A3PS

Rethinking Propulsion.

PROFACTOR®

Bio-methane and bio-hydrogen from organic by-products and their applicability as transport fuels

Werner Ahrer

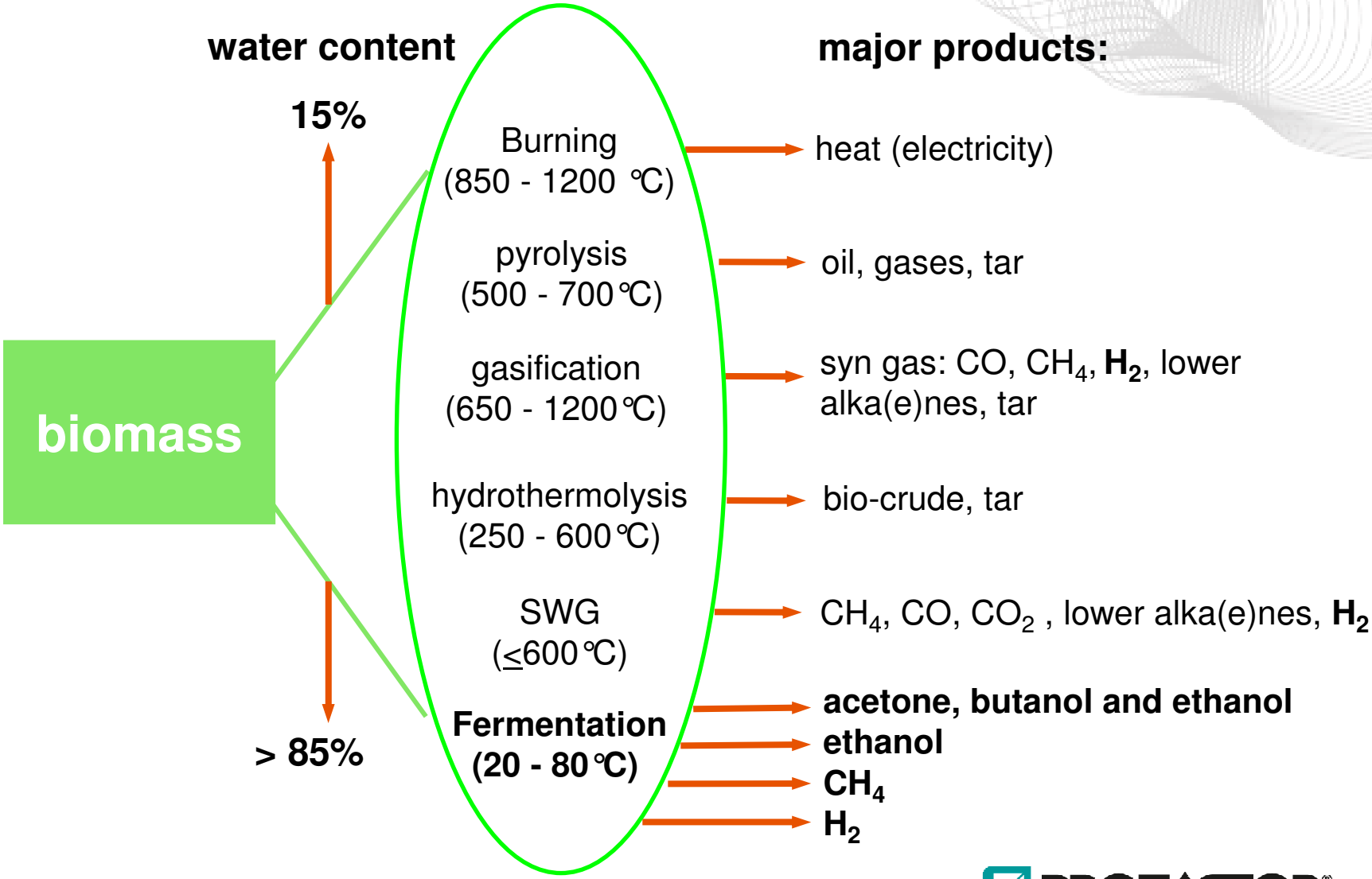
Transport Fuels: Crucial factor and driver towards sustainable mobility

R&D-projects, research institutions and funding programs in Austria, Europe and global cooperation within the International Energy Agency

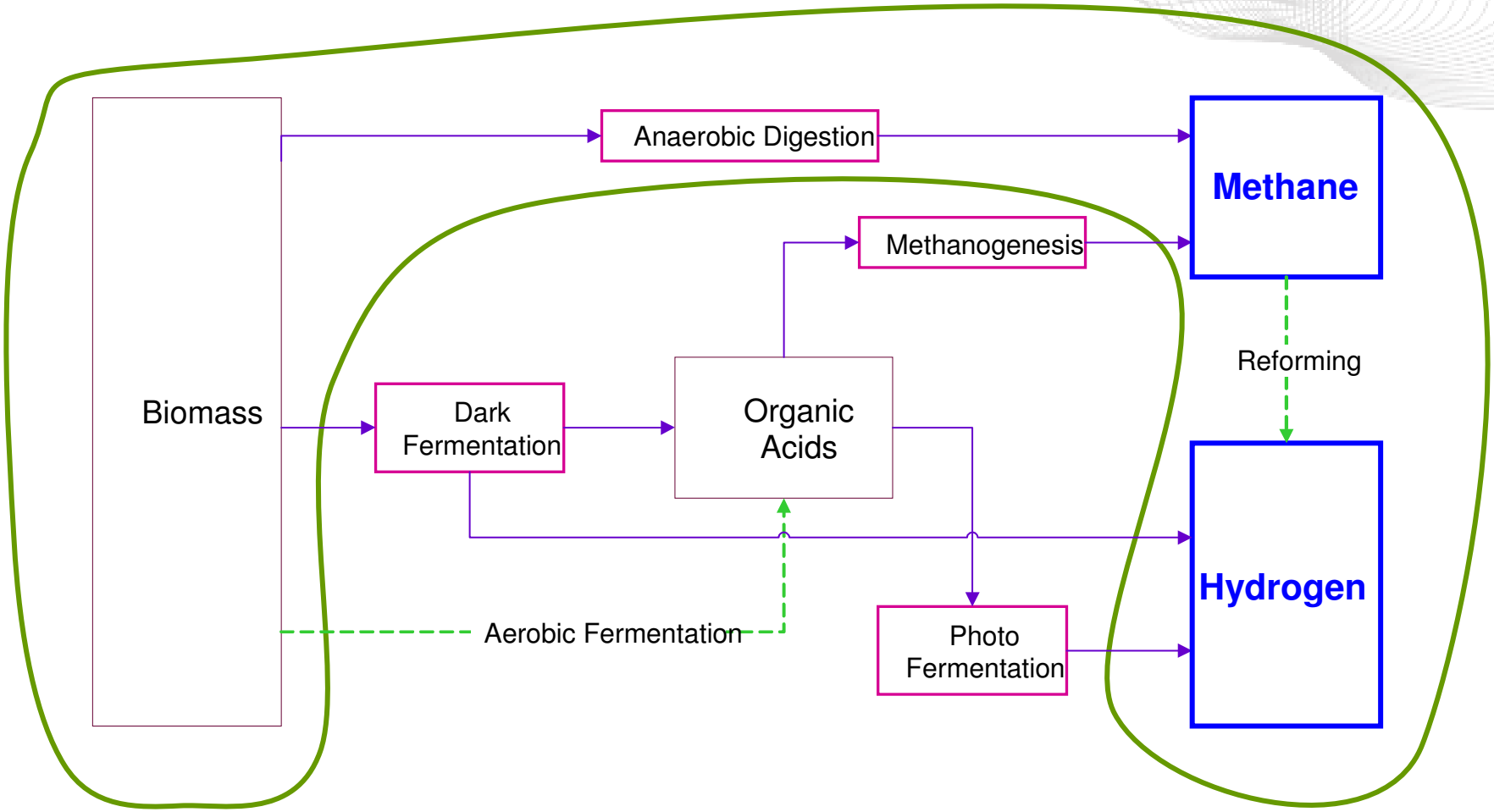
Vienna, 28.05.2008

in cooperation with bmvit

Biomass conversion technologies



Pathways to bio-methane and bio-hydrogen



Sources for biogas from anaerobic digestion

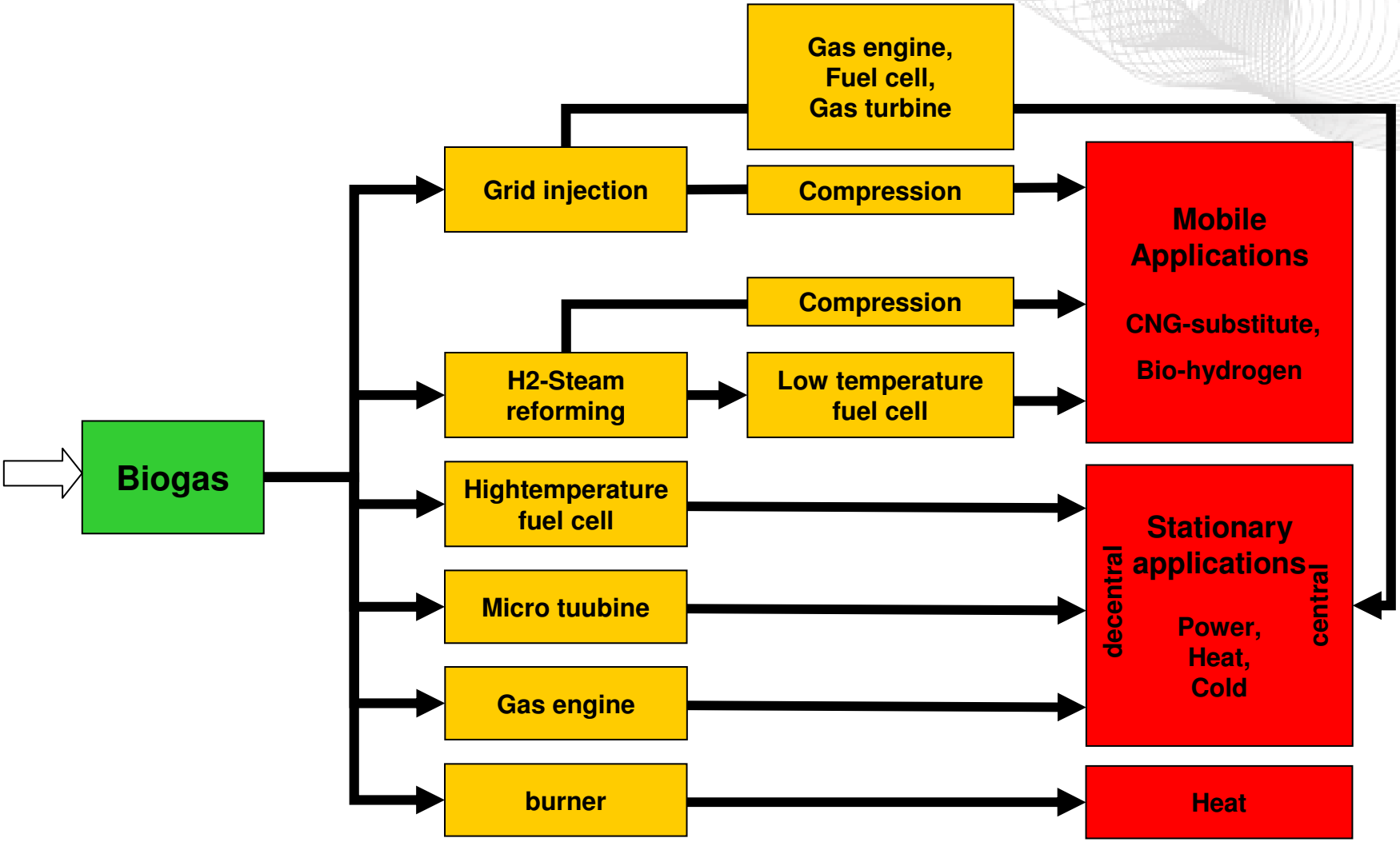
Biogas production

- Agricultural biogas plants
- Waste water treatment plants
- Anaerobic bio waste treatment facilities
- Landfills

Possible materials:

- Manure, energy crops
- organic waste from agriculture and food industry
- Municipal bio waste
- Sewage, landfill disposal
- ...

Biogas - variety of applications



Bio-methane as a vehicle fuel – requirements

	unit	*limits*	
		minimum	**maximum**
rel. density		0,55	0,7
heating value	MJ/m^3	30,2	47,2
Wobbe index	MJ/m^3	46,1	56,6
dust		technically free	
pressure (15 °C)	bar	-	200

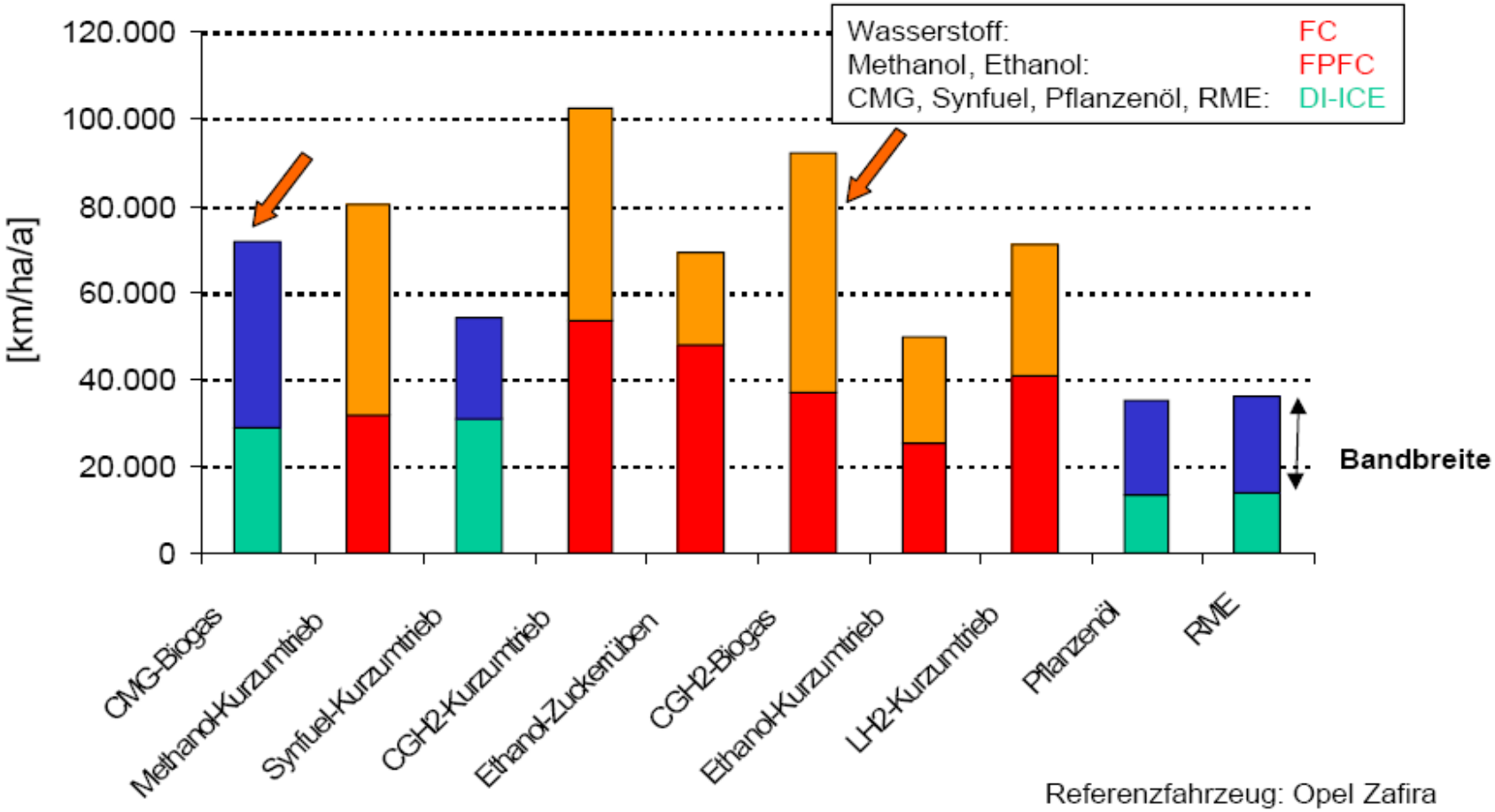
Source: Kraftstoffverordnung, BGBl. II 2004/417

Bio-methane as a vehicle fuel – requirements

		raw-biogas[a)] (dry)	natural gas[b)]	ÖVGW G 31
composition:				
C_xH_y	vol%(dry)	---	0.4	n/a
CH_4	vol%(dry)	50...66	99	n/a
CO_2	vol%(dry)	29...43	0.1	≤ 2
H_2	vol%(dry)	---	---	≤ 4
N_2	vol%(dry)	0.3...20	0.4	≤ 5
O_2	vol%(dry)	0.1...6.3	---	≤ 0.5
H_2S	mg/m³$_N$(dry)	17...2470	---	≤ 5
R-SH	mg S/m³$_N$(dry)	0...90	---	≤ 6
NH_3	mg/m³$_N$(dry)	0.6...50	---	0
Siloxane	mg/m³$_N$(dry)	0...0.9	---	0
firing properties:				
Wobbe-Index	MJ/m³$_N$(dry)	22.7...33.3	52.9	47.7...56.5
	kWh/m³$_N$(dry)	6.3...9.3	14.7	13.3...15.7
heating value	MJ/m³$_N$(dry)	22...28	39.6	38.5...46.0
	kWh/m³$_N$(dry)	6.1...7.8	11.0	10.7...12.8
rel. density	---	0.84...0.97	0.56	0.55...0.65

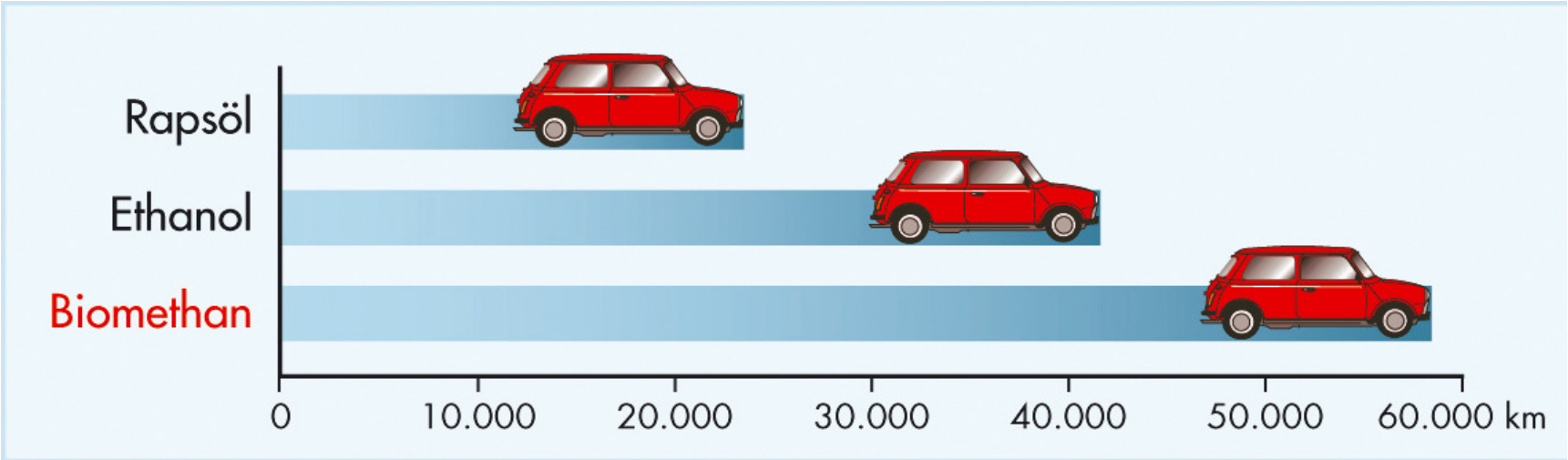
Addtional requirments acc. To ÖVGW G33: CH_4-content ≥ 96%, total silicon: ≤ 10 mg/m³

Bio-methane as a vehicle fuel – range/ha



Source: FNR, IEE, 2004

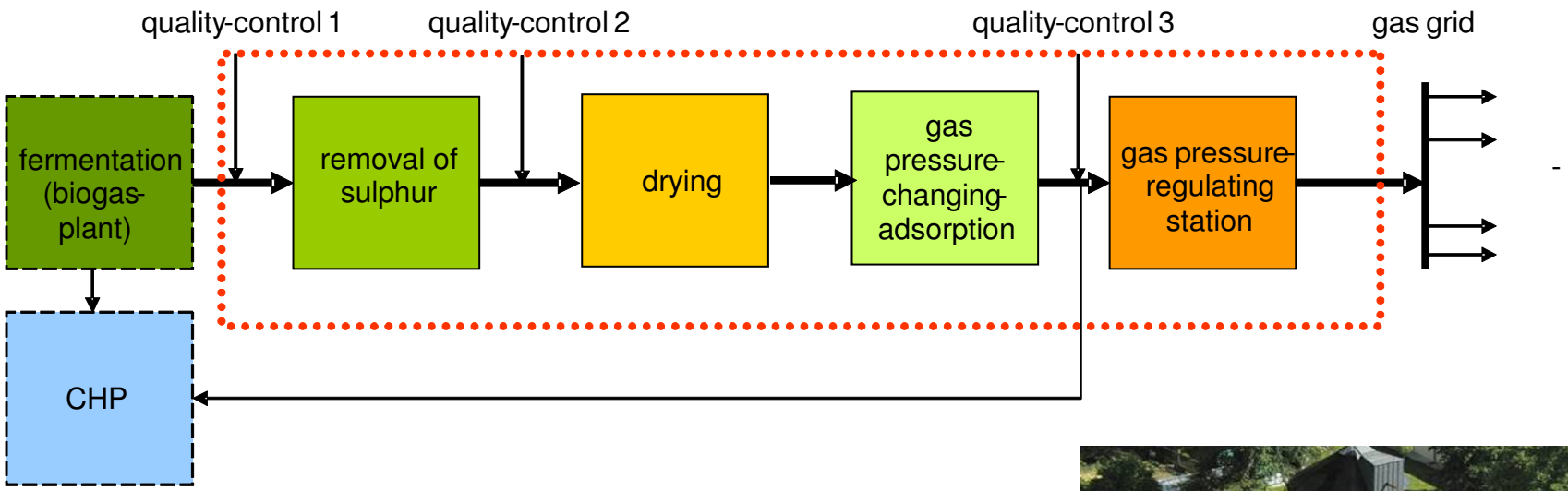
Bio-methane as a vehicle fuel – range/ha



Source: FNR, IEE, 2004

Gas grid injection of biogas - examples

Pilot plant Pucking / Linz (erdgas OÖ GmbH)



- Project start: April 2004
- Put in operation: May 2005
- Operation time: > 3 years
- Power: 10 m³ biogas / h

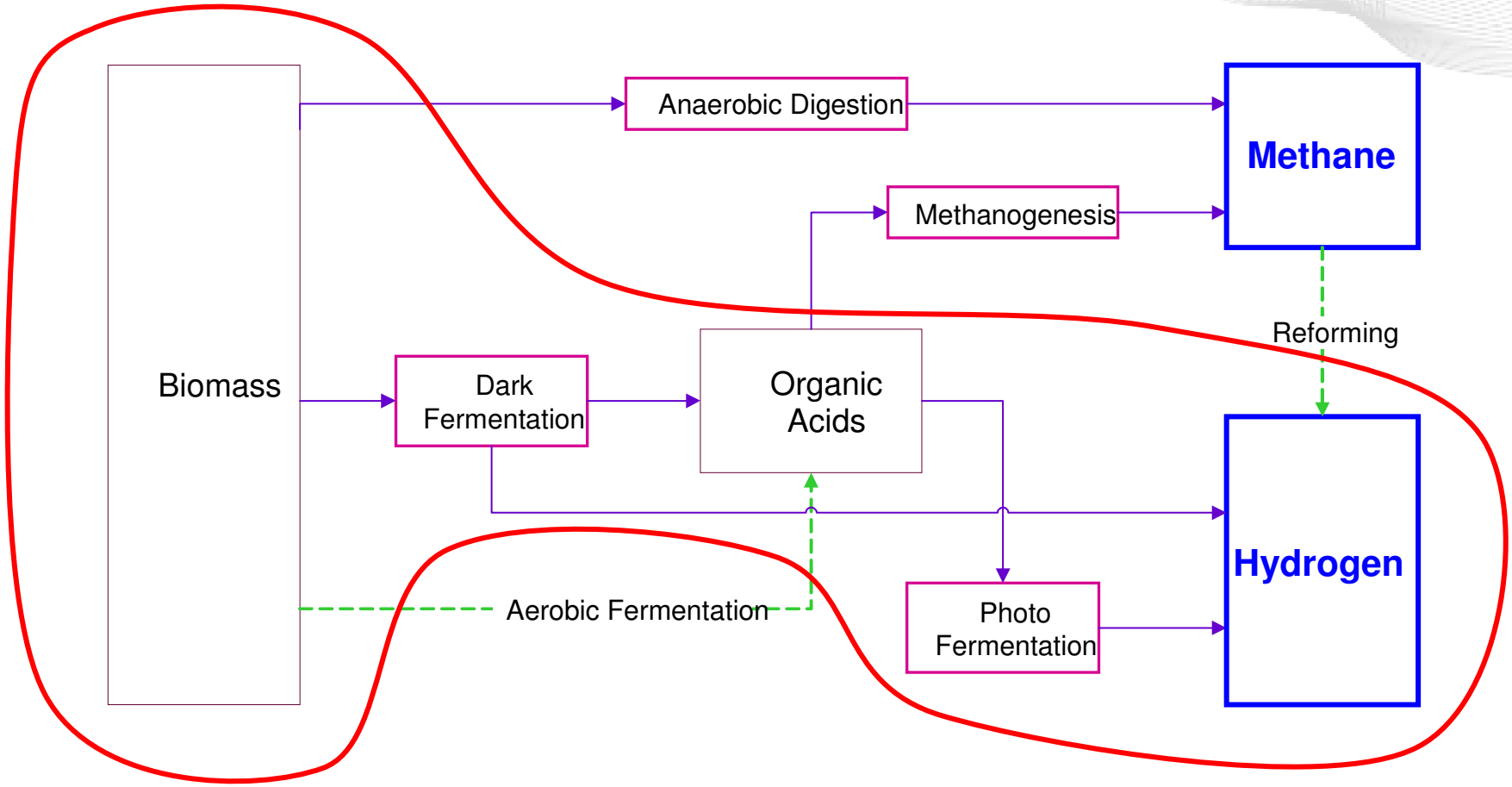
Gas grid injection of biogas - examples

Sewage gas injection Asten / Linz (Linz AG)

- Utilisation of sewage gas for fueling of 86 CNG driven buses in Linz

- Project start: Sept. 2007
- Put in operation: spring 2009
- Operation time: > 15 years
- Power: 750 m^3 biogas / h
- Upgrading technology: under negotiation

Pathways to bio-methane and bio-hydrogen



Substrates for bio-hydrogen production

Sorghum bicolor

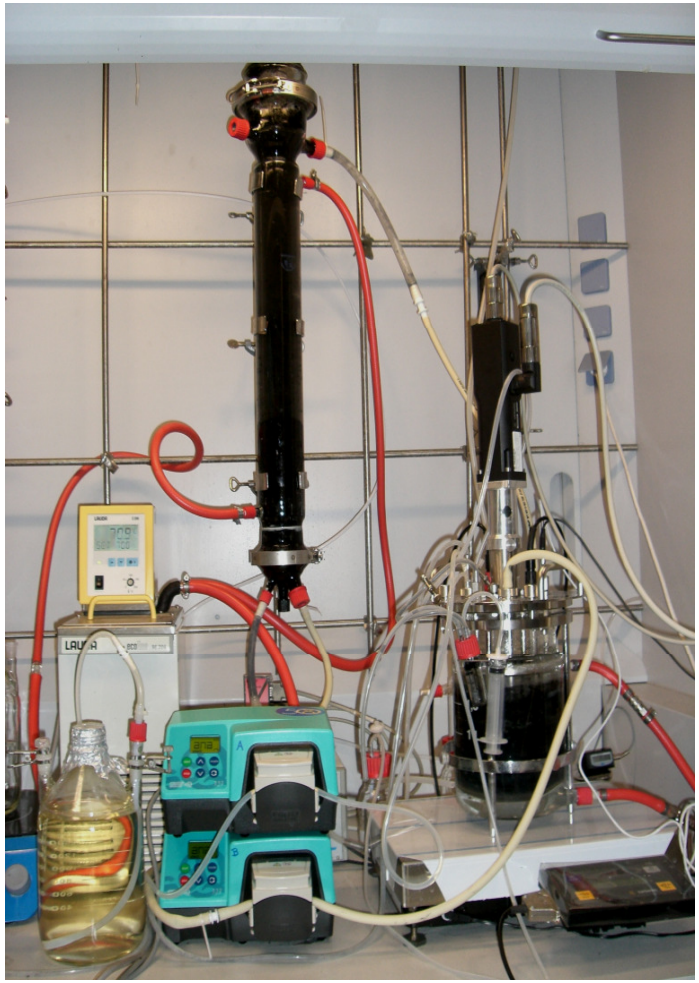
Potato steam peels

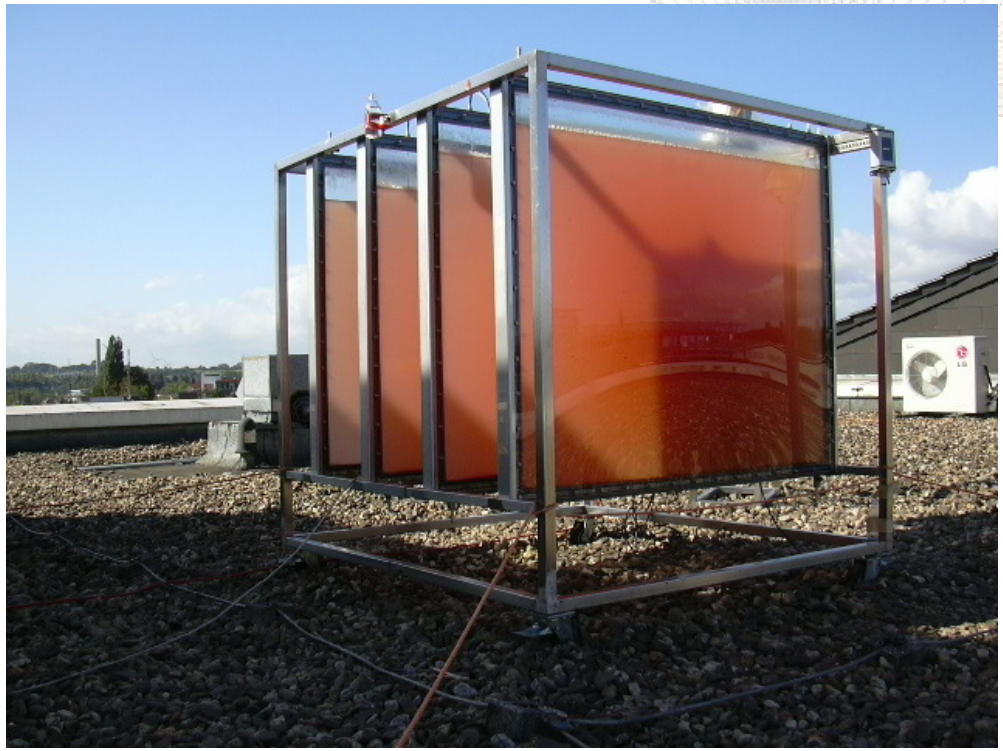
Miscanthus

DOW

Paper sludge

Bio-reactors for bio-hydrogen production

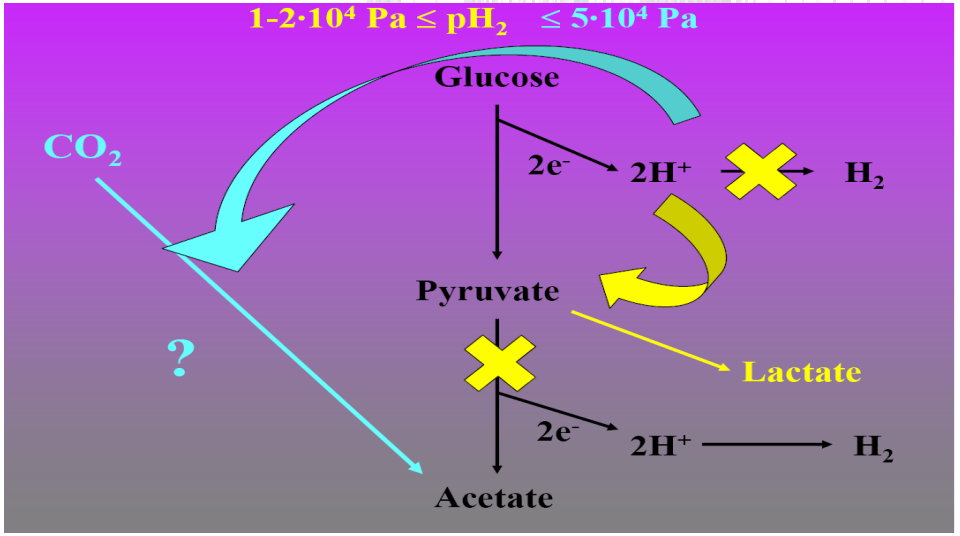




Thermophilic fermentation

Process relevant parameters

H_2 concentration in solution
H_2 partial pressure



Redox potential

$NADH/NAD+ \sim pH_2 \cdot 10^{pH_{int}} \cdot \exp(\Delta G/RT)$

$NADH + H^+ \rightarrow H_2 + NAD^+$

Mosey (1983) Water Sci Technol 15:209

Products and substrates

[NaAc]crit= 365 ±30mM

[NaCl]crit= 344 ±35 mM

[sucrose]crit= 473 ±7 mM

Van Niel et al (2003) Biotechnol Bioeng 81:255-262

Contact

DI Dr. Werner Ahrer
PROFACTOR GmbH

Address:	Im Stadtgut A2 A - 4407 Steyr
Tel:	+43-7252-885-400
Fax:	+43-7252-885-101
web:	**www.profactor.at/erneuerbare_energiesysteme.html**
Email:	werner.ahrer@profactor.at

Thank you for your attention !!!!!