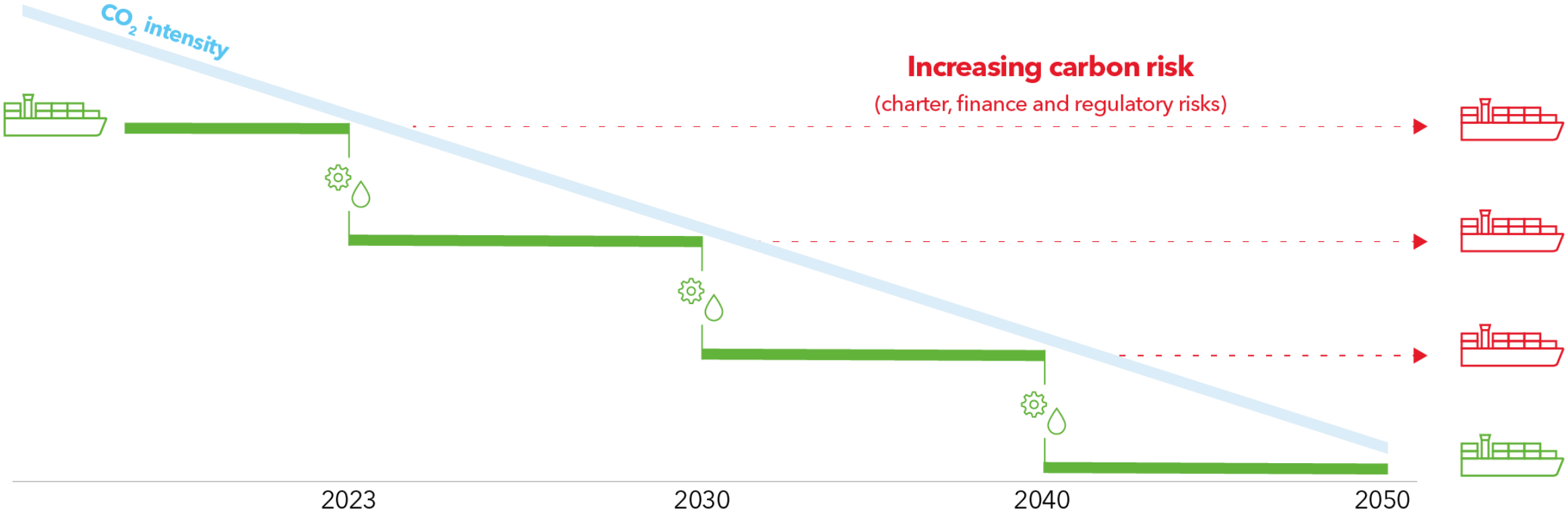
WHEN TRUST MATTERS

Alternative Antriebsarten aus Sicht der Klassifikation - Herausforderungen und Perspektiven

Benjamin Scholz

08 November 2021

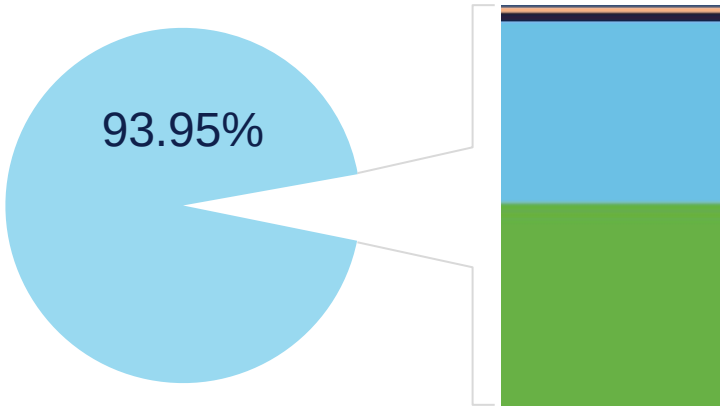
Owners must identify their own ***"decarbonization stairway"*** to manage carbon risk



The fuel transition in shipping has started and is gaining momentum

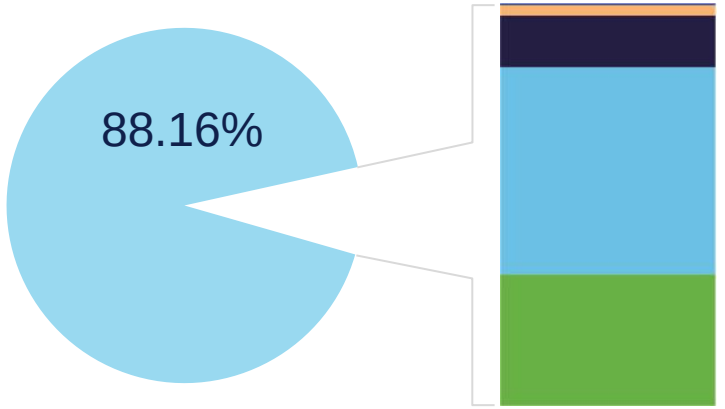
Ships on order

2019



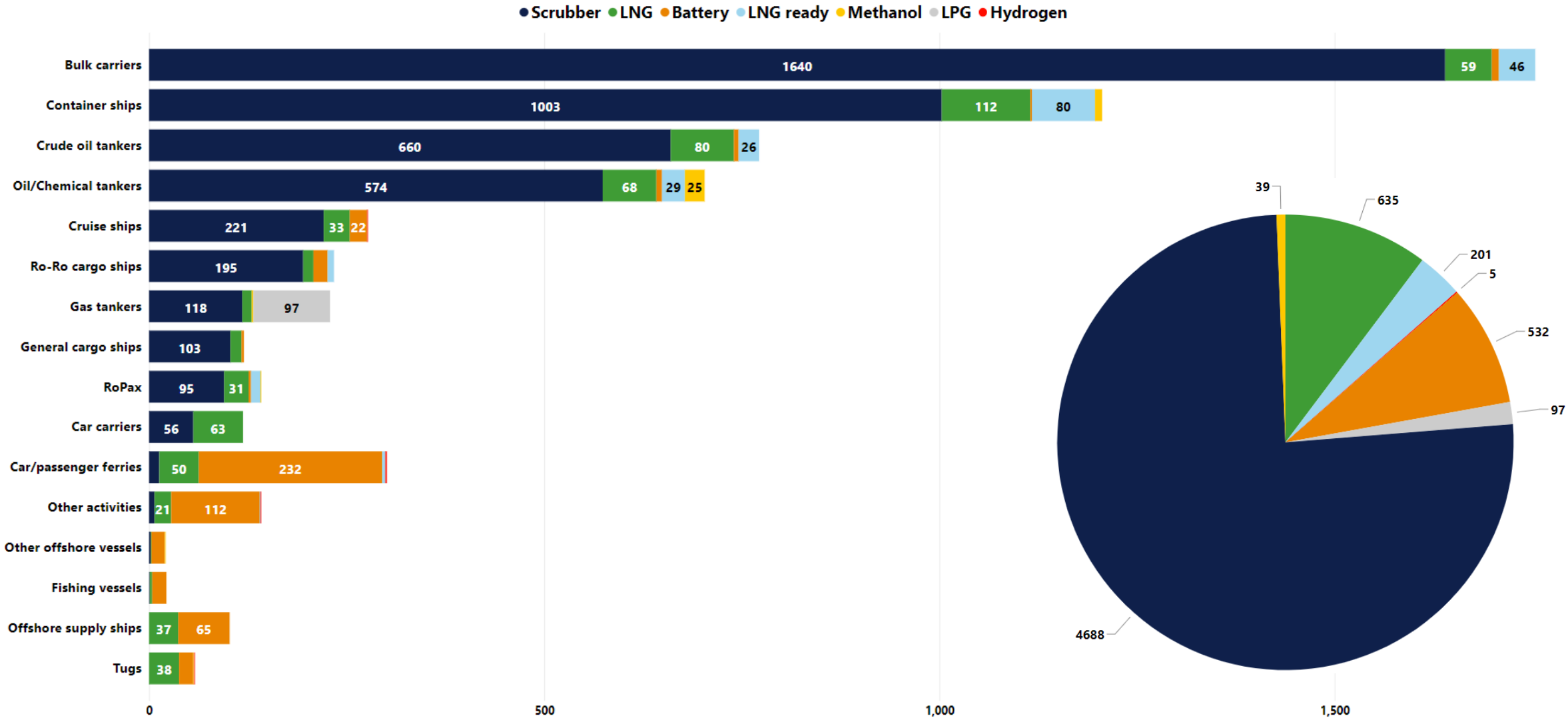
Hydrogen	0.04%
Methanol	0.08%
LPG	0.13%
LNG	2.73%
Battery	3.07%
Total	**6.05%**

2021



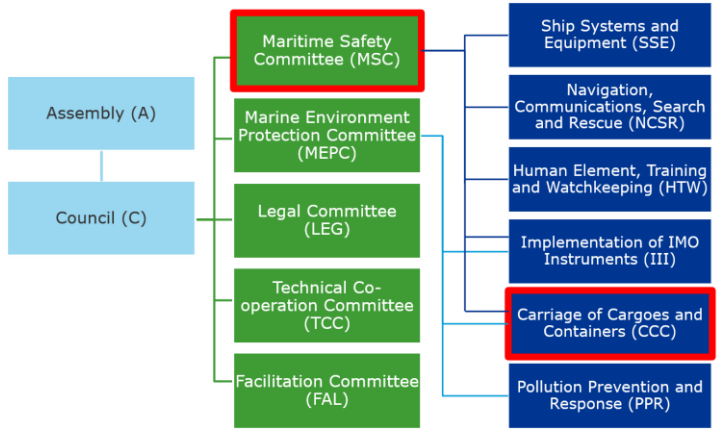
Ammonia	0.02%
Hydrogen	0.06%
Methanol	0.30%
LPG	1.51%
LNG	6.10%
Battery	3.85%
Total	**11.84%**

Total number of ships (in operation and on order)



Overview Rules and Regulations (seagoing vessels)

International Maritime Regulations



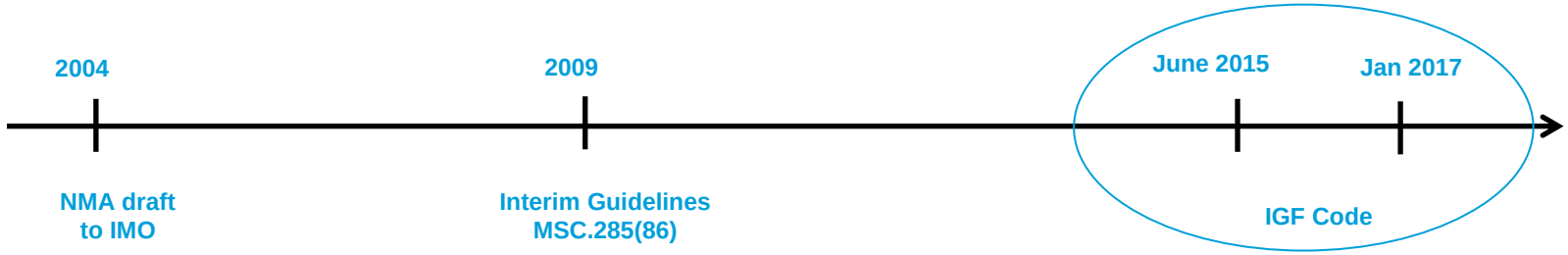
Class Rules

International Standards

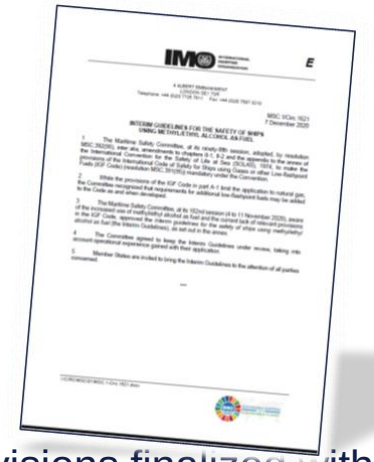
National Regulations

The development of the IGF code

(International Code Of Safety For Ships Using Gases Or Other Low-Flashpoint Fuels)

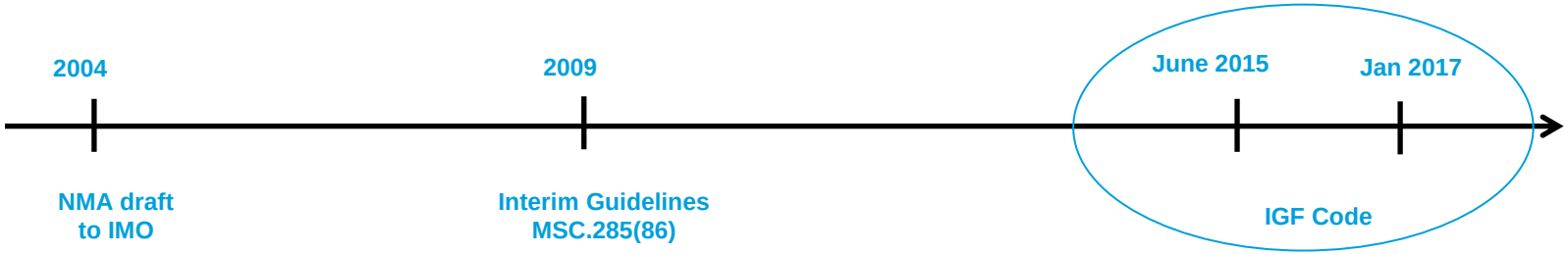


- The IGF Code was adopted by IMO in June 2015 (MSC95) and is in force since 1. January 2017
  - Secondary barrier principle
  - Mandatory for all gas and other low flashpoint fuel ships
- Currently only detailed requirements for natural gas
  - Fuel specific chapters (Part A-1 until C-1 for natural gas)
  - Fuel independent chapters (Part D)
- Other low flashpoint fuels allowed; approval based on alternative design approach
  - More detailed provisions for methyl/ethyl alcohol fuels were under development at IMO, technical provisions finalized within CCC6 in 2019
  - Adoption of the Interim Guideline at MSC 102, Nov. 2020



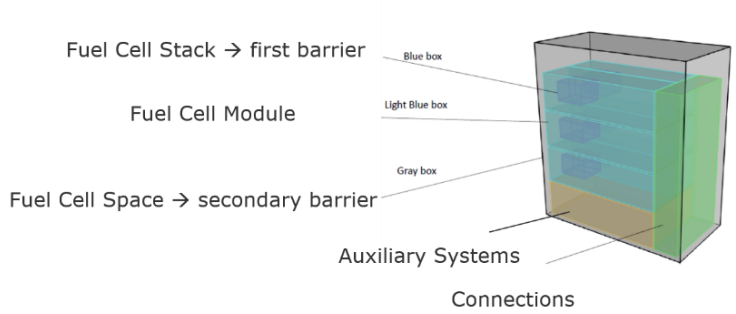
The development of the IGF code

(International Code Of Safety For Ships Using Gases Or Other Low-Flashpoint Fuels)

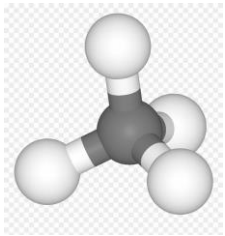


Related to Fuel Cells:

- Decision to develop a chapter E related to technical requirements for fuel cells (fuel independent)
- Decision at CCC5 (Sept. 2018) to develop first Interim Guidelines
  - No mandatory code, flag approval required
  - Storage of Hydrogen excluded
- These guidelines were finalized during CCC7 in September 2021 (to be adopted by MSC 105th session)
- Hydrogen / Ammonia is on the Agenda since CCC 7, Development of technical requirements for hydrogen/ammonia as fuel shall be finalised until 2024

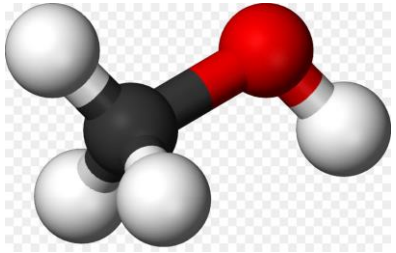


LNG
Comparison to HFO



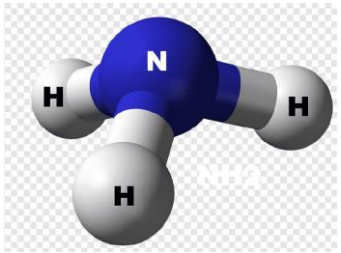
Subject		Description		
Source		Natural gas - main component methane (CH_4) a GHG		
Emission (2-stroke)	SO_X	minus 95 to 98%		
	NO_X	minus 75 to 80%		
	CO_2	minus 14 to 25%	(methane slip convert to CO_2 for low pressure engine)	
International Regulation		existing		
Impact on EEDI / EEXI / CII		yes	yes	yes
Bunker facilities		Rotterdam, Singapore, fast development at other places		
Energy density		higher +19%		
Tank volume		plus ~100%		
Main Engine	Generator	available, built and in operation	available, built and in operation	
Green production		technology available – time prediction +8-10 years		

Methanol
Comparison to HFO



Subject		Description		
Source		Mainly natural gas or coal – from renewable resources as well		
Emission (2-stroke)	SO_X	minus 95 to 98%	same for green methanol	
	NO_X	minus 25 (to 80% with EGR/SCR)	same for green methanol	
	CO_2	minus 5 to 10%	up to minus 80% for green methanol	
International Regulation		Interim guidelines		
Impact on EEDI / EEXI / CII		yes	yes	yes
Bunker facilities		Not developed for deep sea shipping – only by truck or small bunker ships		
Energy density		lower -50%		
Tank volume		plus ~150%		
Main Engine	Generator	available, built and in operation	available, built and in operation	
Green production		technology available and in production		

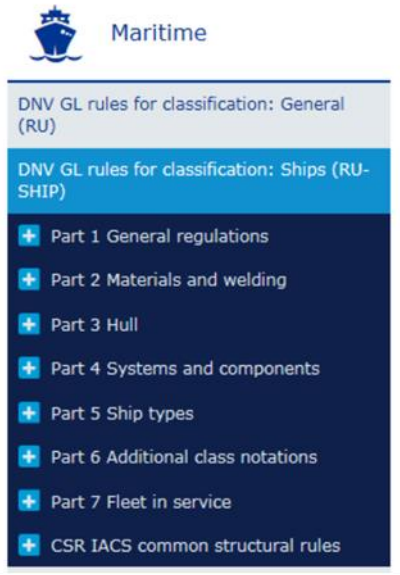
Ammonia
Comparison to HFO



Subject		Description		
Source		Chemical combination of nitrogen and hydrogen		
Emission (2-stroke)	SO_X	minus 95 to 98% (due to pilot fuel) ↑		
	NO_X	Uncertain – SCR systems most likely to be used for NO_X Tier-III →		
	CO_2	minus 80-90% (due to pilot fuel 100% not possible) ↑		
International Regulation		alternative design approach ⊗		
Impact on EEDI / EEXI / CII		yes	yes	yes
Bunker facilities		Not developed ⊗		
Energy density		lower -50% ↓		
Tank volume		plus ~280% ↓		
Main Engine	Generator	not available (schedule 2024-2026) ⊗	not available (schedule 2024-2027) ⊗	
Green production		Haber-Bosch process, electrolysis of water with green electricity		

DNV Rules

- DNV RU SHIP Pt. 6 Ch. 2 Sec. 3 ‘FUEL CELL INSTALLATIONS’
- DNV RU SHIP Pt. 6 Ch. 2 Sec. 5 GAS FUELLED SHIP INSTALLATIONS - GAS FUELLED LNG
- DNV RU SHIP Pt 6. Ch. 2 Sec. 6 LOW FLASHPOINT LIQUID FUELLED ENGINES -LFL FUELLED
- DNV RU SHIP Pt. 6 Ch. 2 Sec. 8 GAS READY SHIPS - GAS READY
- DNV RU SHIP Pt. 6 Ch. 2 Sec. 13 GAS FUELLED SHIP INSTALLATIONS - GAS FUELLED LPG
- DNV RU SHIP Pt 6. Ch. 2 Sec. 14 GAS FUELLED AMMONIA



Main safety principles – fuel gas arrangement on board

Segregation

Protect gas fuel installation from external events

Double barriers

Protect the ship against leakages

Leakage detection

Give warning and enable automatic safety actions

Automatic isolation of leakages

Reduce consequences of a leakage

Main safety principles

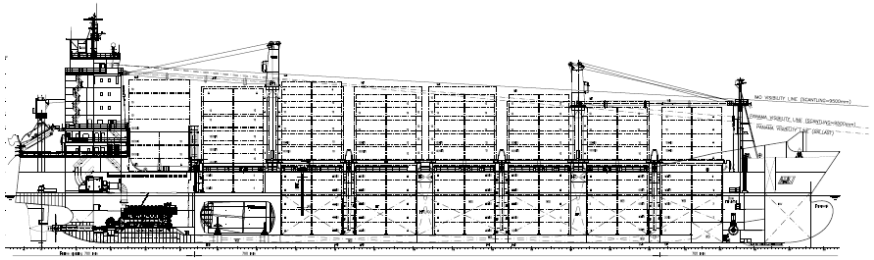
Main safety principles

Main safety principles

Main safety principles

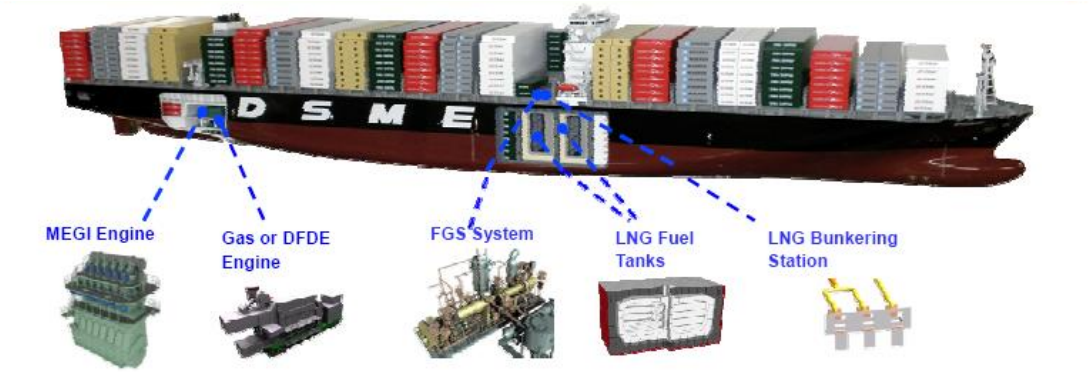
Main safety principles

Projects exploring LNG as ship fuel for container vessels

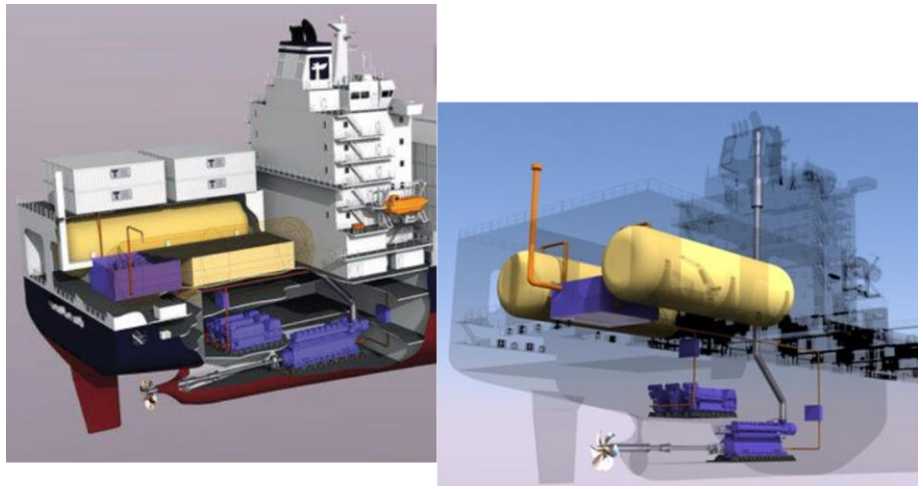


GL 1200 TEU feeder (2009)

IPP 4200 TEU (2011), AiP* by GL

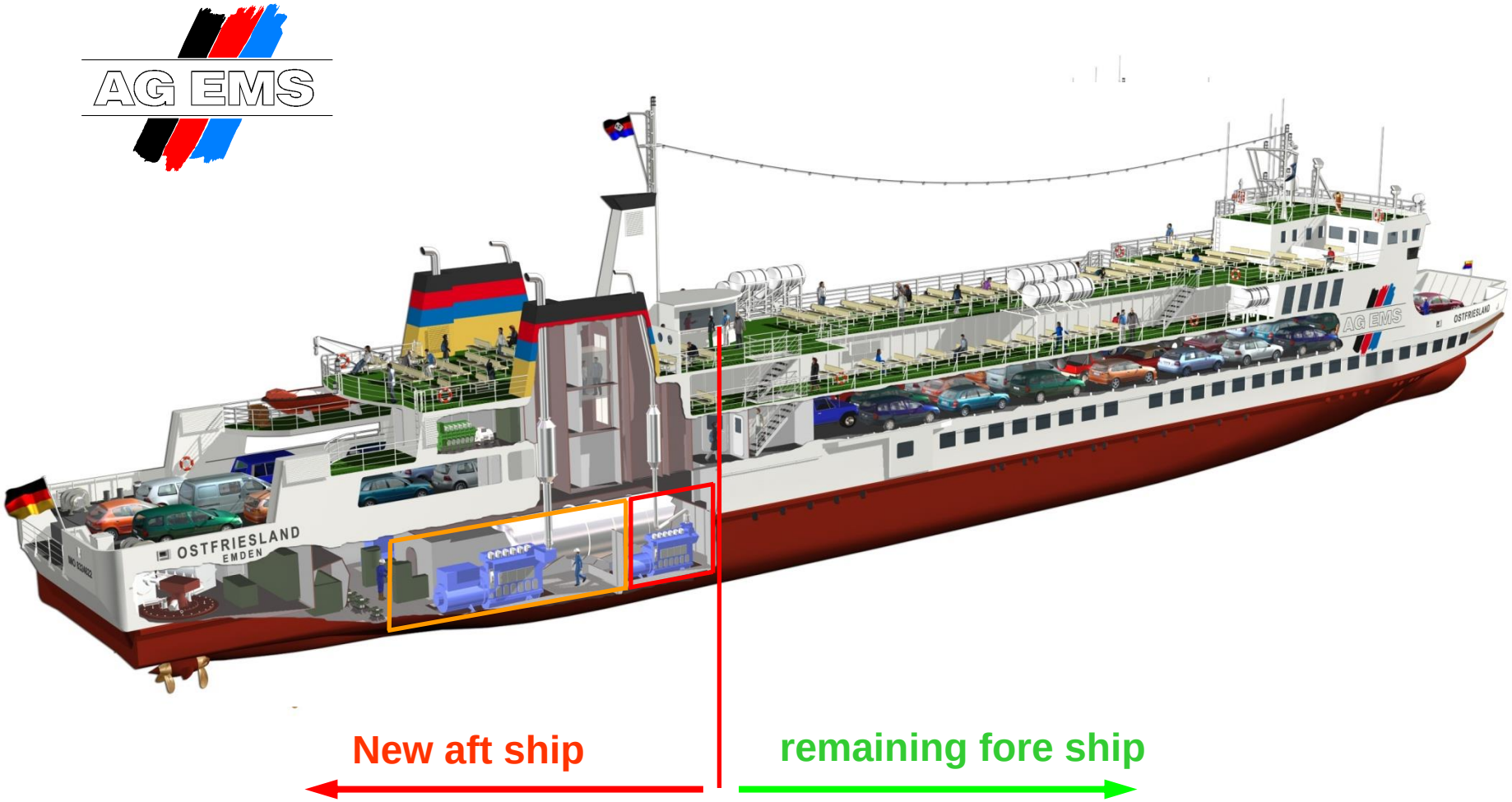


DSME 14000 TEU (2011), AiP* by GL

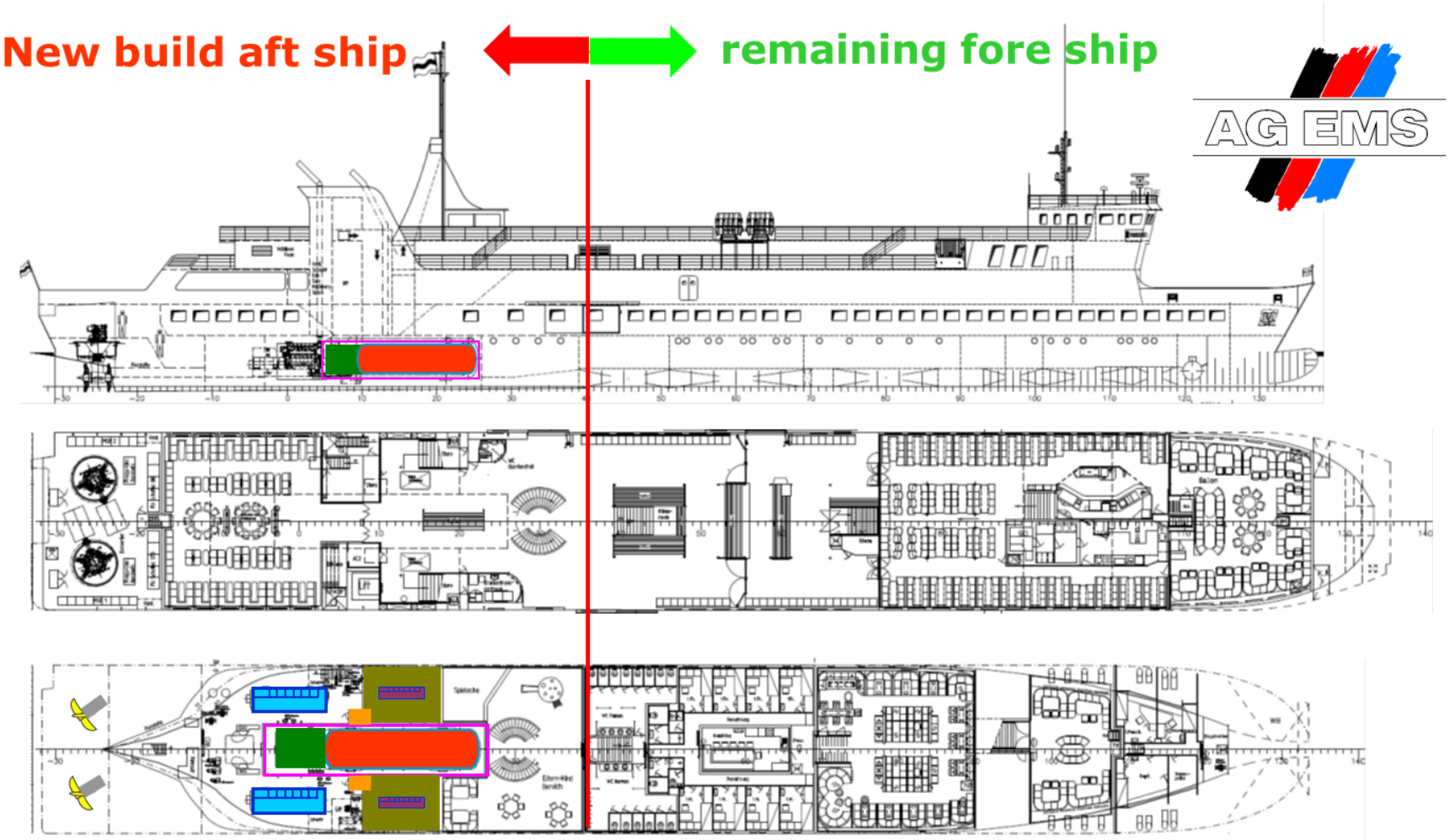


*) Approval in Principle

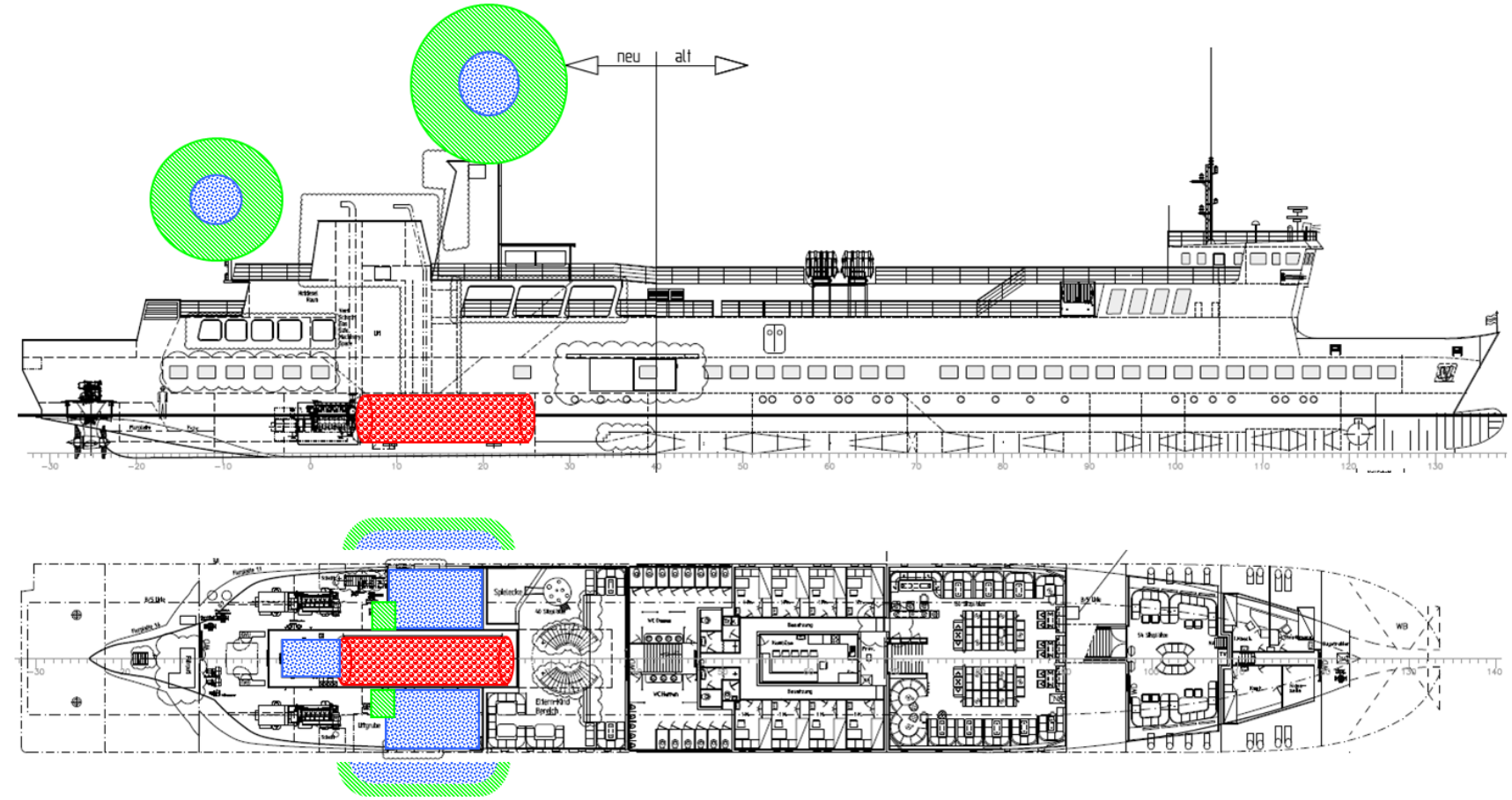
Conversion car / passenger ferry Borkum - Emden



Conversion MS Ostfriesland / Overview



LNG as Ship Fuel - Hazardous Area Plan



Cut off of the Ostfriesland Aft section

Methanol as fuel

Source: www.norderlesen.de

Fuels

Maersk orders world's first methanol-fueled container vessel

July 12, 2021

Photo courtesy of A.P. Moller - Maersk

Hydrogen Fuel cell application
World's first ferry using liquefied hydrogen and fuel cells

Yard: Westcon Yards AS

Designer: LMG Marin AS

Type of vessel: Ferry B

Length over all: 82.40 m

Owner: NORLED, Norway

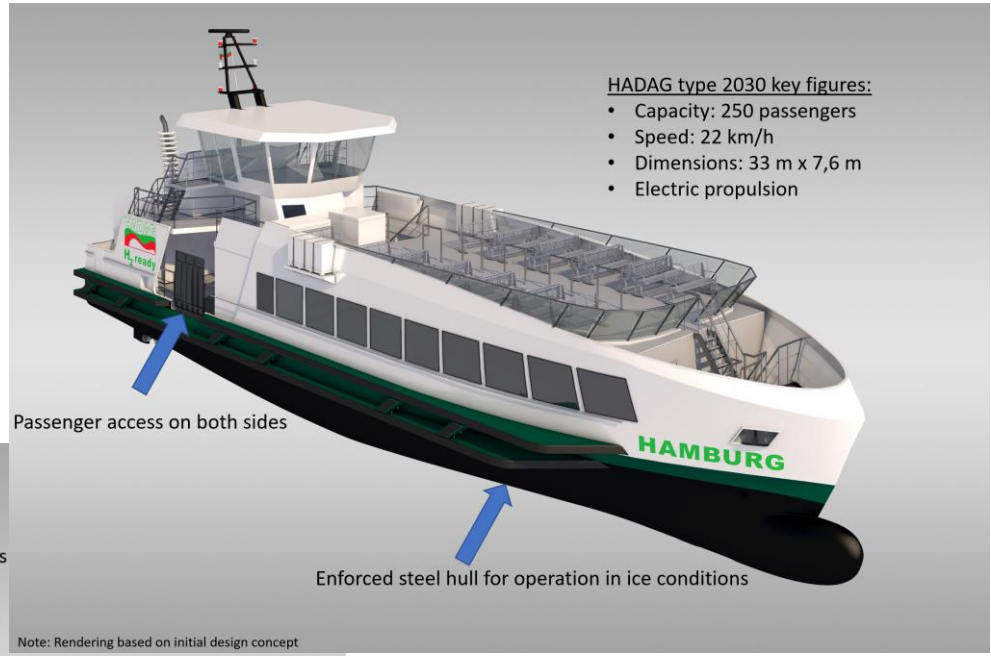
+1A LC Ferry(B) Battery(Power) E0 R4(nor) ***Fuel Cell(safety)***

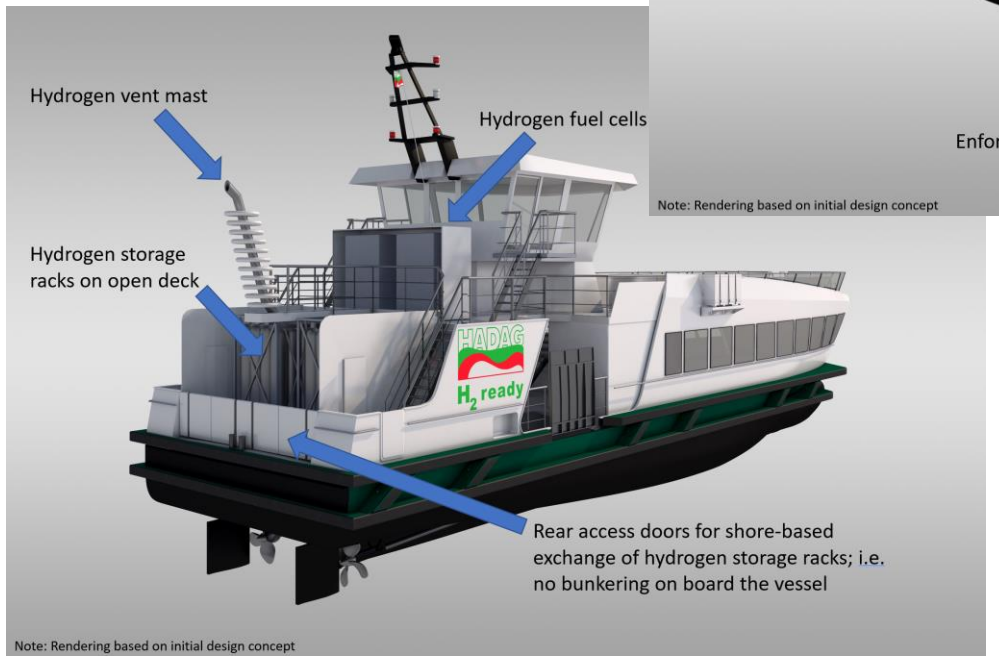
- PEM-Fuel Cell
- Primary fuel: Hydrogen
  - Hydrogen flow rate @200 kW: 3,5 g/s
- DNVGL Type Approval of maritime fuel cell system from Ballard (200 kW) in progress
  - Based on the draft Interim Guideline for fuel cells and DNVGL Pt. 6, Ch. 2, Sec. 3

The hydrogen fuel plant consists of two Ballard Fuel Cell modules of 200kW each and a 74m3 vacuum-multi-layer insulated LH2 tank.

Hydrogen Fuel cell application Concept of HADAG Type 2030

- Main Particulars:
  - Dimension 33 m x 7,6 m
  - Capacity 250 passengers
  - Electric propulsion (redundant batteries with fuel cells as range-extender)
- Overall Safety Concept:
  - Separation of passenger and technical area (storage of hydrogen and installation of the fuel cells)
  - Short distances between the hydrogen system components
  - Bunkering via exchange of hydrogen racks at dedicated pier
- Hydrogen storage: two racks with compressed hydrogen (appr. 500 bar)
- Fuel cells: appr. 400 kW located in a dedicated room





Hydrogen Fuel cell application: HyShip

HyShip part of decarbonisation journey in shipping

- The Topeka vessel will be built for zero emission through a combination of 1,000 kWh battery capacity and a three-megawatt PEM (proton exchange membrane) hydrogen fuel cell. Hydrogen will be sourced from the new LH2 production plant planned at Mongstad outside Bergen by BKK, Equinor and Air Liquide.

- DNV GL to
  - Contribute transnational regarding hydrogen systems / fuel cells,
  - assist the consortium regarding safety related questions of zero emission concepts.

Further fuel cell applications: Freudenberg / Methanol

- FC onboard Passenger Vessel – Pa-X-ell 2 Phase 2
- Project duration: 2019 - 2022
- Development of methanol fuel cell system for onboard power supply
- Test onboard AIDAnova beginning in 2021

- Project Partners:
  - Meyer Werft
  - Lürssen Werft
  - Freudenberg
  - DNV GL
  - DLR
  - AIDA Cruises
  - Besecke
  - EPEA.

- Strictly Confidential -

Freudenberg's portfolio strategy for deep sea applications offers a multi-fuel approach for fleet operators

Fuel Cell System with integrated **Methanol reforming** process
=> **Zero Emission** by renewable Methanol

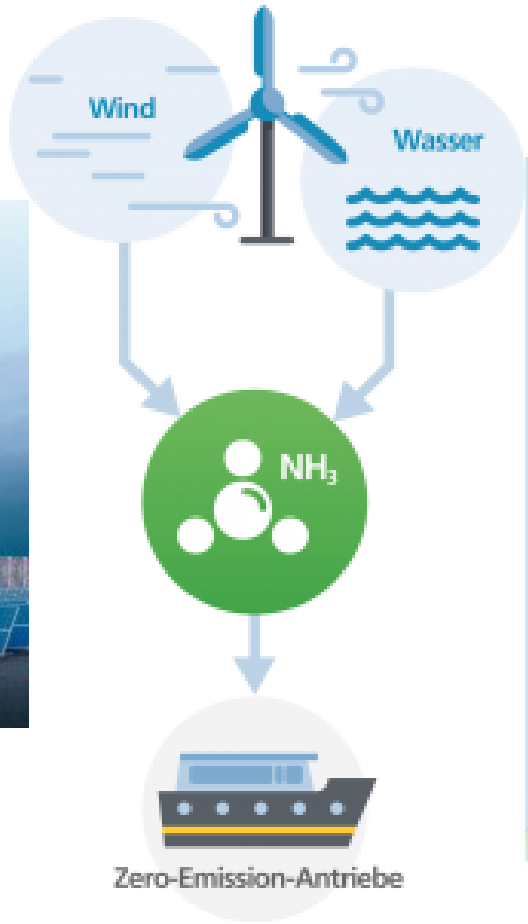
Fuel Cell System with integrated **LNG reforming** process
=> **Ultra Low Emission** without methane slip

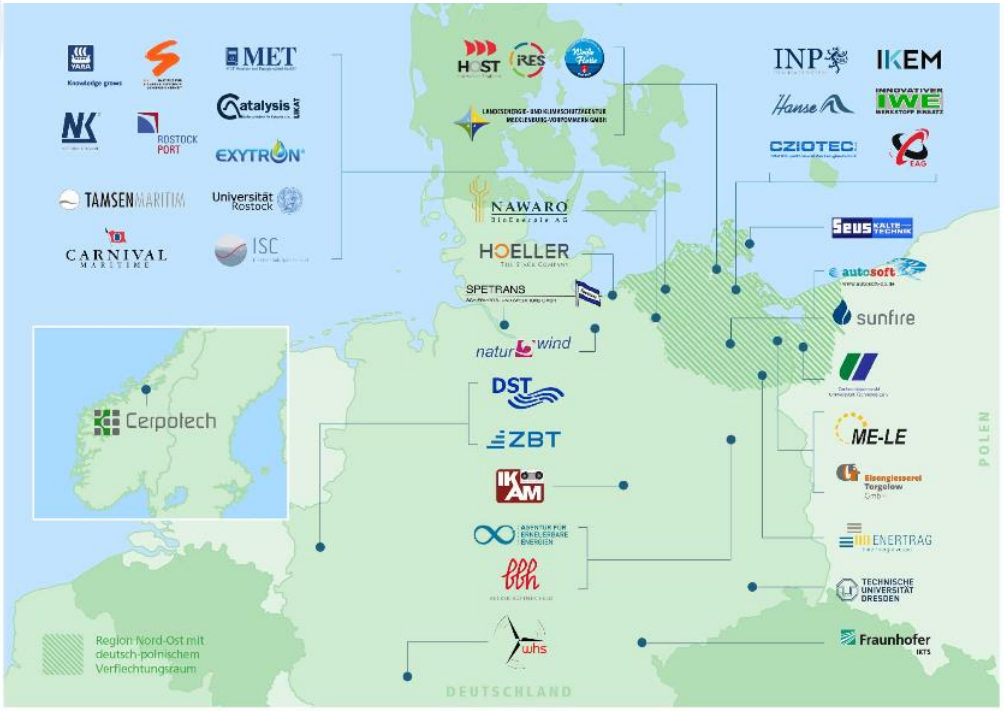
On board production of hydrogen for maximum ranges and easy fuel handling - Besides new-builds easy retrofit and continued FC power ramp-ups @vessels by use of existing fuel infrastructure

FREUDENBERG
SEALING TECHNOLOGIES
Page 14

FREUDENBERG
INNOVATING TOGETHER

Campfire:Wind und Wasser zu *Ammoniak* – maritimer Kraftstoff und Energiespeicher für eine emissionsfreie Zukunft





Summary alternative fuels – Services DNV

Classification

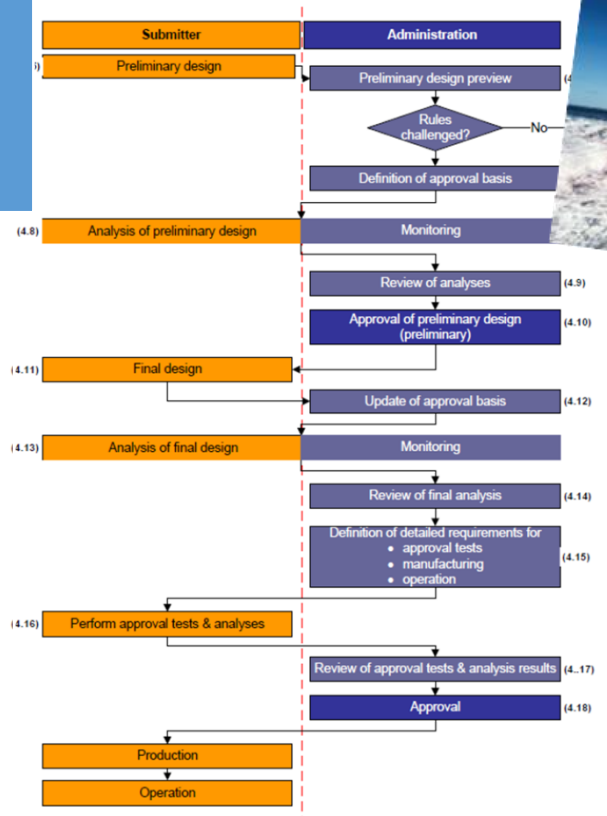
- Type approval of alt. fuel systems and components
- Classification of ships using alt. fuels
- Survey of ships using alt. fuels
- Approval in Principle (AiP) for alt. fuel ship installations

Advisory

- Facilitation/support of Alternative Design Approval processes
- Alternative design and arrangement analysis of onboard alt. fuel systems
- Technology Qualificaiton of hydrogen, fuel cell and bunkering systems (based on DNV GL RP)

- HAZID, FMECA, HAZOP, QRA, CFD and Explosion Risk Analyses
- Alt. fuels and fuel cell systems and components on board vessels
- Alt. fuel bunkering process and arrangement
- Support on the development of port specific alt. fuel bunker guidelines

- Feasibility studies of alternative fuels including hydrogen



Thank you for your kind attention!

Benjamin.scholz@dnv.com
0160 5387873

www.dnv.com