



Use of Fuel Cells under Application of the IGF Code

Stephan Assheuer, CESA

CCC 1 Lunch Presentation, IMO, 09.09.2014



Fuel Cells and the IGF Code

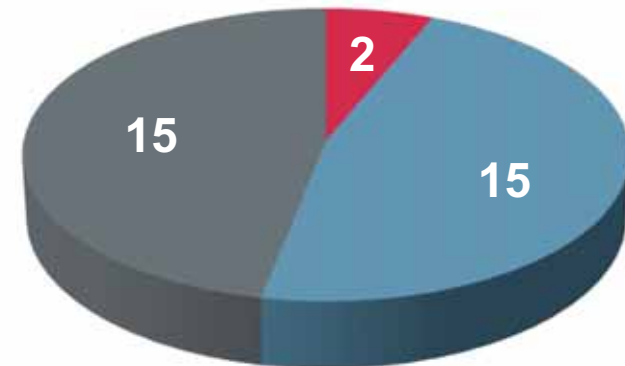
- ≡ New environmentally friendly energy converters are available
- ≡ New environmentally friendly fuels are available
- ≡ Input has been introduced into the IGF Code development since 2009
- ≡ Reliable international regulatory framework is needed ensuring a level playing field and planning reliability
- ≡ Inclusion is required as soon as possible in order not to lose industry momentum



Research activities on ship borne fuel cells



Project Volume [M€]



■ e4ships ■ SchIBZ ■ Pa-X-ell



09.09.14

IMO, CCC 1, Lunch Presentation
Stephan Assheuer, CESA

Research activities on ship borne fuel cells



SchIBZ



- ≡ Framework project
 - ▶ *Focus on safety and application*
- ≡ Fuel cell systems on board of a Passenger Vessel (Cruise and Yacht)
 - ▶ *Focus on integration in ship design, ship safety (SOLAS) and overall efficiency*
- ≡ High Temperature Fuel Cell systems on board of Passenger and Special Vessels
 - ▶ *Focus on application of diesel fuel oil and hybrid design (FC – Battery Buffer)*
- ≡ Fuel Cell systems on board of an inland navigation Vessels
 - ▶ *Hybrid system design (Diesel, Fuel Cell, Energy Buffer)*

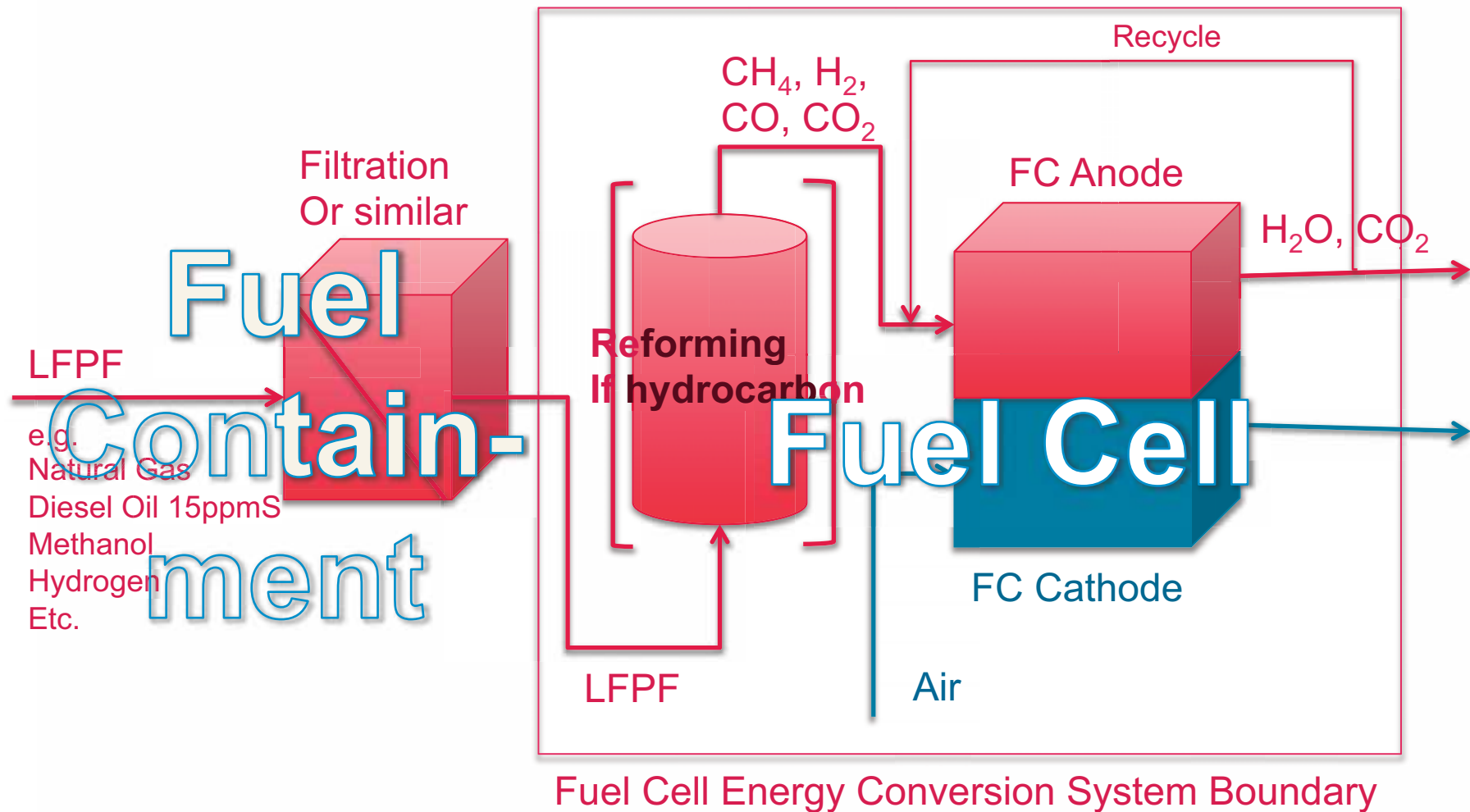


09.09.14

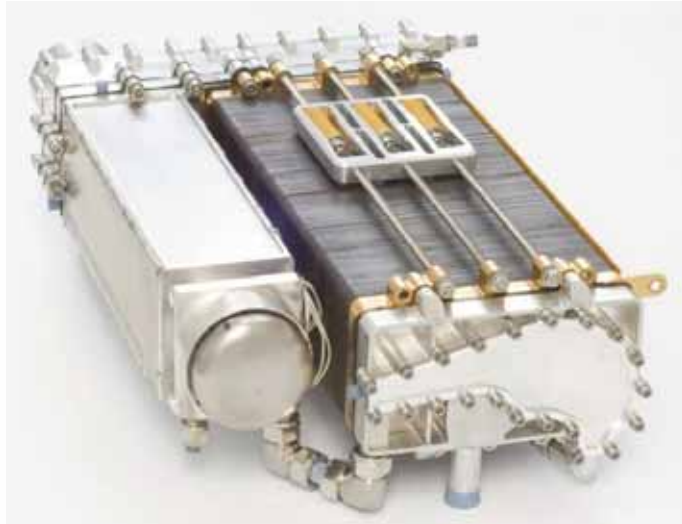
IMO, CCC 1, Lunch Presentation
Stephan Assheuer, CESA

4

Structure of a fuel cell energy conversion system



Types of Fuel Cells and potential fuels



Several fuel types can be used by various type of fuel cells and new reformer technologies expand the portfolio fuels available for fuel cells

Fuel types:

- ≡ LNG
- ≡ Methanol
- ≡ Ethanol
- ≡ Hydrogen
- ≡ LFP Diesel
- ≡ ...

Reformer
technology
(if required)

Available Fuel Cell types:

- | | |
|----------|--------------------------|
| ≡ HT-PEM | High Temperature PEM |
| ≡ PEM | Proton exchange Membrane |
| ≡ AFC | Alkaline FC |
| ≡ MCFC | Molten Carbonate FC |
| ≡ SOFC | Solid Oxide FC |
| ≡ DMFC | Direct Methanol FC |



Actual Achievements of e4ships

- ≡ Diesel reforming: proof of concept over more than 3200h with 10ppmS diesel fuel with the result of a clean fuel gas
- ≡ SOFC Module: construction of a 27kW SOFC module for ship borne use, test with minimal degradation over more than 1000h, electrical efficiency 50+%
- ≡ Systems: design of multiple module 30kW HTPEM and 100kW SOFC systems ready to commercial use



Marine Fuel Cell application



- ≡ 120 kW Fuel Cell Container – Methanol Fuel Cell Rack with auxiliary equipment
- ≡ In operations since May 2014 for long term trials
- ≡ Design and safety aspects based solely on class rules as statutory requirements were not available

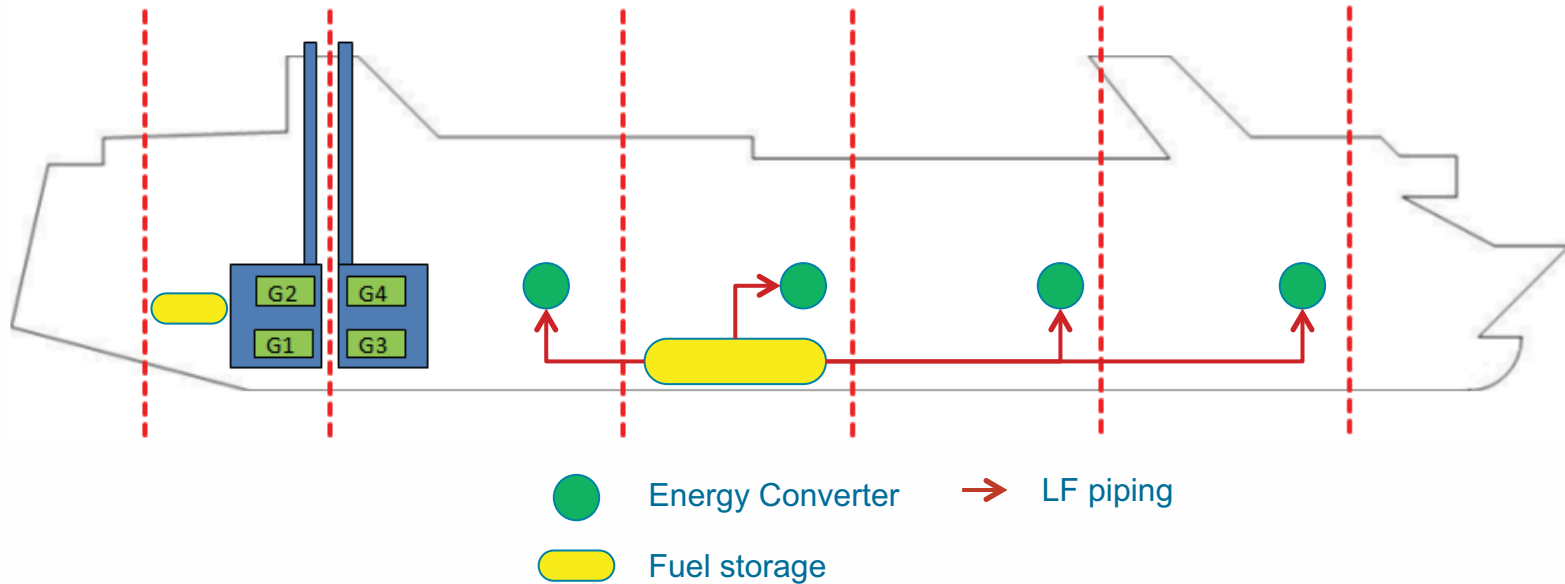


09.09.14

IMO, CCC 1, Lunch Presentation
Stephan Assheuer, CESA

8

Distributed Energy Conversion and Integration



- ≡ Fuel cells in different fire zones
- ≡ Safe supply of fuel cells
- ≡ Thermal integration of Fuel cells
- ≡ Electrical integration of Fuel cells

- ▶ SOLAS
- ▶ IGF piping for low-flashpoint fuels
- ▶ increased fuel efficiency
- ▶ development of control, energy buffer



09.09.14

IMO, CCC 1, Lunch Presentation
Stephan Assheuer, CESA

9

SchIBZ – Application of Solid Oxide Fuel Cells



- ≡ 100 kW_{el} high-temperature fuel cell for seagoing vessels has been developed and manufactured
- ≡ SOFC is fuelled with low flash point diesel oil
- ≡ 100 kW demonstrator unit: end 2014
- ≡ Installation onboard 2015



09.09.14

IMO, CCC 1, Lunch Presentation
Stephan Assheuer, CESA

10

Work Package Rule Development

- ≡ Main project partner for this package DNV and GL (today DNVGL)
- ≡ Definition of functional safety requirements for Fuel Cell applications
- ≡ HAZID/FMEA: Evaluation of the designs by DNVGL for failure modes according to class rules and IGF code
- ≡ Deduction of IGF Code Requirements for Fuel Cells for submission to the IMO through the German Government and CESA
- ≡ Improvement of Class rules



Other Research activities on ship borne fuel cells

- ≡ FellowSHIP: a project which started in 2003, operating a 330KW FC on board Viking Lady since 2009
- ≡ DCNS: project FILHyPyNE for the application of PEM fuel cells in Fishing Vessels
- ≡ Fincantieri/Nuvera: Cooperation for the application of PEM fuel cells in vessels



Fuel Cell Ships in Service



09.09.14

IMO, CCC 1, Lunch Presentation
Stephan Assheuer, CESA

13

Conclusion

- ≡ Fuel Cells have an enormous potential for environmental and climate protection
- ≡ Fuel Cell technology is not a vision, it is reality
- ≡ Fuel Cell technology is not limited to hydrogen as fuel
- ≡ Classification Societies gained experience with fuel cells and have class rules in place providing a sound basis for proposed IGF Code requirements



Conclusion in view of the IGF Code

- ≡ Finalization of the IGF Code at this session to provide planning reliability
- ≡ Inclusion of Fuel Cells as energy converter for LNG
- ≡ Inclusion of low flash point fuels other than LNG which have been discussed for several sessions (diesel, methanol)
- ≡ Broad definition of low flashpoint fuels in general to be open for future developments





e4ships

Brennstoffzellen im maritimen Einsatz



Thank you for your kind attention!

www.e4ships.de



AIDA Cruises | CMT Center of Maritime Technologies | DNV GL | DLR | Flensburger Schiffbau-Gesellschaft | Fr. Lürssen Werft | hySOLUTIONS | Imtech Marine Germany | INVEN Engineering | Leibniz Universität Hannover | MEYER WERFT | OWI Öl-Wärme-Institut | Reederei Rörd Braren | Serenergy | Sunfire | ThyssenKrupp Marine Systems | VSM Verband für Schiffbau und Meerestechnik | ZBT Zentrum für BrennstoffzellenTechnik