Methanol in fuel cells

Dr. Alexander Dyck
Department of Urban and Residential Technologies and Fuel Cells

Webinar from Oldenburg, 29.04.2020

DLR Institute of Networked Energy Systems

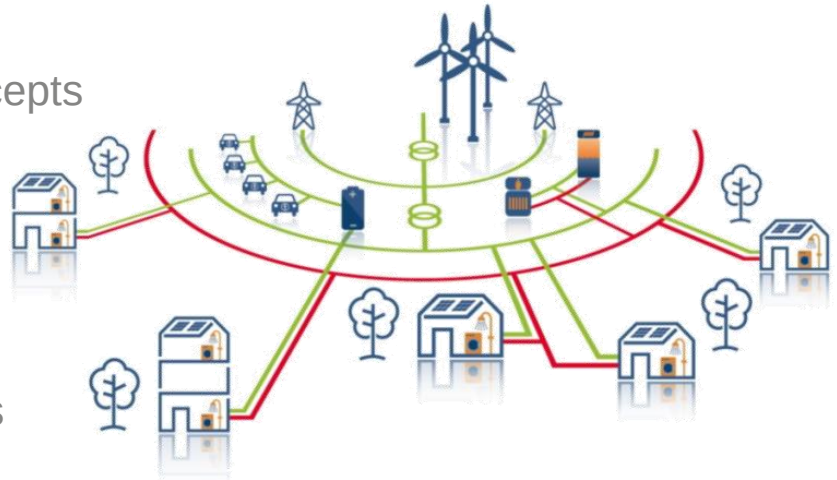
DLR Institute of Networked Energy Systems

- Foundation of NEXT ENERGY
  in 2007 as affiliated institute of the University of Oldenburg through the EWE AG, the University of Oldenburg and the Federal State of Lower Saxony

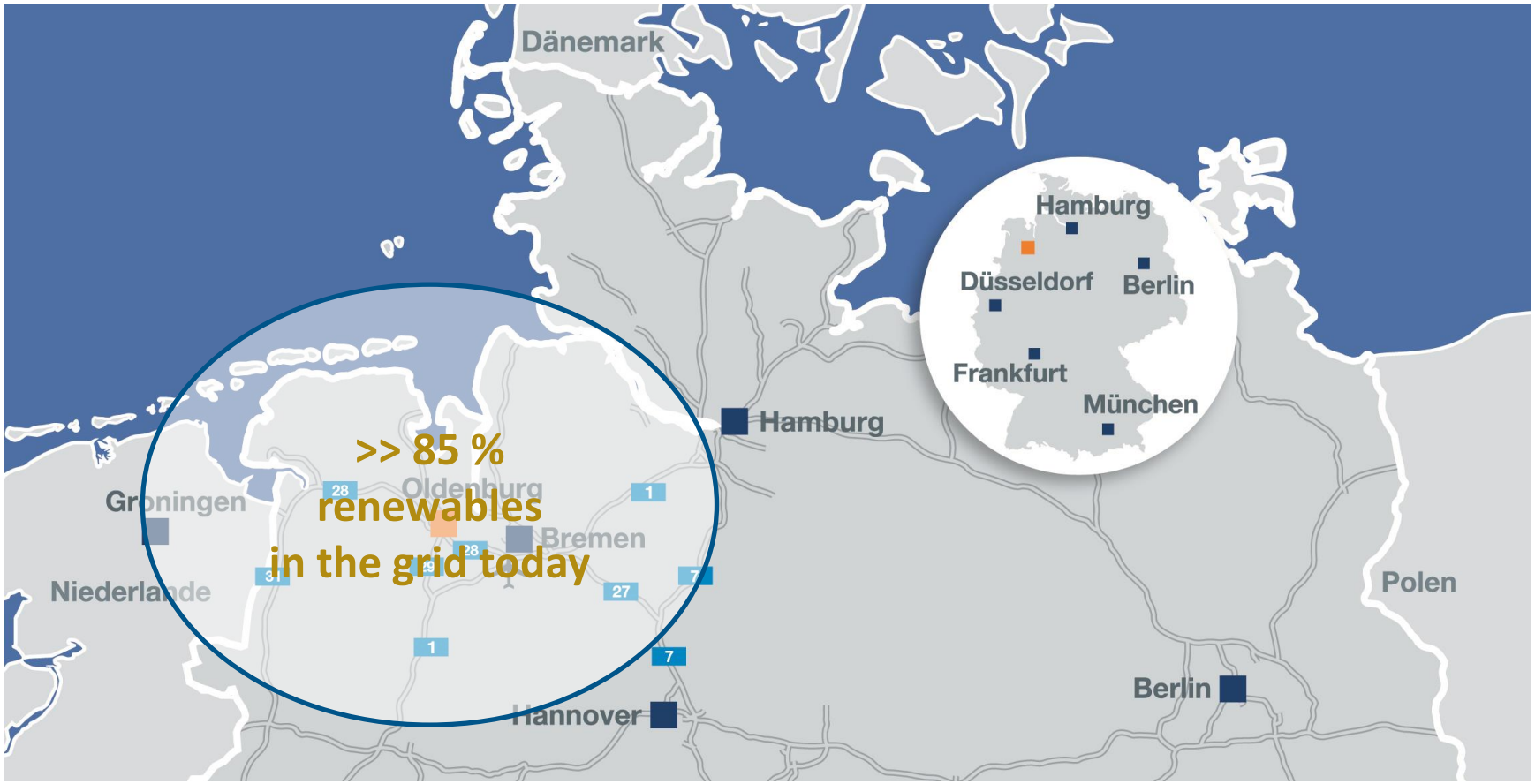
- 28th of June 2017:
  Decision of the DLR senate

NEXT ENERGY DLR Institut für Vernetzte Energiesysteme

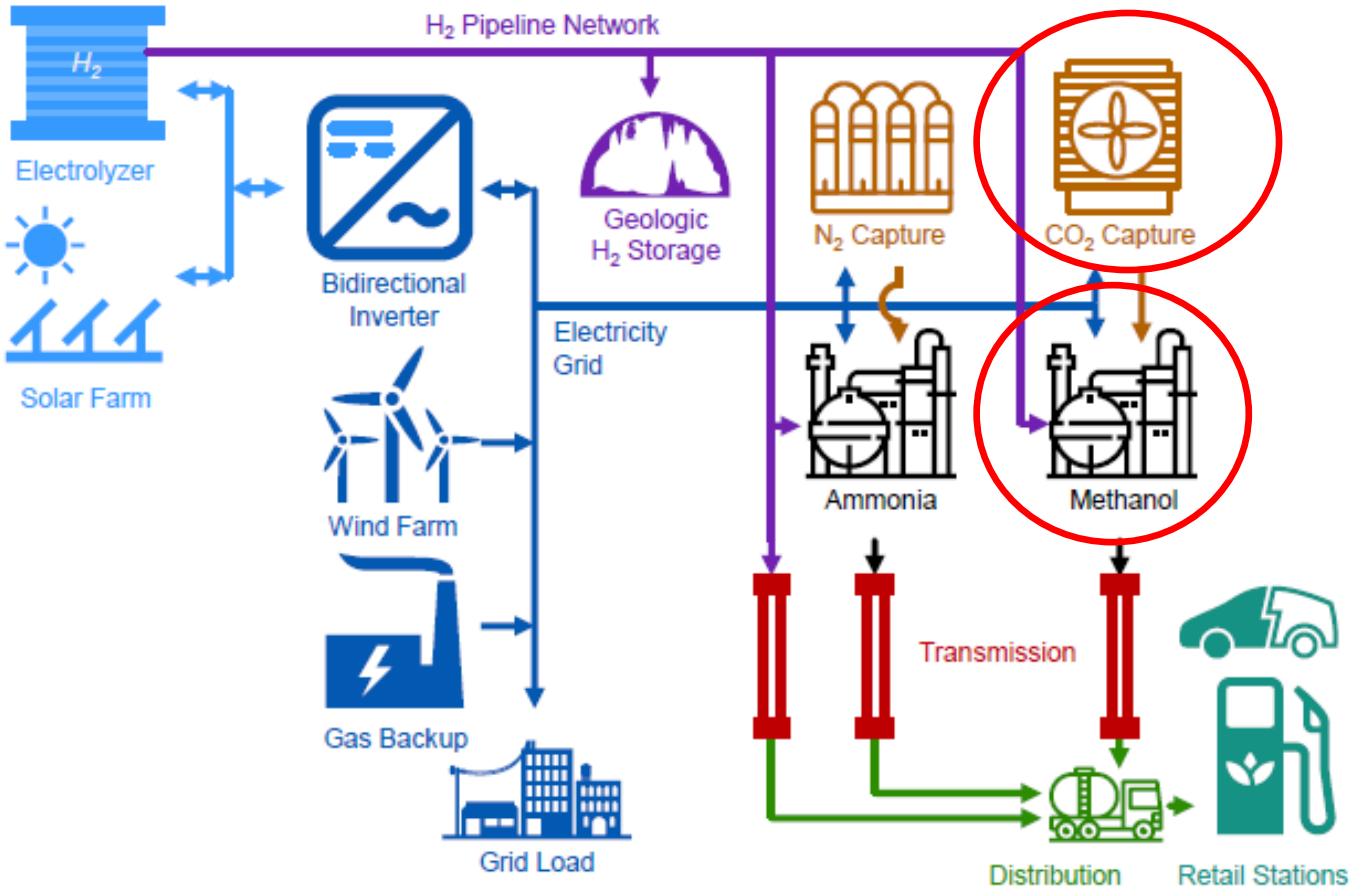
- Mission
  Development of technologies and concepts for future energy supply based on renewable energies
  - Energy System Analysis
  - Energy System Technologies
  - Urban and Residential Technologies



Oldenburg as a Centre of Research for Energy Transition

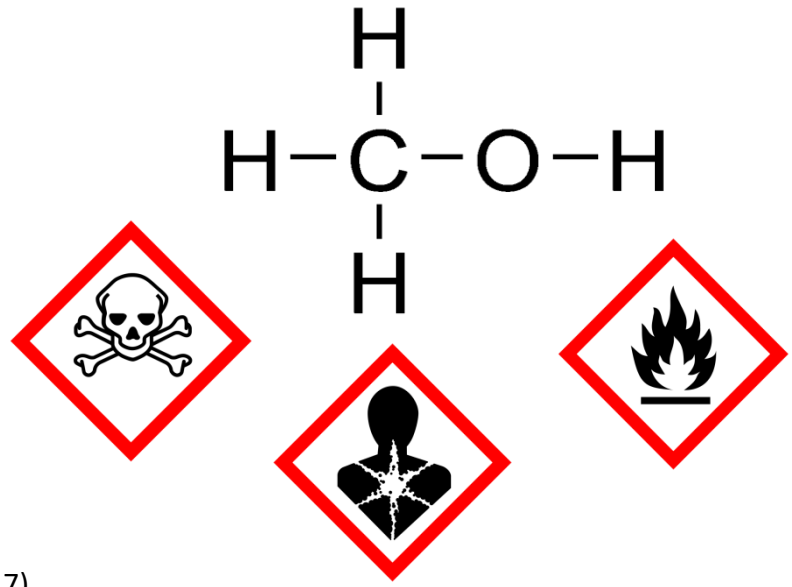


Energy Transition towards a Low Carbon Economy



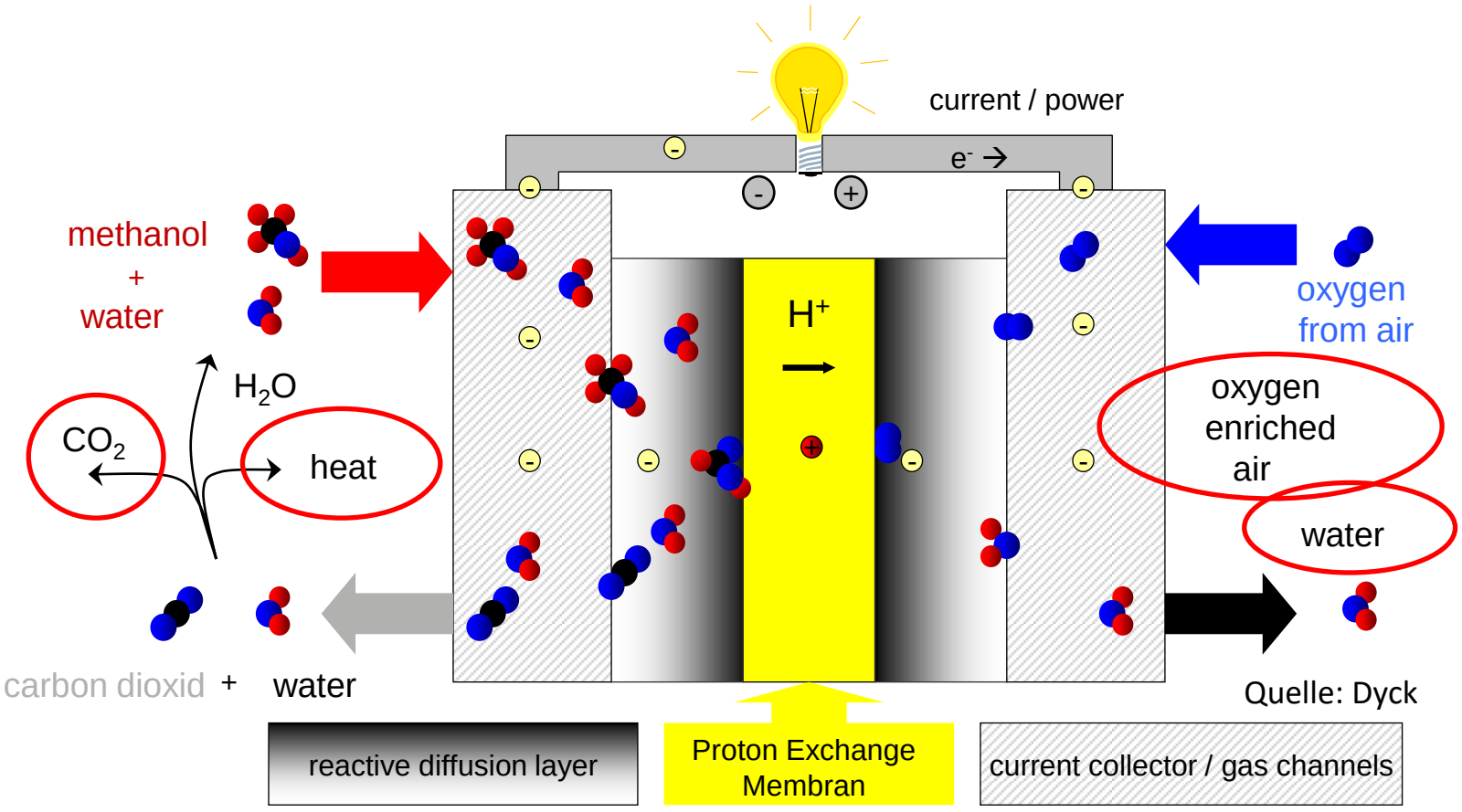
Methanol characteristics

- Methanol (CAS 67-56-1)
  - the simplest alcohol
  - colourless, easily portable, combustible and poisonous liquid
  - melting point -98 °C
  - boiling point 64.5 °C
  - explosive limits: 6.0- 31.0 Vol.-%
  - ignition temperature 455 °C
  - density 0.7869 kg/L (25 °C)
  - energy density 4.4 kWh/L



Source: Haber (2017); Chemie.de Information Service GmbH (2017)

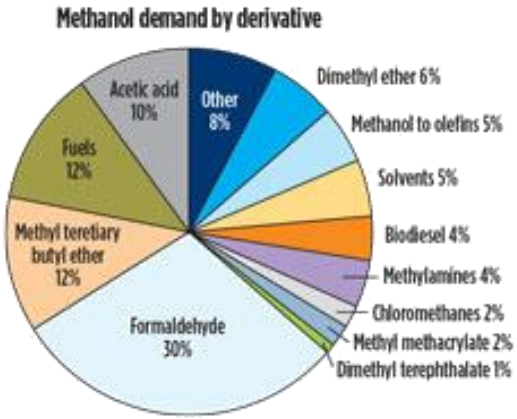
Direkt Methanol Fuel Cell - DMFC

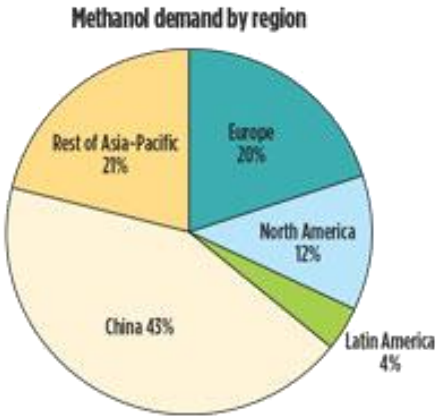


Anode reaction	Cathode reaction
$CH_3OH + H_2O \rightarrow CO_2 + 6\ H^+ + 6\ e^-$	$O_2 + 4\ H^+ + 4\ e^- \rightarrow 2\ H_2O$
Overall reaction: $CH_3OH + 1{,}5\ O_2 \rightarrow CO_2 + 2\ H_2O$	

Methanol as a chemical

- Methanol in fuels
  - as MTBE
  - direct
  - for biodiesel
- Methanol-Fuel Cell Systems for small mobikle applications
- Methanol as hydrogen source for fuel cells or ICE
  - e.g. clean shipping (also hotel operation)





http://www.gasprocessingnews.com/features/201510/small-scale-methanol-technologies-offer-flexibility,-cost-effectiveness.aspx

www.efoy.com

www.serenergy.com

Research approach: Identifying adequate energy carriers for the design of sustainable energy systems

- The key element for the design of low emission propulsion systems is to evaluate future fuels based on renewables for maritime applications
- The following energy carriers will be investigated
  - Low sulfur Heavy Fuel Oil (HFO) Ref.
  - Liquefied Natural Gas (LNG)
  - Methanol (CH_3OH)
  - Ammonia (NH_3)
  - Hydrogen (H_2, liquefied or compressed)
  - Liquid Organic Hydrogen Carrier (LOHC)
  - Batteries

Energy source	Fossil (without CCS)					Bio	Renewable[3]		
Fuel	HFO + scrubber	Low sulphur fuels	LNG	Methanol	LPG	HVO (Advanced biodiesel)	Ammonia	Hydrogen	Fully-electric
High priority parameters									
• Energy density									
• Technological maturity									
• Local emissions									
• GHG emissions			[2]						
• Energy cost									[4]
• Capital cost (Converter / Storage)									
• Bunkering availability									
Commercial readiness [1]									[5]
Other key parameters									
• Flammability									
• Toxicity									
• Regulations and guidelines									
• Global production capacity and locations									

[1] Taking into account maturity and availability of technology and fuel.
[2] GHG benefits for LNG, methanol and LPG will increase proportionally with the fraction of corresponding bio- or synthetic energy carrier used as a drop-in fuel.
[3] Results for ammonia, hydrogen and fully-electric shown only from renewable energy sources since this represents long term solutions with potential for decarbonizing shipping. Production from fossil energy sources without CCS (mainly the case today) will have a significant adverse effect on the results.
[4] Large regional variations.
[5] Needs to be evaluated case-by-case. Not applicable for deep-sea shipping.

DNV GL AS Maritime, Comparison of Alternative Marine Fuels, 2019-07-05, Document No.: 11C8I1KZ-1

Research Topics on Fuels

DLR Institute of Networked Energy Systems

Sector integration for an energy system based on renewable hydrogen

Sector integration gas technology

Mobility technologies & the power network, coupling of chemical energy with the energy system

Sector integration mobility

DLR Institute of Engineering Thermodynamics (Site Oldenburg)

Measurement technology & analytics for the scientific description of degradation, HT-PEMFC

Characterisation

Structure-property study of catalysts, membranes and bipolar plates for sustainable energy applications

Materials

DLR - Knowledge for Tomorrow

Thank you for your attention!
Any questions?

Contact:
Dr. Alexander Dyck
+49 441-99906-310
alexander.dyck@dlr.de