

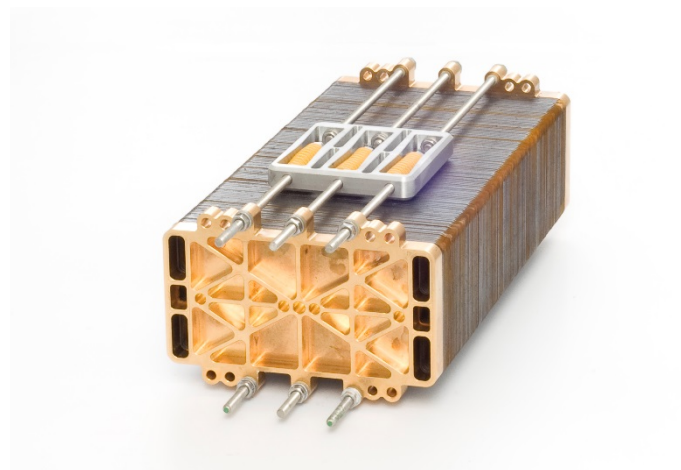
Using Unconventional Energy Sources to improve Efficiency

TARGETS Public Workshop

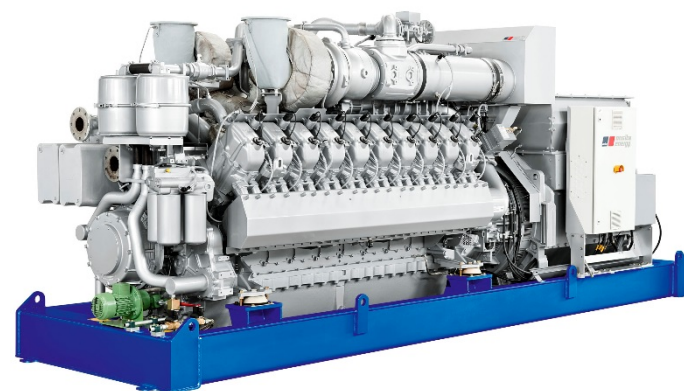
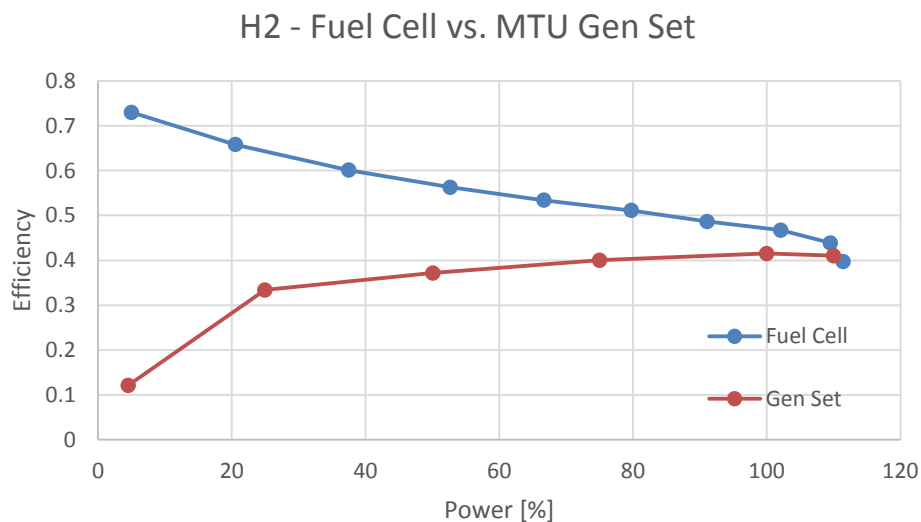
13 March 2014, London

C. Gentner - CMT

fuel cells reach high efficiencies and show a good part load behavior



Serenergy fuel cell stack 2,7kW



MTU 8V 4000 760kW

why fuel cell systems?

- What benefit do we get by using fuel cell systems?
- Which fuels can be used for operation?
- Can fuel cell systems operate on commercial vessels?

Fuel Cells on Bord



Zero Emission Ship „ALSTERWASSER“
(protonmotors.de)

Hybrid System

- 50 kW fuel cell system
- 50 kg H₂ in pressurized tank
- 200 kWh lead acid batteries
- 100 kW drive motor
- 100 passengers
- 14 km/h

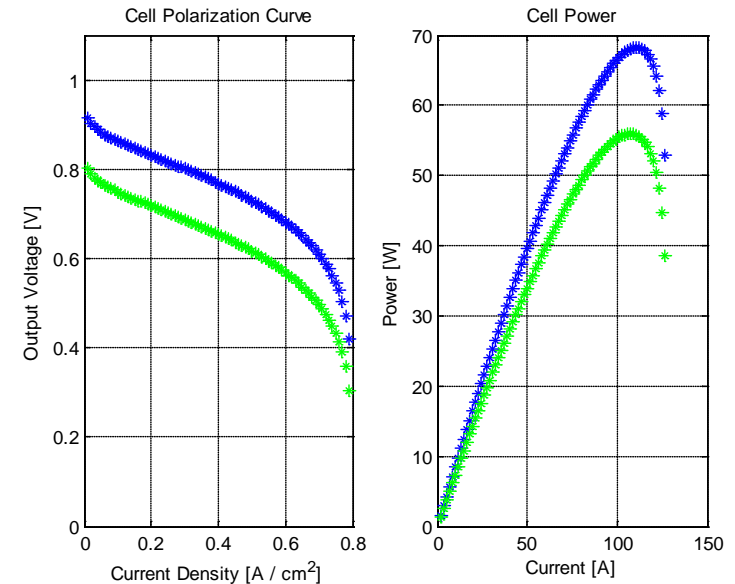
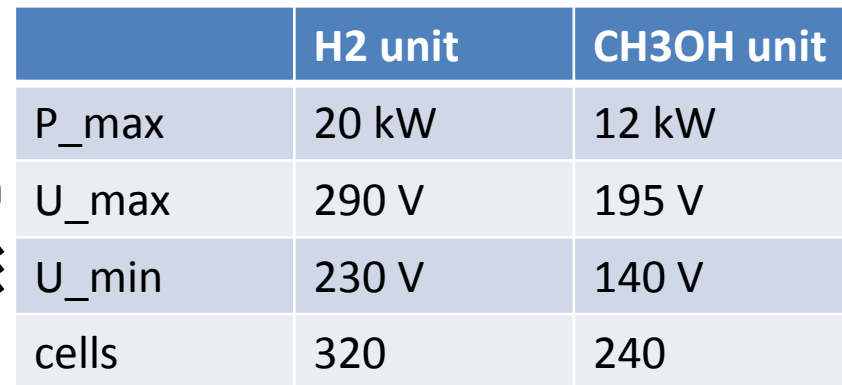


TKMS Submarine Class 212 A

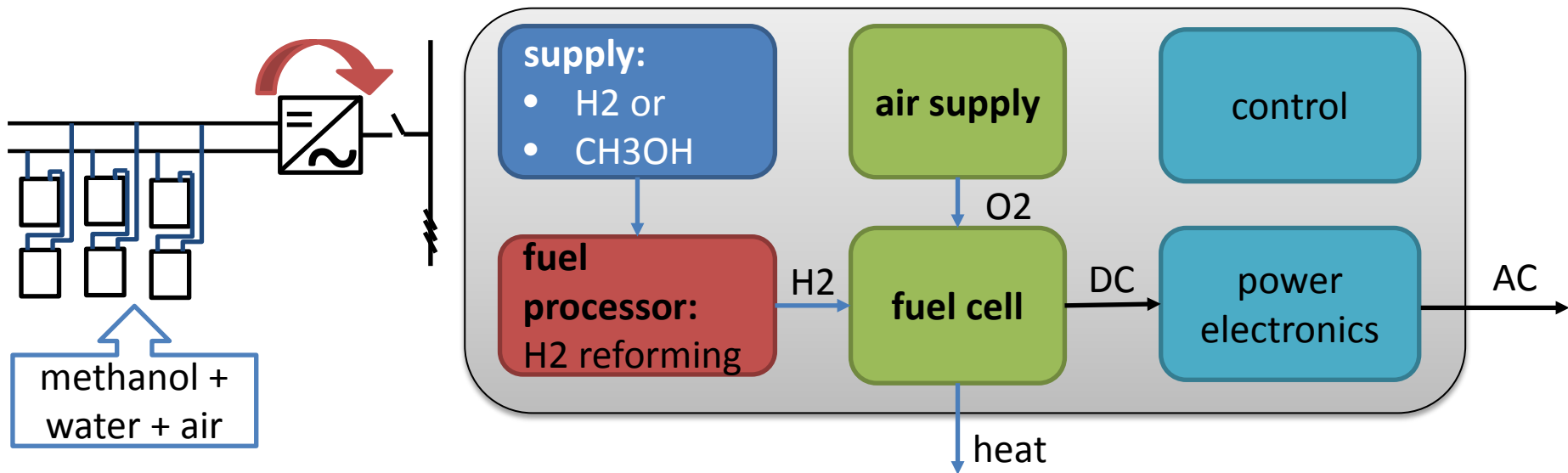
Hybrid System

- 306 kW fuel cell system
- 2,5 t H₂ in hydride storage
- O₂ is carried liquidous at -180°C
- lead acid batteries
- 1700 kW drive motor
- 14 kt / 20 kt (underwater)

replace one auxiliary generator by a hydrogen driven fuel cell system



Use of liquid fuels on Bord



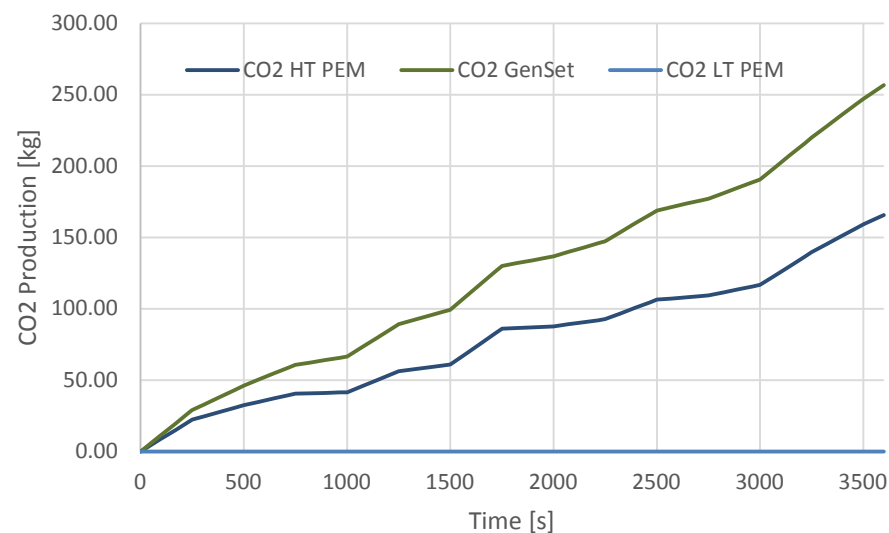
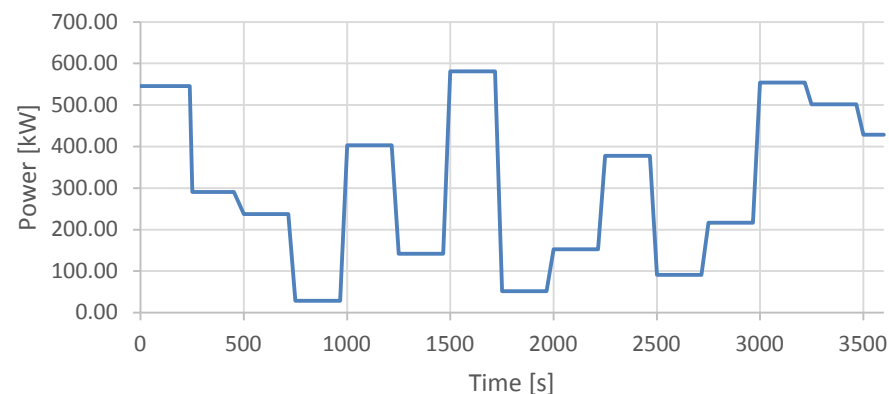
fuel processor

inflow	methanol + water
outflow	hydrogen + carbondioxide
endothermic reaction	use of fuel cell waste heat

fuel cell

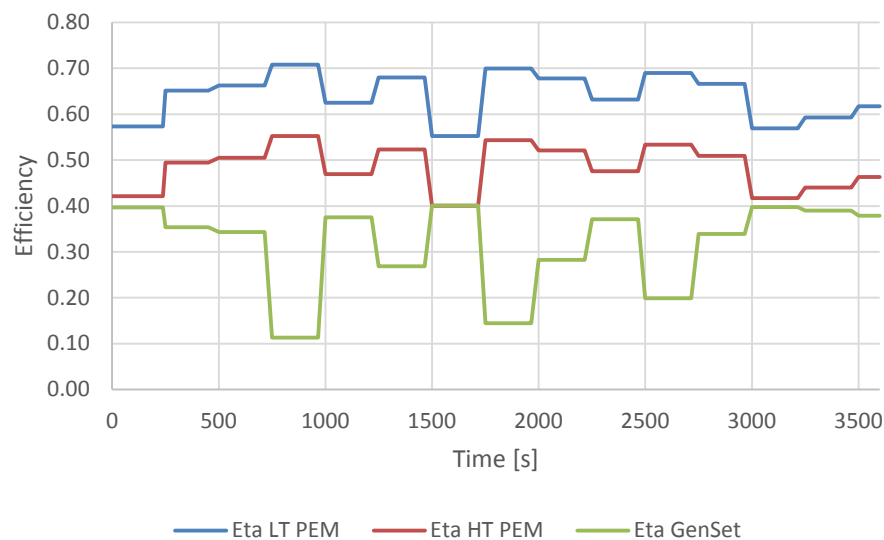
fuel	hydrogen
oxidant	air
exhaust	humid air
operating temperature	60 ... 1000°C (fue cell type)

Comparison



CO2 production at 80% load

	H2 - Fuel Cell	CH3OH - Fuel Cell	MDO-GenSet
CO2 [kg/kWh]	0	0,55	0,86



Fuel cell benefits

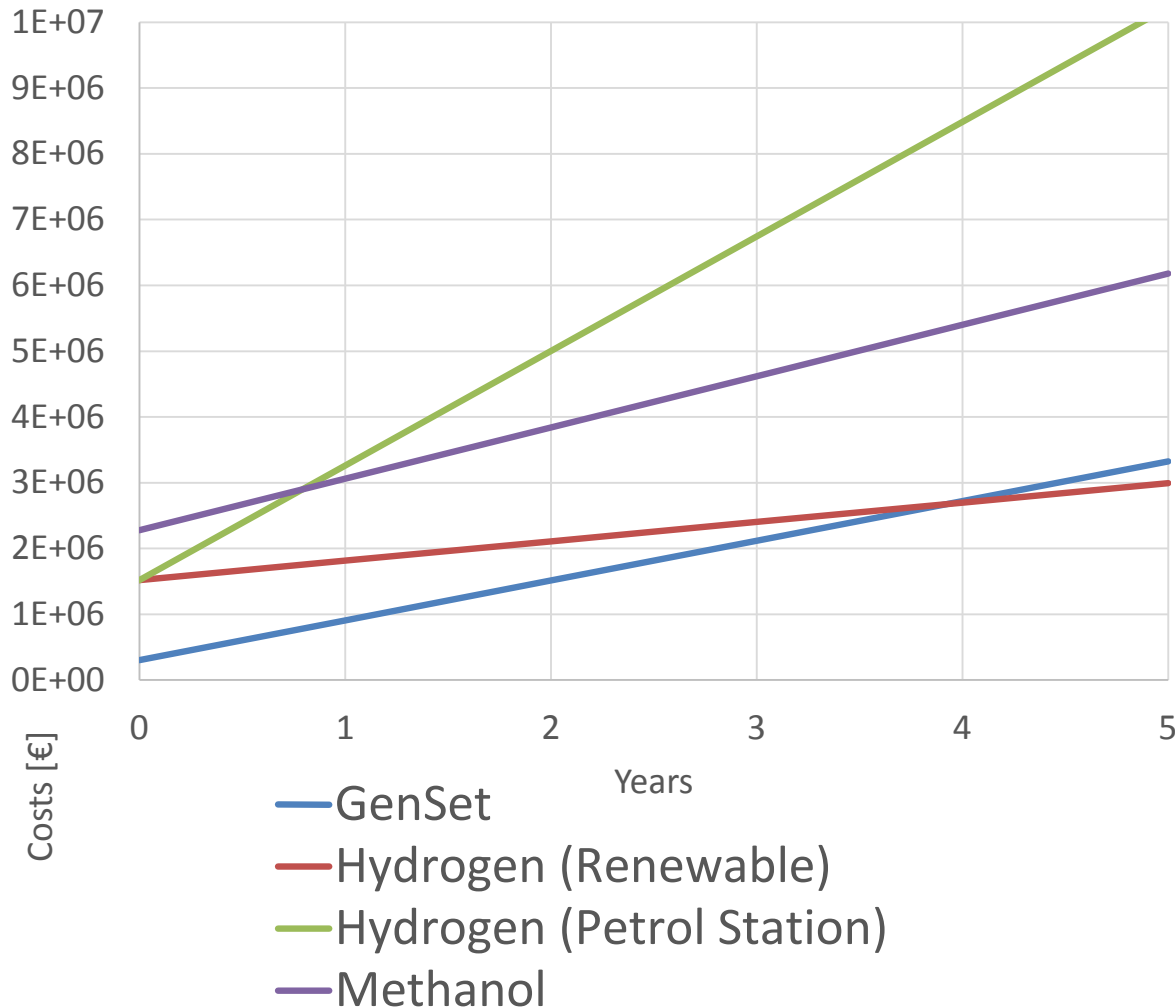
- higher efficiencies
- lower CO₂ emissions
- greatly reduced NO_x, SO_x, CO, CmHn, particulate emissions
- reduced acoustic emissions
- reduced vibration emissions



Fuel cell benefits

- distribution of numerous smaller generators in multiple locations possible
- modular design
- flexibility in ship machinery layout
- use of waste heat

Investment / operational costs



- $P_{\max} = 760\text{kW}$
- load 75%
- runtime 320 d/a
- Genset: 400 €/kW
- H2 FCS: 2000 €/kW
- CH4O FCS: 3000€/kW
- (aim 600...800 €/kW)
- MGO: 655 €/t
- H2: 1370 €/t
- H2: 8100 €/t
- CH3OH: 4 50 €/t

End

Thank you for your attention!

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