

VDR + MARIKO Workshop „Alternative Kraftstoffe“

Status LF Fuels and Fuel Cells



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Research and Development

*Innovative passenger ships
with alternative drives*

Alternative fuels
for passenger
ships

- LNG (GasPax; Bungas)
 - 2009-2013
 - successfully completed
 - first gas-fuelled cruise ship:
delivery 2018
- Methanol (MethaShip)
 - Project end: 28th February 2018

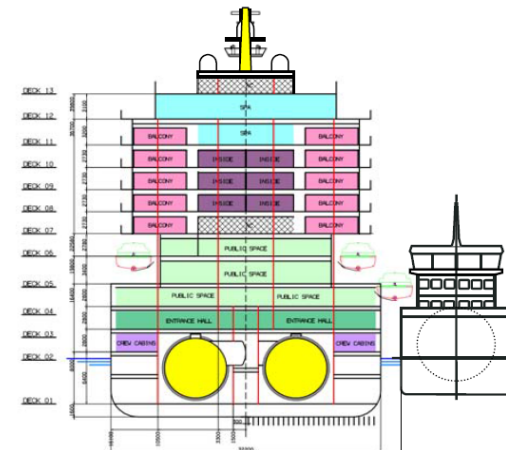
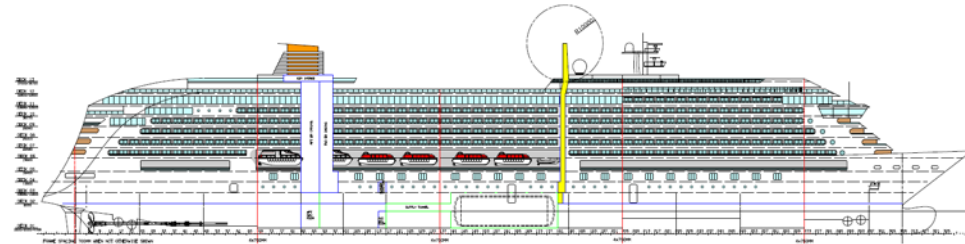
Fuel cells for
passenger ships

- Pa-X-ell (seagoing ships)
- RiverCell (inland waterways)
 - Project end: 31st December 2016
 - Follow-up projects in preparation

Alternative Fuels

GasPax and Bungas:

- LNG as alternative fuel
- Development of storage and entire process
- Development of ship design
- Approval in Principle of DNV GL and LR
- Design of bunker vessel
- Development of bunker process
- Development of bunker safety chain
- Basis for IGF-Code



Some orders of gas-fuelled ships confirm the success of the projects

4 orders of cruise ships
2 orders of ferries
2 orders of gas tankers

Alternative Fuels

MethaShip:

- Alcohols as alternative fuels (Methanol, Ethanol)
- Market potential and methanol infrastructure
- Ship system- and energy converter technology
- Design of a methanol-fuelled cruise vessel
- Evaluation of rules and regulations
- Life cycle assessment and safety analysis
- Main advantages of Methanol:
 - Liquid at ambient temperature
 - Base product in chemical industry for decades
 - Less (near to zero) emissions
 - Could easily be produced from renewable sources



} Keyword „Paris Agreement“

Fuel cells



Framework of support:

- Initiation of german federation, industry and science
 - Research programme: NIP
 - Coordination and steering: NOW
 - Project funding
 - ~ 50 % german federation (BMW, BMVI)
 - ~ 50 % involved industry companies
- Main objectives
 - Clean energy supply
 - Global competitiveness for germany/german industry
 - Market preparation and launch of fuel cell applications
 - Extensive demonstration projects



e4ships

Synergy Module „Toplaterne“

Technology

Management

Safety

Ecology

Economy

Rules and regulations

Demonstration Modules

Pa-X-ell (MW, FLW, FSG) Passenger ships

- R&D
- Marinizing
- HT PEM Fuel Cells
- Methanol, NG
- Utilization of heat
- Decentralisation
- Demonstration

SchIBZ (TKMS) Yachts, spec. ships

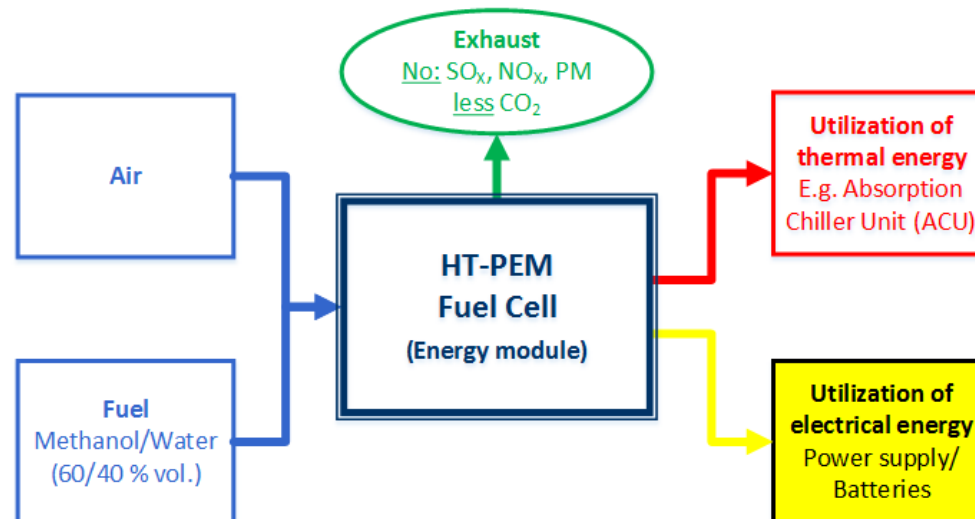
- R&D
- Marinizing
- SOFC
- XTL-Diesel
- Energy storage
- Demonstration

RiverCell (MW, NW) River cruiser

- LNG, LPG, (M)ethanol
- HT PEM Fuel Cells
- Gas engines
- Hybrid systems
- Batteries
- Photovoltaic
- Utilization of heat
- Demonstration

Pa-X-ell

- Fuel cells for use on seagoing ships
- Fuel is a methanol/water-mixture (60/40 vol.-%)
- Utilization of thermal energy
- Increase of energy efficiency
- Decrease of emissions



Pa-X-ell

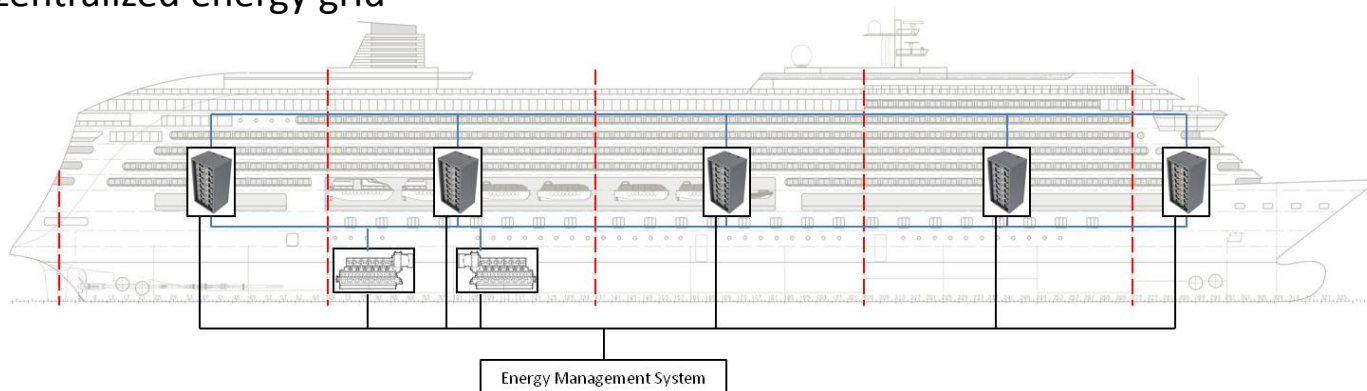
- Development/optimization of the fuel cell systems
- Modular and standard industrial system setup → series production
- Adaption of the systems for maritime use
- Liquid-cooled HT-PEM fuel cells
- 5 kW P_{el} per module (1. Generation)
- Internal H_2 reforming
- Rack design → one row, actual up to 30 kW P_{el}
- SerEnergy – designer and manufacturer



5 kW HT PEM-module
and 30 kW rack
(both © SerEnergy)

Pa-X-ell

- Electrical and thermal energy system
- Decentralized energy grid – decentralization of energy production
 - Low energy flows within the systems
 - Less material and energy demand
 - Modular system setup
 - High redundancy and safety („Safe return to port“)
- Development of rules and regulations
 - Fuel cells
 - Dezentralized energy grid

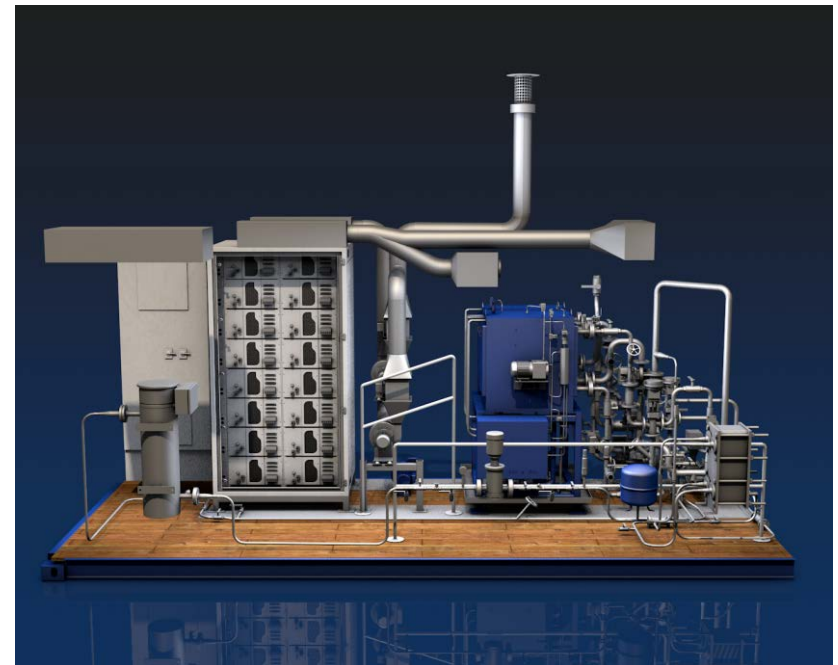


Pa-X-ell

First demonstrator in in Papenburg (MEYER WERFT):



Research facility maritime fuel cells



Design inside the container

Pa-X-ell

Second demonstrator to be installed aboard the ferry MS Mariella:



Container in building phase (housing in centre, bottom group downright)



Container in the final building phase

SchiBZ

- Thyssen Krupp Marine Systems (TKMS) as shipyard and project leader
- Seagoing ships
- SOFC (Solid Oxide Fuel Cell)
- XTL-Diesel as fuel
- Reformer for hydrogen production
- Battery for energy storage



CAD of planned installation
aboard MS Forester © TKMS



SOFC © TKMS

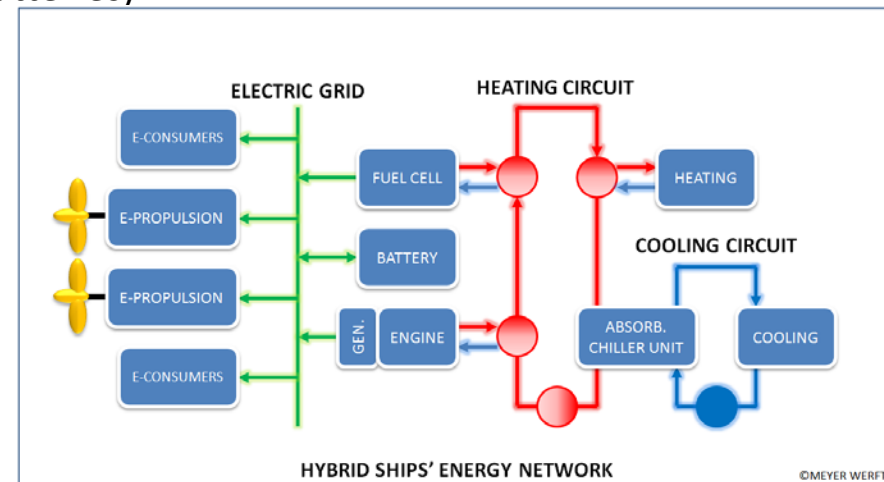
RiverCell

- Fuel cells for river cruisers
- Main differences
 - Layout and design of the ships
 - Driving profile and areas
 - Rules/regulations and responsible authorities
- Other requirements for a system
 - Hybrid energy system (energy converter + batteries)
 - Initially in addition to conventional engines
 - In the future for the overall energy supply



Flusskreuzfahrtschiff VIKING FREYA

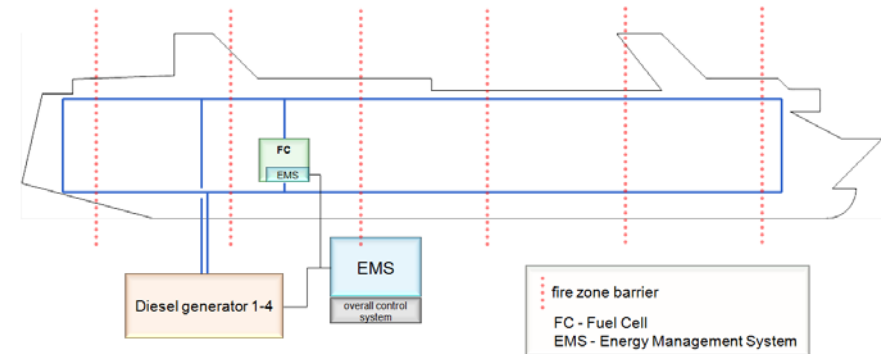
© Viking River Cruises



©MEYER WERFT

Outlook fuel cells

- Further development and optimization
- Power increase
- Continue testing of the demonstrators
 - MEYER WERFT
 - MS Mariella (incl. fuel supply and storage on board)
- Next steps
 - Cruise ship: Supply of one fire zone (approx. 2020)
 - River cruiser: Hybrid energy system for hotel load (approx. 2019)
- Further strong involvement in development of rules and regulations
 - Fuel cells
 - Decentralized energy grids



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