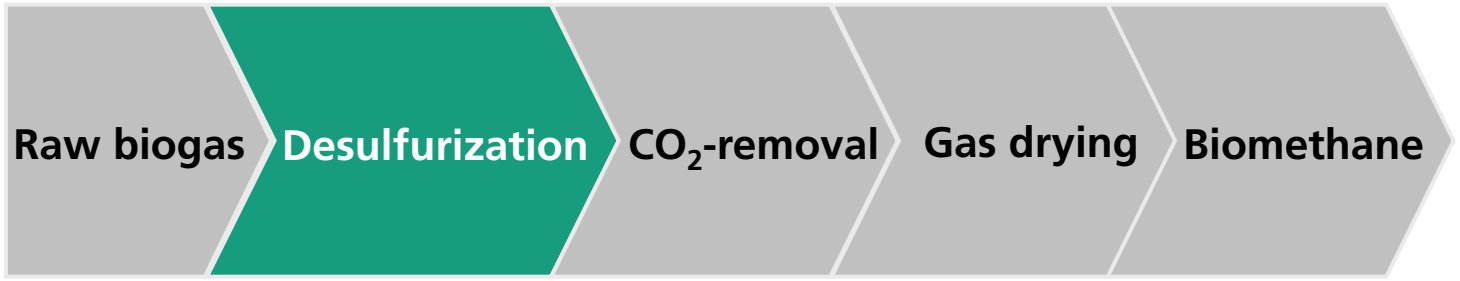


Overview on upgrading technologies

From Biogas to Biomethane



Overview on upgrading technologies
Desulfurization



Rough desulfurization

Biological treatment
Scrubber + external regeneration, air dosage (N_2!)

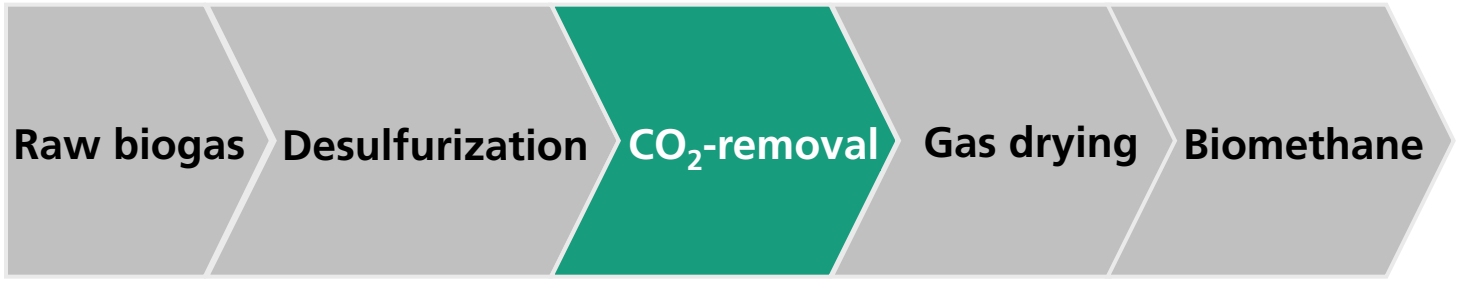
Sulfide precipitation
Fe(II)Cl_2, FeOH

NaOH scrubber

Fine desulfurization

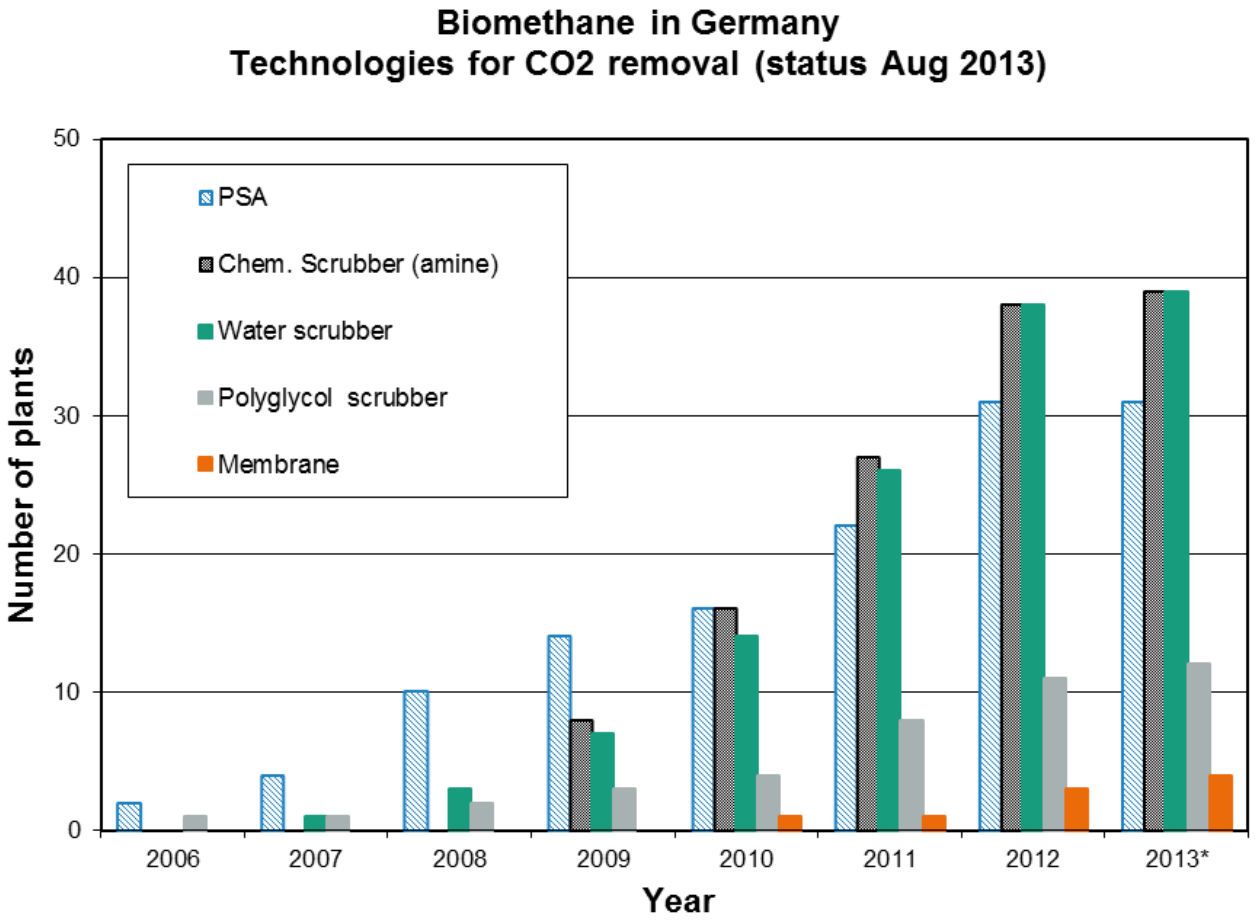
Activated carbon

Overview on upgrading technologies
CO_2-removal

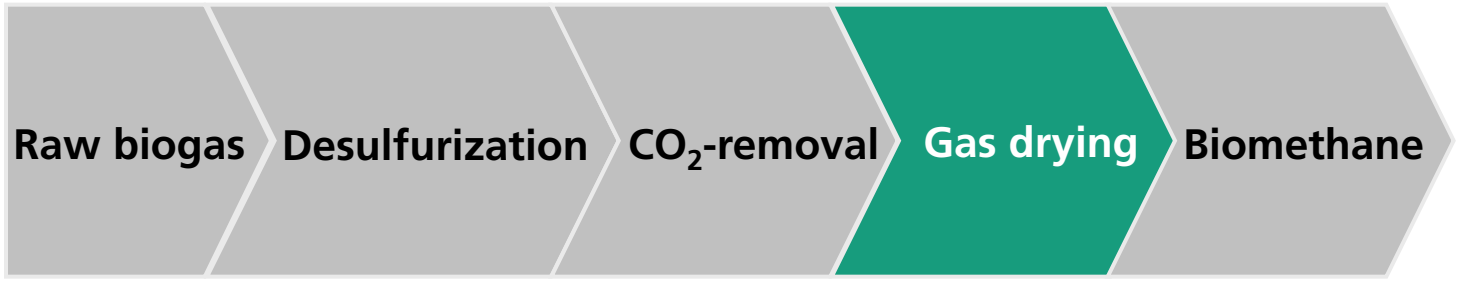


- Adsorption
- Absorption
- Gas separation with membranes
- Cryogenic technology

Overview on upgrading technologies
CO_2-removal



Overview on upgrading technologies
Gas drying



Condensate removal when gas cooling

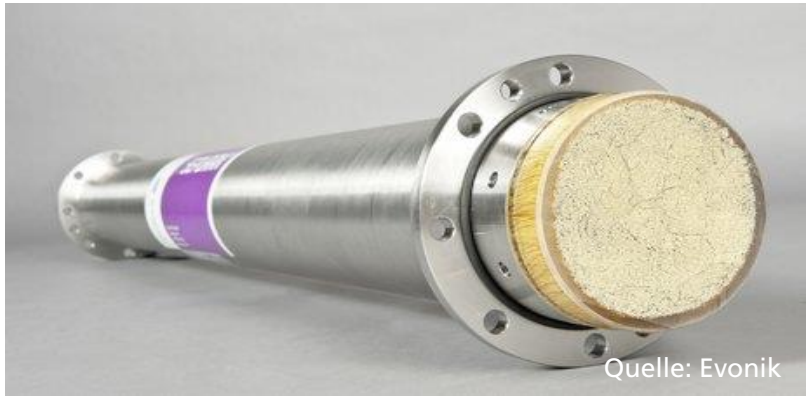
Adsorption at silica gel

Overview on upgrading technologies
Examples


Amine scrubber (Dreyer & Bosse)


Pressurized water scrubber (Malmberg)

Overview on upgrading technologies
Examples



Overview on upgrading technologies
Flue gas treatment

- Methane has a GHG potential of 25!
- Methane loss is to be avoided, flue gas with methane concentrations is to be treated
- Available technologies:
  - Thermal oxidation
  - Catalytic oxidation
  - Regenerating-thermal oxidation
  - FLOX-burner


Quelle: Fraunhofer UMSICHT


Quelle: Fraunhofer UMSICHT

Overview on upgrading technologies

Summary

Criteria	PSA	Water wash	Polyglycol scrubber	Amine scrubber	Membrane technology	Hybrid Membrane/ Cryogenic
Fine desulphurization of RBG required	Yes	No	Recommended	Yes [a)]	Yes	Yes
Methane slip [% of RBG] [b)]	<3%	1-2%	1-2%	< 0,1%	0,6-3%	0,004%
Operation pressure [bar]	4-7	5-10	4-7	0-5	5-16	Membrane: 6-10 Cryogenic:17
Electricity consumption [kWh/Nm³ RBG] [d)]	0,19-0,26 [e)]	0,2-0,25 [e)]	0,24-0,33	<0,09	0,2-0,3	0,35-0,37 [c)]
Heat demand (temperatur level)	No	No	Yes (55-80 °C)	Yes (110-160 °C) [e)]	No	No
Demand for chemicals	No	No	Yes	Yes	No	No
References in Germany (ca.) (Aug 2013)	31	39	12	39	3	0

a) dependent on type of amine

b) methane loss strongly dependends on plant set up and mode of operation. The figure refers to minimum values at realised plants in praxis.

c) energy recovery from CO2 condensation

d) at biomethane capacity 700 Nm³/h, ambient temperature of 15°C, Methan concentration in RGB 55%, residual concentration CO2 in biomethane <3%, Data obtained from suppliers of upgrading technology

e) dependent on operation pressure

RBG - raw biogas

Status August 2013

Overview on upgrading technologies

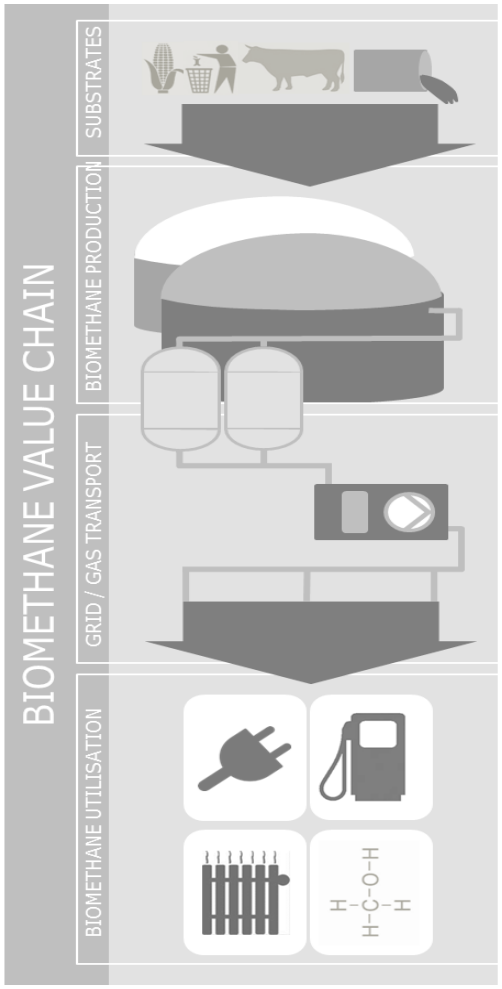
Technology suppliers

(Examples! No claim to be complete)

PSA	Cirmac Mahler AGS	ETW Energietechnik Vissmann CarboTech
Chem. Scrubber (amine)	Cirmac Bilfinger Berger Industrial Services Dreyer & Bosse	MT Biomethan Dr. Günther Engineering (DGE)
Water scrubber	Malmberg Ros Roca / YIT	Greenlane Biogas / Flotech
Polyglycol scrubber	Haase Energietechnik	Schwelm Anlagentechnik
Membrane	Bioenergy International (BDI) / Axiom Eisenmann AG (Evonik) Methapower (Evonik) Pentair Haffmans	Cirmac Envitec Biogas (Evonik) MT Biomethan (Evonik)

Technical aspects

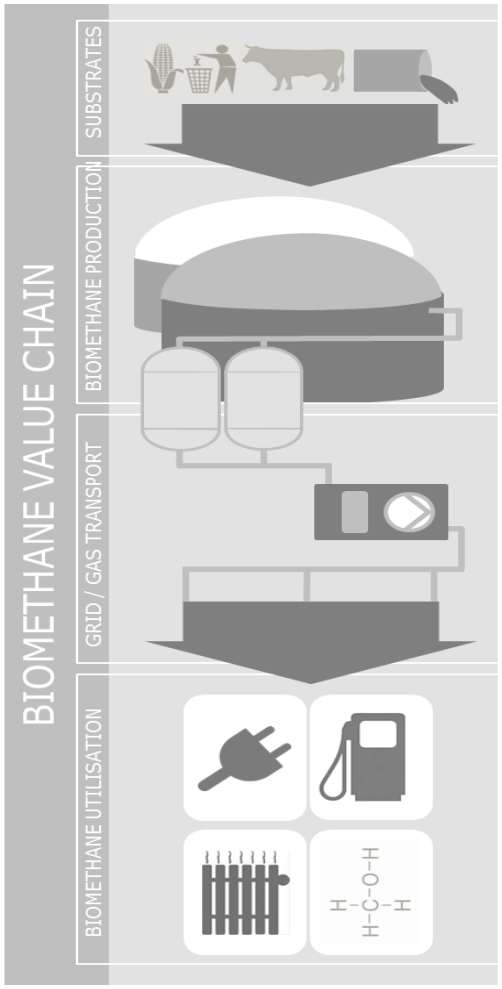
Synergies for increasing energy efficiency



- Raw gas production
  - Heat demand (fermenter heating, drying digestate etc.)
- Requirements and outputs of the upgrading stage
  - Heat demand
  - Provided pressure level product gas
  - Provided CV
  - Heat provided by lean gas treatment
- Requirements grid connection
  - MOP
  - Required CV (L-/H-gas net)

Financial aspects

Costs aspects along the biomethane production chain



- Substrates (e.g. waste collection, energy cropping)
- Raw biogas production (gas pre-treatment, digestion, digestate disposal)
- Biogas upgrading
- Grid connection and injection (CV adjustment, compression, odorization)
- Biomethane trade (balancing, certification, biomethane register)

Summary

- Technology is available and proven at more than 180 feed-in plants throughout Europe
- Different types of technologies exist, but site conditions matter for choosing the appropriate technology and grid injection concept
- Methane emissions must be avoided e.g. by flue gas treatment and appropriate mode of plant operation
- Substrate costs are an important factor → biogas and biomethane must take advantage of their unique property – flexibility

FRAUNHOFER UMSICHT

Research group Biogas

Thanks for the attention!

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