

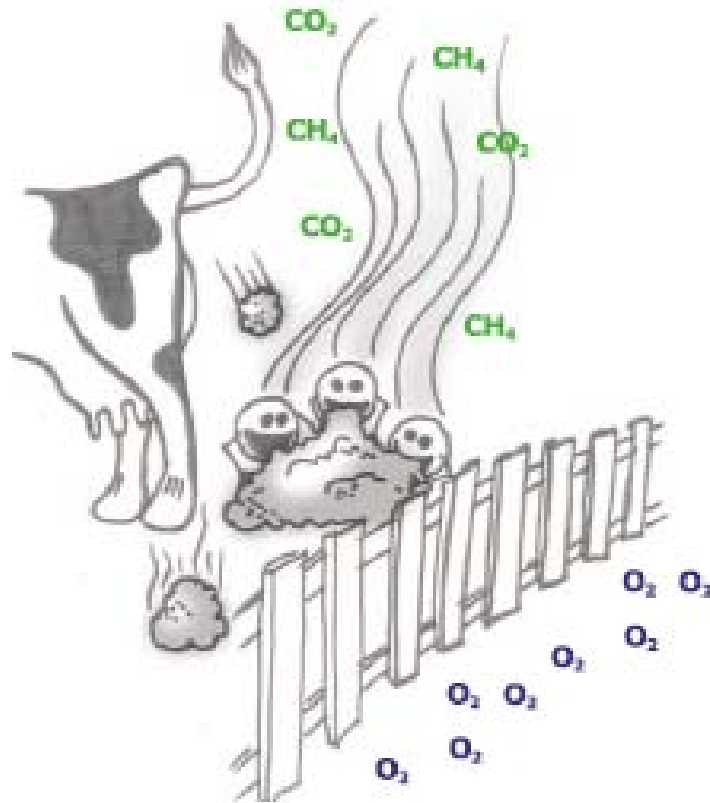
Biomethane: Upgrading, grid injection and vehicle fuel

Arthur Wellinger
Nova Energie GmbH
arthur.wellinger@novaenergie.ch

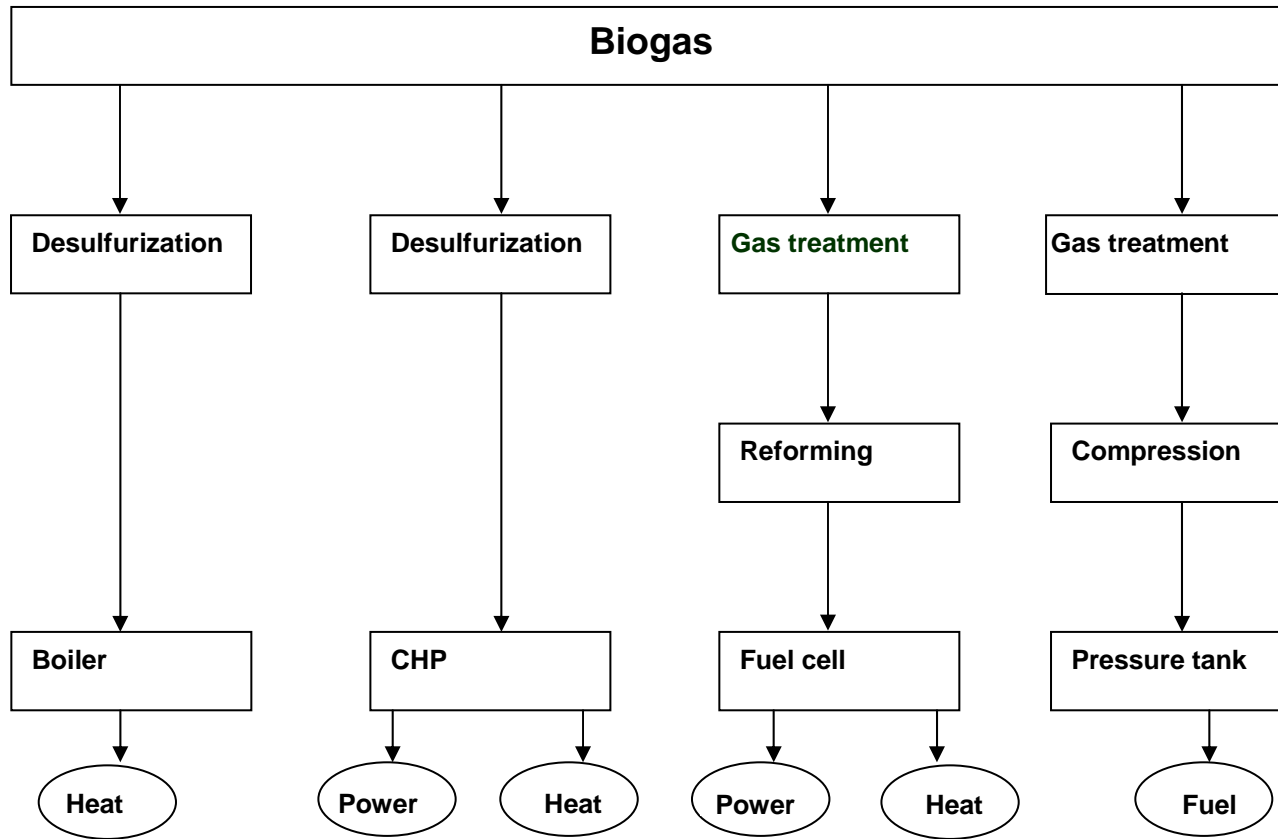
Member countries participating in Task 37: Energy from Biogas and Landfill Gas

Switzerland:	Arthur Wellinger, Nova Energie (Task Leader)
Austria:	Rudolf Braun, Boku
Canada:	Jody Anne Barclay, NR Canada
Denmark:	Jens Bo Holm-Nielsen/ Teodorita Al Seadi Southern Danish University
EC:	David Baxter, JRC Petten
Finland:	Juka Rintala, University of Jyväskylä
France:	Olivier Théobald, ADEME
Germany:	Peter Weiland, FAL
Sweden:	Anneli Petersson, Swedish Gas Center
Netherlands:	Mathieu Dumont, SenterNovem
UK:	Claire Lukehurst

Biogas Production



Biogas Utilisation



Application	H₂S	CO₂	H₂O	Silox- ane
Heating	< 1'000 ppm	no	no	no
Cooking	yes	no	no	no
Engine (CHP)	≤ 500 ppm	no	no conden- sation	yes
High pressure compression	yes	recommen- ed	yes	no
Grid and fuel quality	yes	yes	yes	Event- ually
Hot fuel cells	yes	No	No conden- sation	yes

Gas composition

		Landfill gas	Biogas from AD	North sea natural gas	Dutch natural gas
Lower heating value	MJ/nm ³	16	23	40	31,6
	kWh/nm ³	4,4	6,5	11	8,8
	MJ/kg	12,3	20,2	47	38
Density	kg/nm ³	1,3	1,2	0,84	0,8
Higher Wobbe index	MJ/nm ³	18	27	55	43,7
Methane number		> 130	>135	70	-
Methane	vol-%	45	63	87	81

Biogas Upgrading

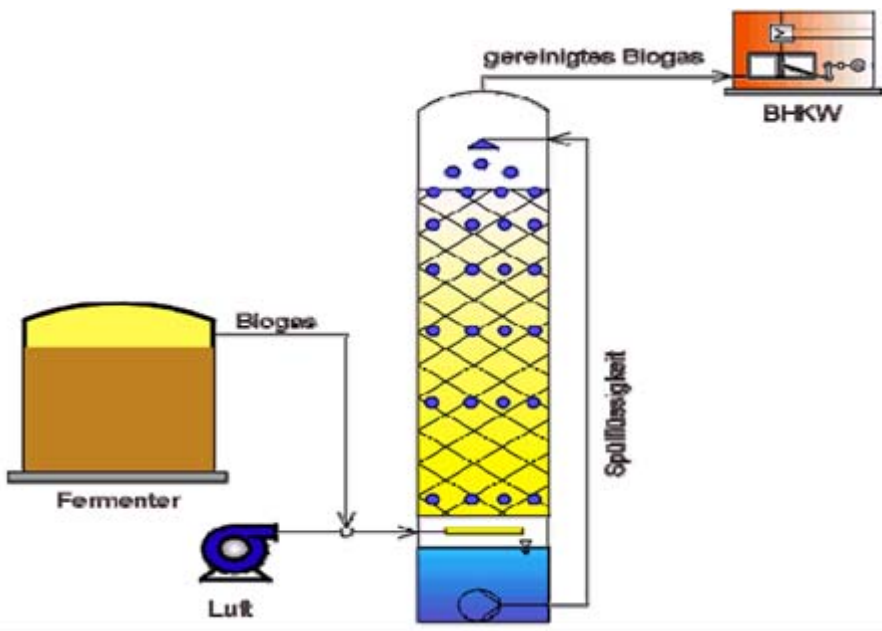
What are the crucial compounds ?

- **Hydrogen sulfide**
- **Water vapour**
- **Carbon dioxide**
- *Siloxanes*
- *Oxygen, nitrogen*
- *Halogenic compounds (Chlorides, Fluorides)*

Hydrogen sulfide removal:

Biological oxidation:

- Air/Oxygen dosing into the digester
- Biological oxidation on a filter bed



Hydrogen sulfide removal:

Chemical/physical removal:

- Iron chloride dosing into the digester
- Adsorption on iron oxide
- Adsorption on activated carbon





CO2 removal with scrubbers: Water washing & chemical absorption



Abs

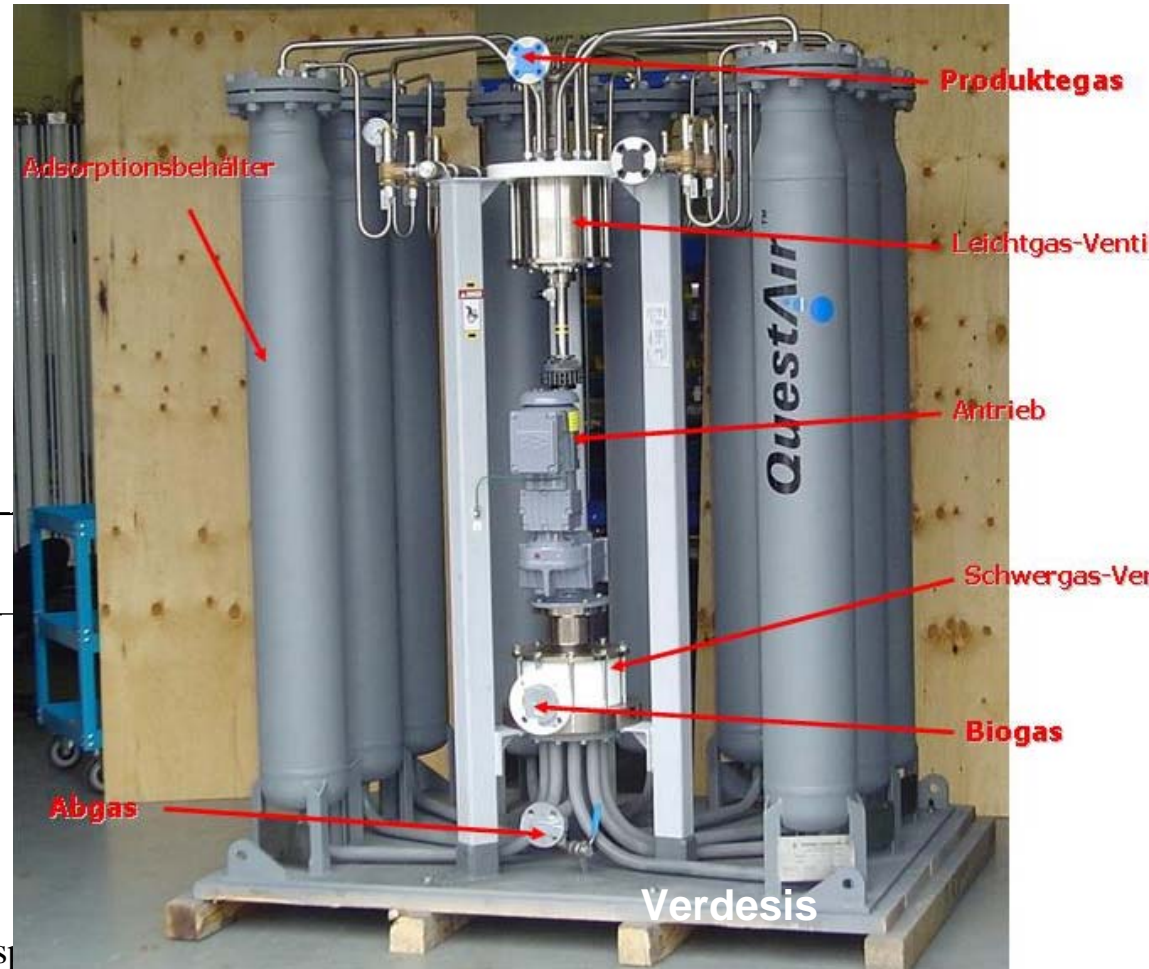
omp

n B

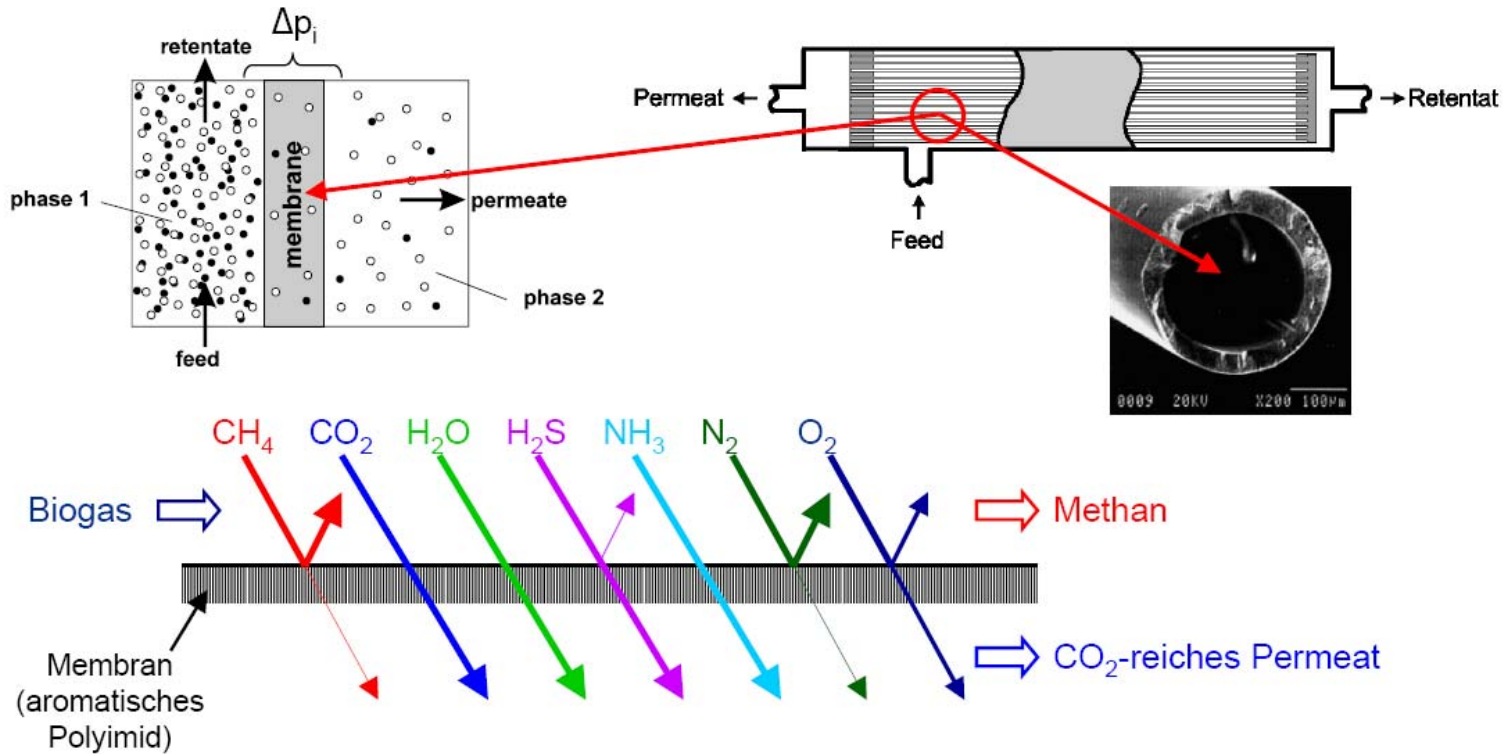
sh

)

PSA with activated carbon



Membrane separation: Low & high pressure



Source: TU Wien

Membrane separation: Low & high pressure



Electricity production



Biomethane as fuel



System for upgraded biogas and



EUROPEAN ALTERNATIVE FUELS POLICY

% Fuel Replacement, Transport Sector, 15 EU Countries by 2020

() = Optimistic

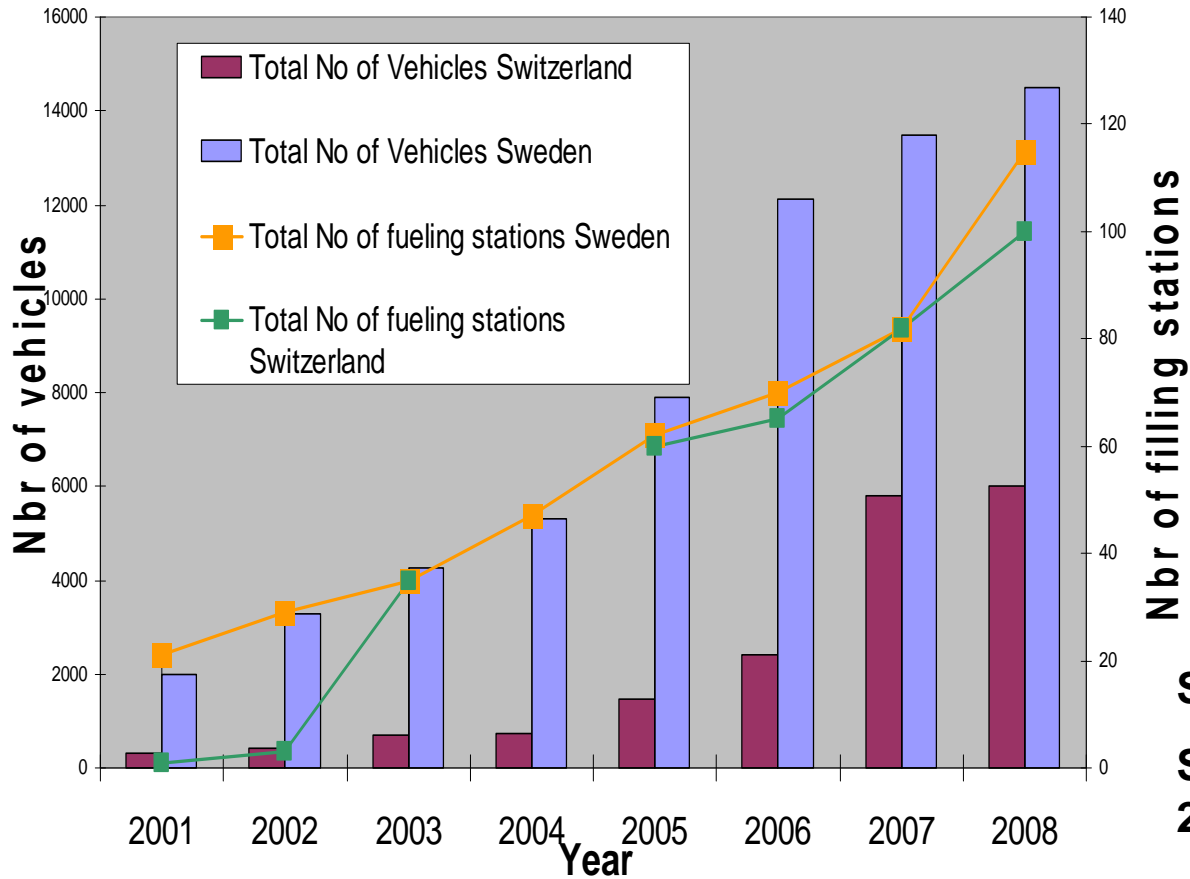
	Biofuels	Natural gas	Hydrogen	Total
2005	2			2
2010	6	2		
2015	(7)	5	2	14
2020	5 (8) 10	10	2(5)	(23)

Biomethane as fuel (Source ENGVA)



**6.4 million methane powered vehicles:
127,000 buses, 113,000 trucks, and 6,200,000 cars running on natural gas or biomethane**










Biomethane in Sweden and Switzerland



Sweden: 51% Biomethane

**Switzerland:
26% Biomethane**

The number of brands and models in Europe

	Passenger cars	Light transporters	Remarks
	2	1	
	3	1	
	11	1	only retrofited
	2	1	
	3	2	only retrofited
	1	1	
	3	0	
 CHEVROLET	3	0	
	0	2	



IEA Bioenergy Task 37



IVECO



VOLVO



Trucks and buses operated on biomethane



MAN



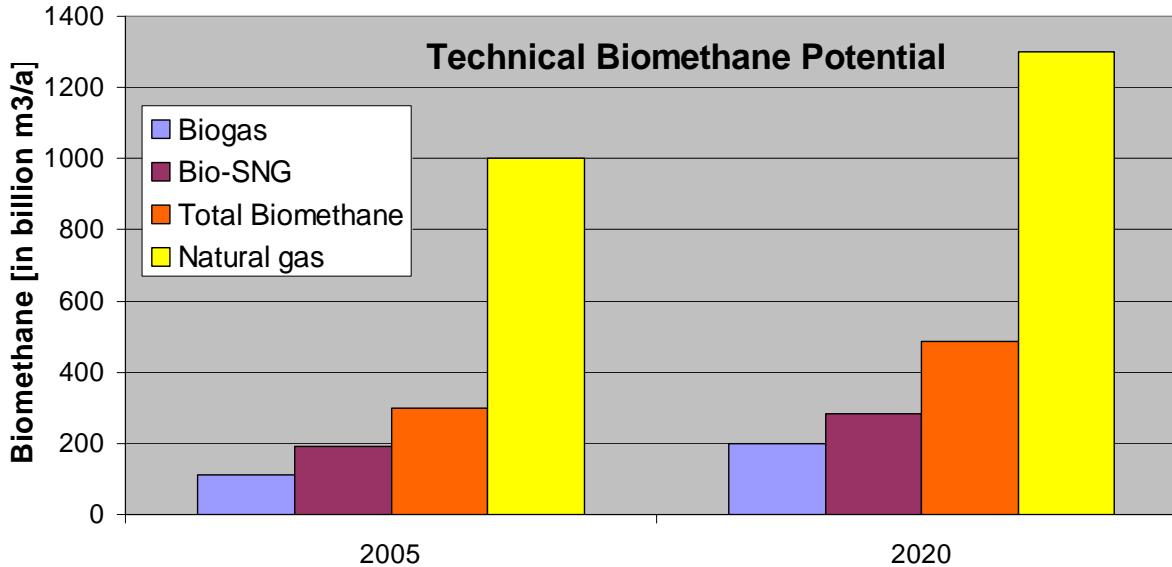
Mercedes-Benz

ation Biofuels 5 Feb 2008



KENWORTH

Biomethane Potential in EU28 plus CIS



Sources: EU Vision report and IEU

The potential is 17.5 EJ corresponding to 37% of gas consumption (approx 100x Germany)

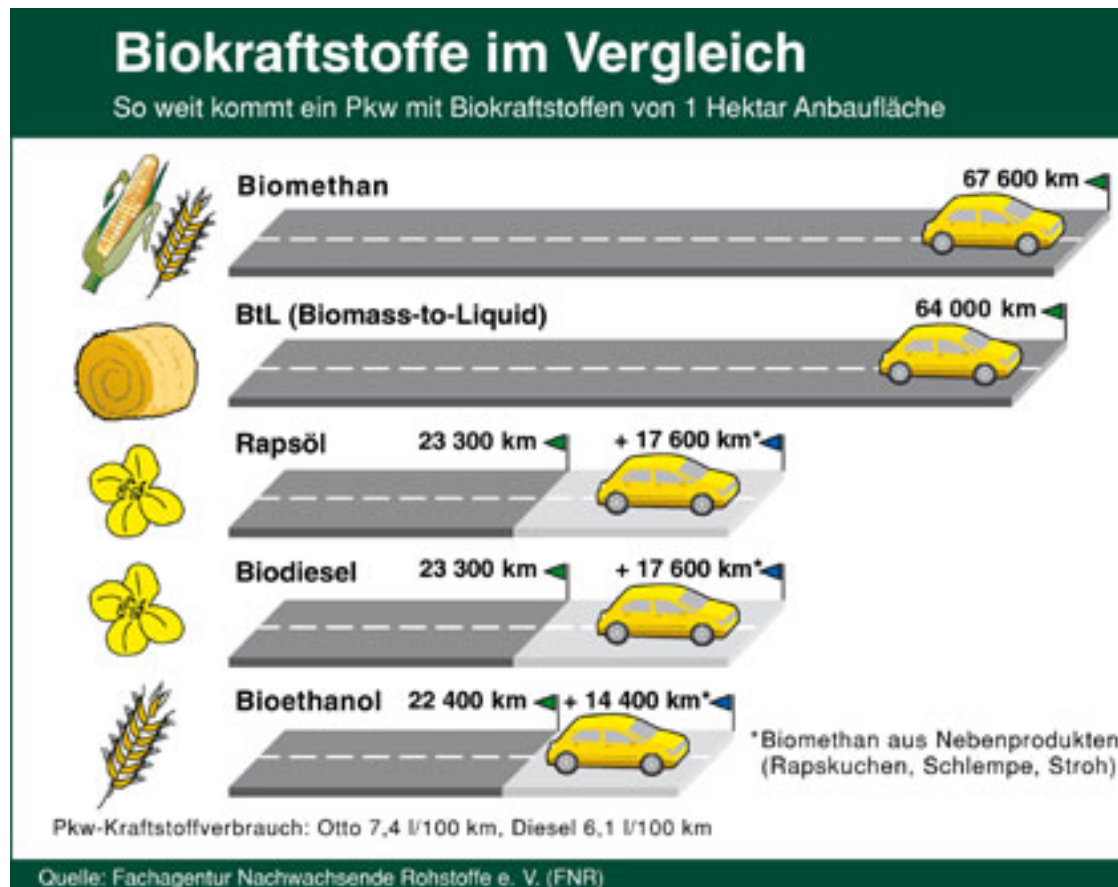
How does biogas compare to other bio-fuels?

Energy yield (Output/Input):

- EtOH from sugar cane (Brasil) 8.6-10.0
- EtOH from maize (USA) 1.34
- RME (Germany) 2.2 - 3.7
- Biomethane from Gras (D) 3.6 – 5.7
- Biomethane from maize (D) 3.3 - 4.2

Comparison of different bio-fuels

How far can a car run with different biofuels produced on 1ha of land

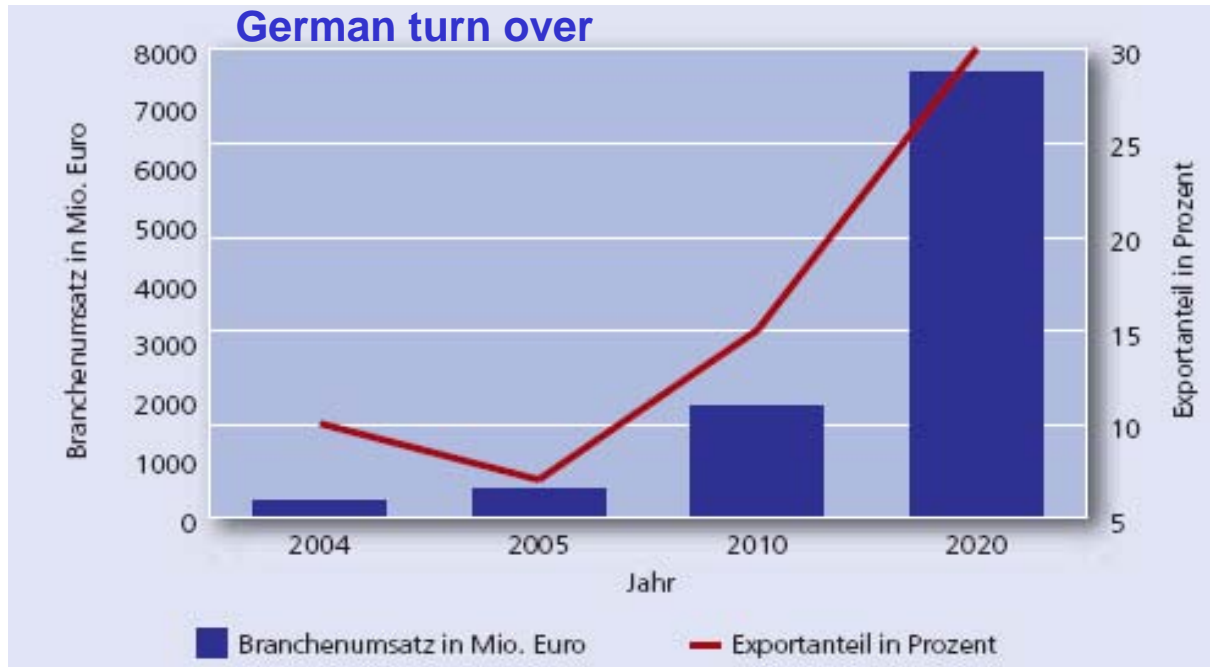




Emissions of biofuel powered vehicles

Vehicle	Fuel	CO2 Emissions, G/KM
Fiat Punto 5-d 1,2 60 Bi-Power	Biogas	9
VW Golf Variant BiFuel 2,0	Biogas	11
Opel Astra CNG	Biogas	11
Volvo S60 2,4 Bi-Fuel	Biogas	12
Opel Zafira 1.6 CNG	Biogas	12
Volvo S80 Bi-Fuel CNG	Biogas	12
Volvo V70 Bi-Fuel CNG	Biogas	13
Mercedes E200 NGT sedan	Biogas	14
Ford Focus 1,8 FlexiFuel	E85 (Ethanol)	54
Saab 9-5 Sedan 2,0t BioPower	E85 (Ethanol)	69
Toyota Prius HSD	Gasoline	107

Export is an important factor



Germany achieved an export rate of >15% in 2007
The turn over was 650 Mio. € (Source: Fachverband Biogas)

The bottle necks:

1. The number of plants

To cover the potential approx. 200'000 biogas plants and 1200 gasification plants are needed

2. The methane emission

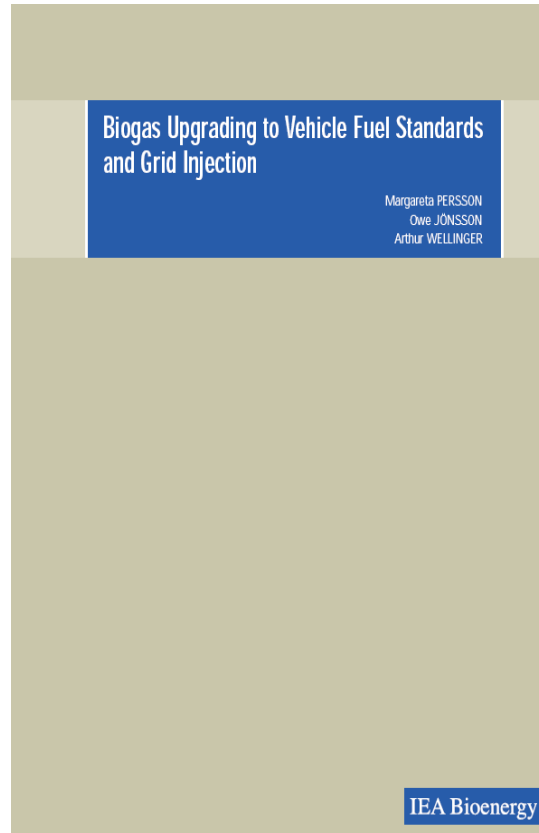
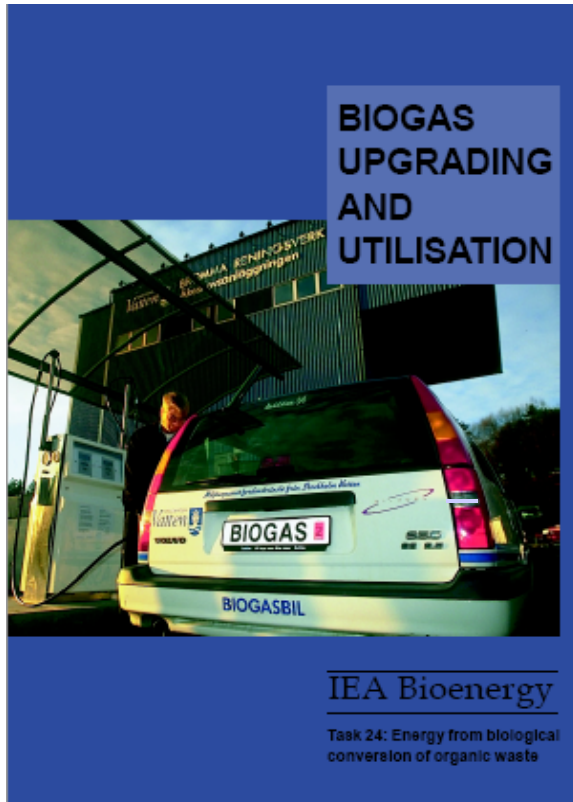
Methane is a 21 time stronger GHG than CO₂. For a optimal LCA total methane slip should be lower than 2%. The actual situation is rather like 4 to 6% emission!

3. The competition with the liquid Biofuels

The oil companies (with the worlds strongest lobby group) favour liquid fuels because they do have the necessary infrastructure and logistic



IEA Bioenergy Task 37



www.iea-biogas.net > Publications





European biofuels

- **Transport accounts for 30% of the energy consumption**
- **Less than 2% thereof is biofuel**
- **90% of CO2 increase from 1990 to 2010 will be attributable to transport**
- **Directive 2003/30/EC of 2003 on the promotion of biofuels for transport: targets: 2% by 2005; 5.75% by 2010**
- **Vision is to cover 25% of total consumption with biofuel by 2030**
- **Expectation is that 13% of agricultural land will be needed to produce the energy crops**
- **Biogas is expected to cover around 10 to 15% of biofuel**

Siloxanes

At low concentrations and low flows (< 500m³ per hr) siloxanes are removed with activated carbon. At higher concentrations and voluminas by a combination of cooling and activated carbon

