Decentralized CO_2- neutral Bio-Methanol production system

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Alois Hauk
Company Development

AEN autarke Energie GmbH

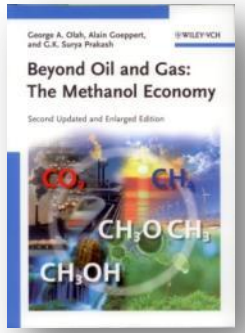
hauk@hauk-consulting.com

R&D: Michael Prestel, m.prestel@aen-energy.com

Renewable energy challenges

Generation **Storage** Transportation

- New and efficient ways to store energy needed
- A new, viable alternative approach is based on **methanol**
  - Suggested some years ago by **Prof. Dr. George Olah**[1], Distinguished Professor and Director of the Loker Hydrocarbon Research Institute at University of Southern California.
  - Awarded Nobel Prize in Chemistry in 1994



- "Methanol is the simplest, safest and easiest to **store** and **transport** liquid oxygenated hydrocarbon"

[1]see book: Beyond Oil and Gas: The Methanol Economy, ISBN 978-3-527-32422-4

Methanol (CH_3OH)

hydrogen **methanol** ethanol

- Currently almost exclusively prepared from synthesis gas (syn-gas, a mixture of CO and H_2)
- Obtained from incomplete combustion and reforming of fossil fuels - mainly natural gas and coal - with steam

- Methanol can also be prepared from
  a. biomass (wood, agricultural by-products (e.g. straw), municipal waste)
  b. fermentation (bio)- and sewage gas
  c. environmental recycling of CO_2

- Our Methanol production efficiency is 10x of Ethanol

AEN Solution Concept

Decoupling consumption from generation

be local and autonomous

Source

Consumption

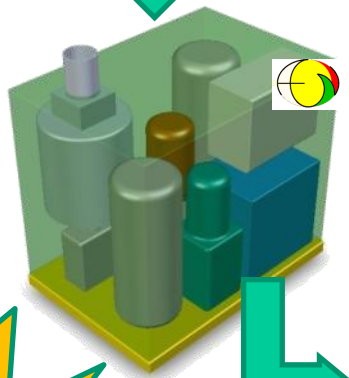
Bio-Methanol Storage

Economic Green Electricity Storage

3000 h/y

15kW/u

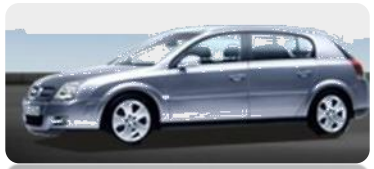
9 t/y/u



5 l/h

usage

bio-methanol
15.000 l/y



100.000 km or

100 ha farming

0,50 €/l
CO_2-neutral

u = user

Methanol as Fuel in ICE[1]

- Methanol is a simple chemical, in contrast to gasoline
  - Approx. ½ the energy density of gasoline
  - Has a higher octane rating of 100 (average of RON 107 and MON 92)
  - Fuel/air mixture can be more compressed before ignition (10-11:1 vs. 8-9:1)
  - Higher “flame speed” – faster and more complete fuel combustion

- **Important: current gasoline engines can be rel. simply modified**

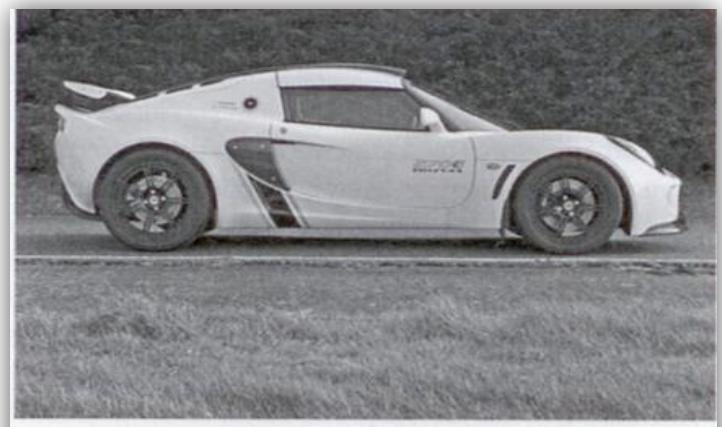
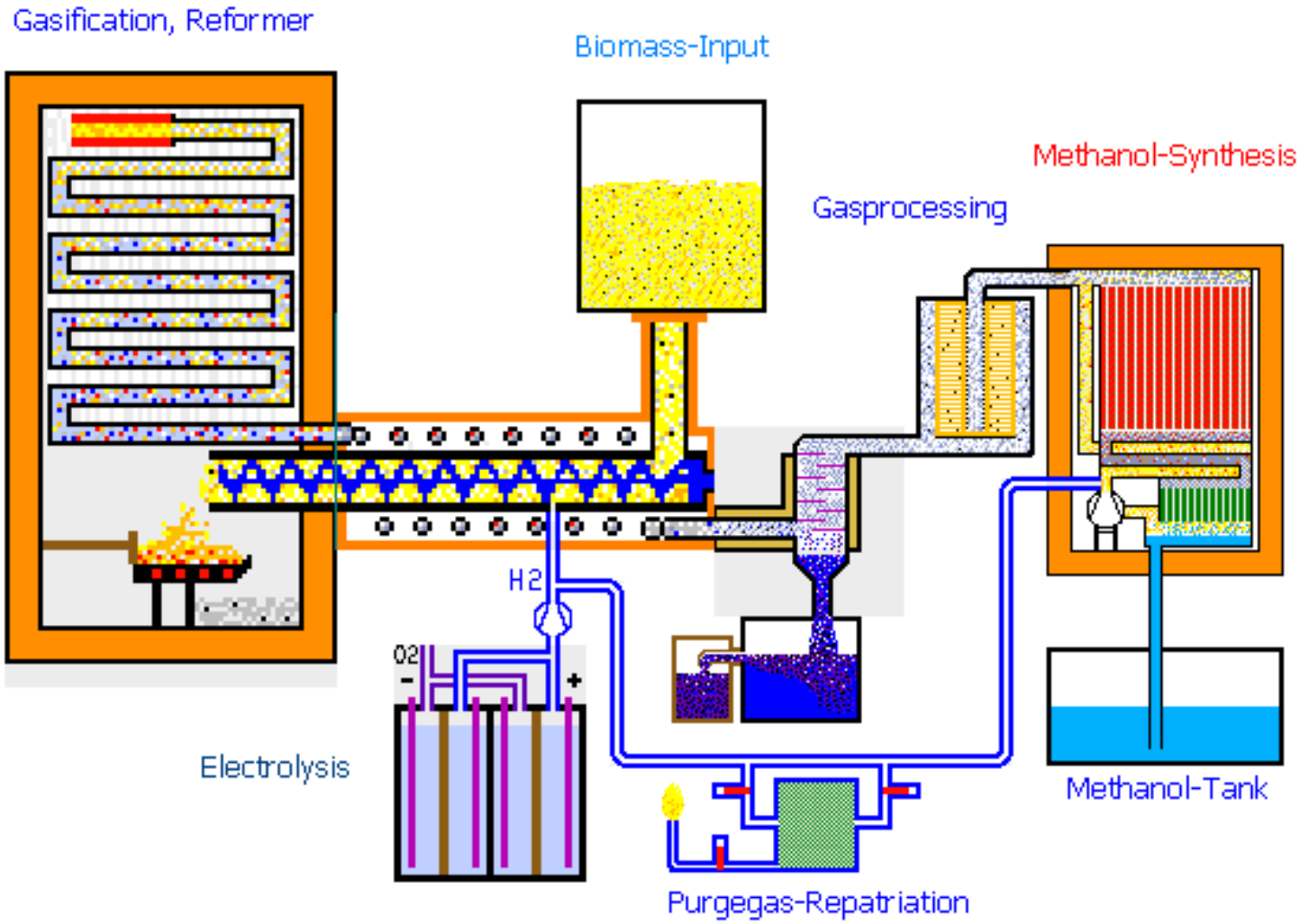


Figure 11.2 Lotus Exige 270E tri-fuel – able to run on any mixture

- Methanol-specific engines
  - Could be more compact and lighter
  - 3.7 x higher latent heat of vaporization – less cooling
  - Low overall emissions of air pollutants (NO_X, SO_2, particulates)
  - CO_2 neutral, due to biomass and green electricity

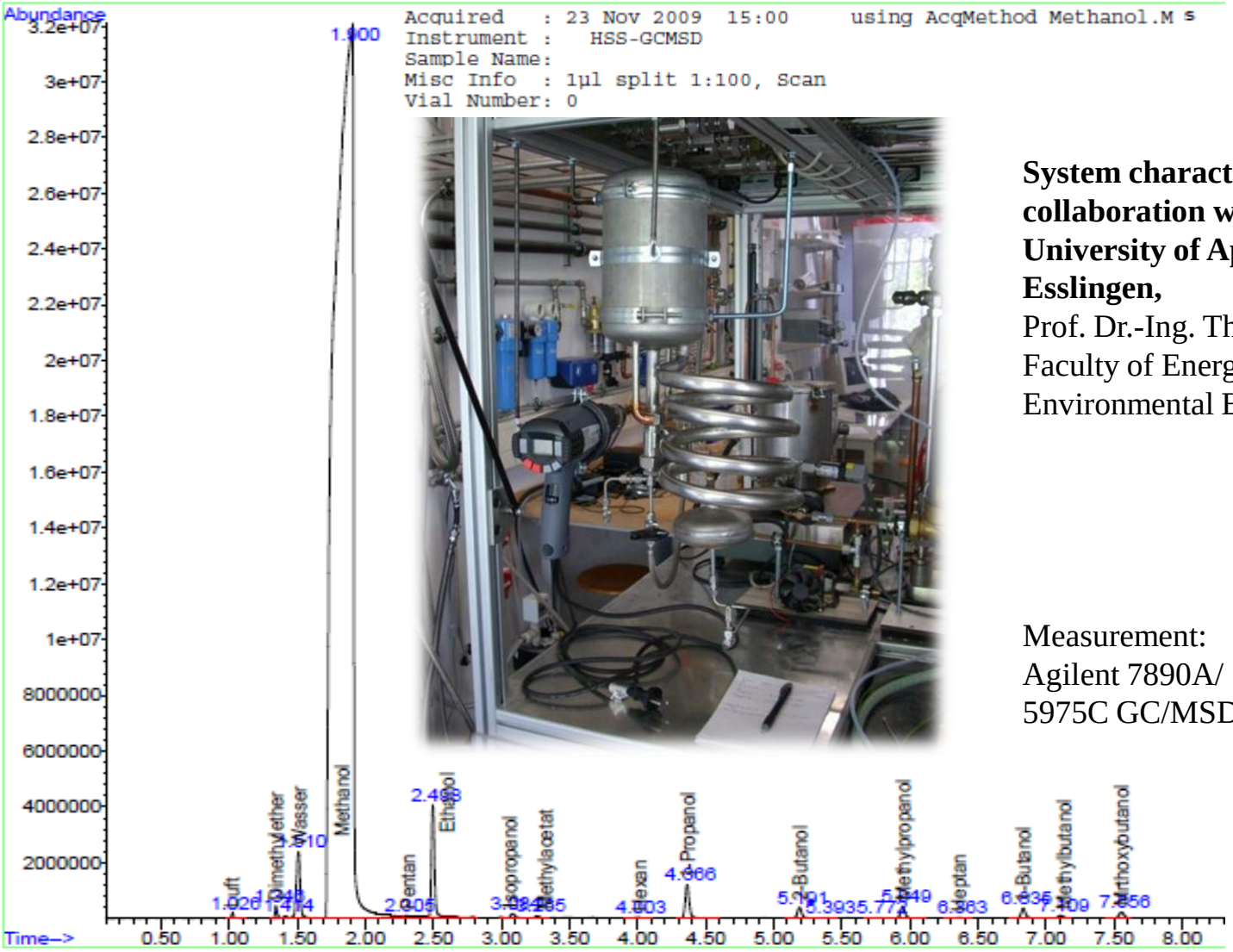
[1]ICE: Internal Combustion Engines

Electricity-Biomass-Methanol System



Bio-/Sewage Gas equally efficient

Prototype System



System characterization in collaboration with the University of Applied Sciences Esslingen,
Prof. Dr.-Ing. Thomas Rohrbach
Faculty of Energy & Environmental Engineering

Measurement:
Agilent 7890A/
5975C GC/MSD

Storage Efficiency

Mass balance		
Biomass - steam reforming and H2-Electrolysis		
kg Biomass Input	**1,0**	kg biomass (BM)
kg water H2O total input	1,0	kg H2O / kg BM
kg water H2O to syn-gas steam-reforming	0,25	kg H2O / kg BM
kg water H2O to H2-electrolysis using electricity	0,75	kg H2O / kg BM
kg H2 in to syn-gas from H2-electrolysis using electricity	0,083	kg H2 / kg BM
Output [kg] methanol / kg biomass	**1,33**	
Output [liter] methanol / kg biomass	**1,69**	

Energy balance		
Biomass in KWh	**5,0**	KWh / kg BM
Required electricity for H2-electrolysis in KWh	**4,2**	KWh / kg BM
Required electricity in KWh / liter methanol	**2,5**	KWh / L MeOH
Efficiency	**80%**	
Methanol output /electricity input	**200%**	KJ MeOH / KJ e-power

In summary - we provide …

- Bio-Methanol
  - An effective green electricity storage
  - A CO_2 neutral, price competitive transportation fuel
- Utilizes domestic biomass and biogas
- Compact, economical and scalable system

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Thanks

Questions?
Comments?
Interests?

Contact:
hauk@hauk-consulting.com
m.prestel@aen-energy.com