



FREUDENBERG e-Power Systems

Maritime Fuel Cell Systems with integrated fuel reforming

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Who we are: A global technology champion with long-term focus

Freudenberg Business Groups



e-Power Systems
HD Battery & FC Systems



Sealing Technologies



Vibracoustic



EagleBurgmann



Performance Materials



Medical



**Home & Cleaning
Solutions**



Chemical Specialties



Oil & Gas Technologies



Filtration Technologies



Japan Vilene Company

Key Facts Freudenberg

> €11.7bn
sales

> 5%
R&D quota

~ 60
countries

> 50,000
employees

> 50%
equity

> 170
years history

Freudenberg Combined Long-Term Component Expertise

Complemented by targeted acquisitions to enter FC system market

Business Group e-Power Systems

Freudenberg Fuel Cell e-Power Systems



Freudenberg Battery Power Systems



TRUCK & BUS



MARITIME



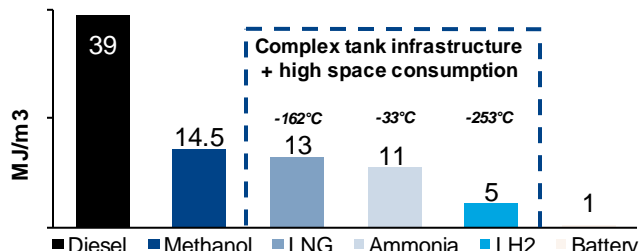
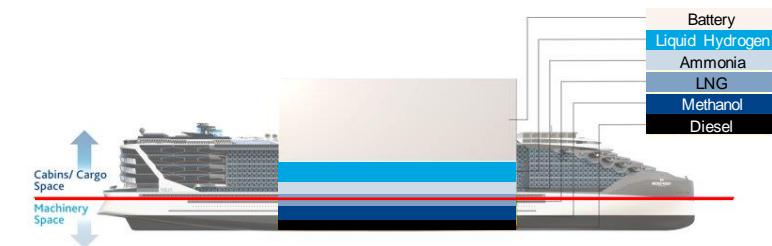
Fuel Cells designed for use
in heavy-duty systems
with the highest **lifetime**,
quality and durability
requirements

Lifetime heavy-duty system (**>35,000 h**) vs.
passenger car (5 - 8,000 h)

Target Market Maritime

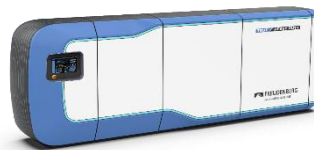
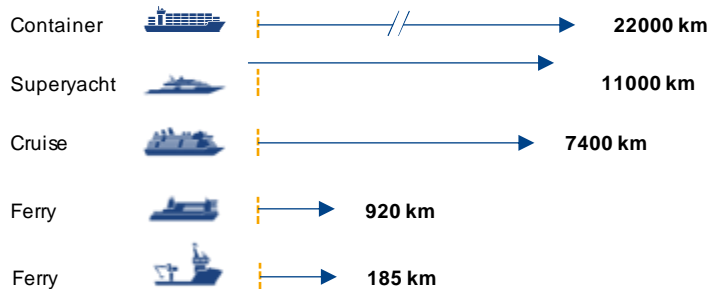
Pure hydrogen as energy storage is no option for most maritime segments

STORAGE SIZE REQUIRED TO ACHIEVE SAME RANGE



Green Methanol has best usable space ratio in maritime

RANGE REQUIREMENTS



Fuel Cell Systems with integrated fuel reforming meet maritime range requirements & best TCO

Strong partnership with power to industrialize in large-scale

Project HyCruisE

Development of a large-scale PEM fuel cell system with integrated fuel reforming for the LNG/Syngas fuel type in the power class 500 kW.

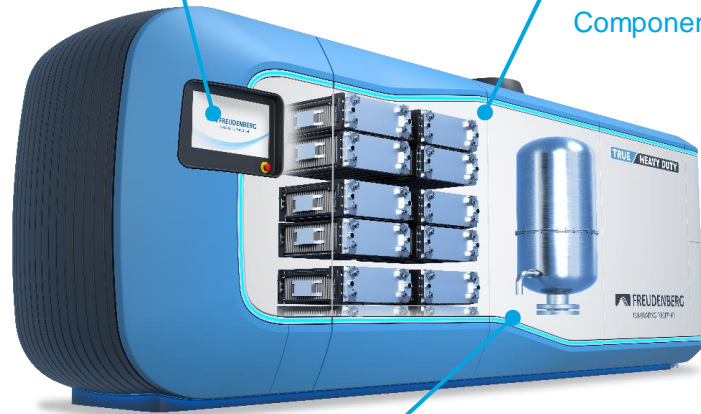


Electronic Module

Electrical Infrastructure
+ Control System /
Safety

Fuel Cell Modules

Stacks + Balance of Plant
Components



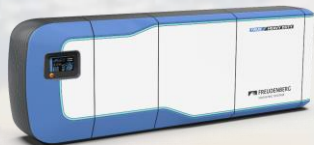
Illustrative image

Hydrogen Supply Module

- Media Interfaces
- Fuel Reformer

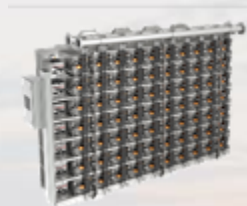
The Future is happening

Large-scale demonstration project within a strong consortium



4 MW Freudenberg Fuel
Cell - **LNG 500 System**

1.6 MWh Freudenberg
Batterie System



Royal
Caribbean
Group

SILVER SEA – Evolution Class
First ship class with
carbon-neutral hotel load

2027+

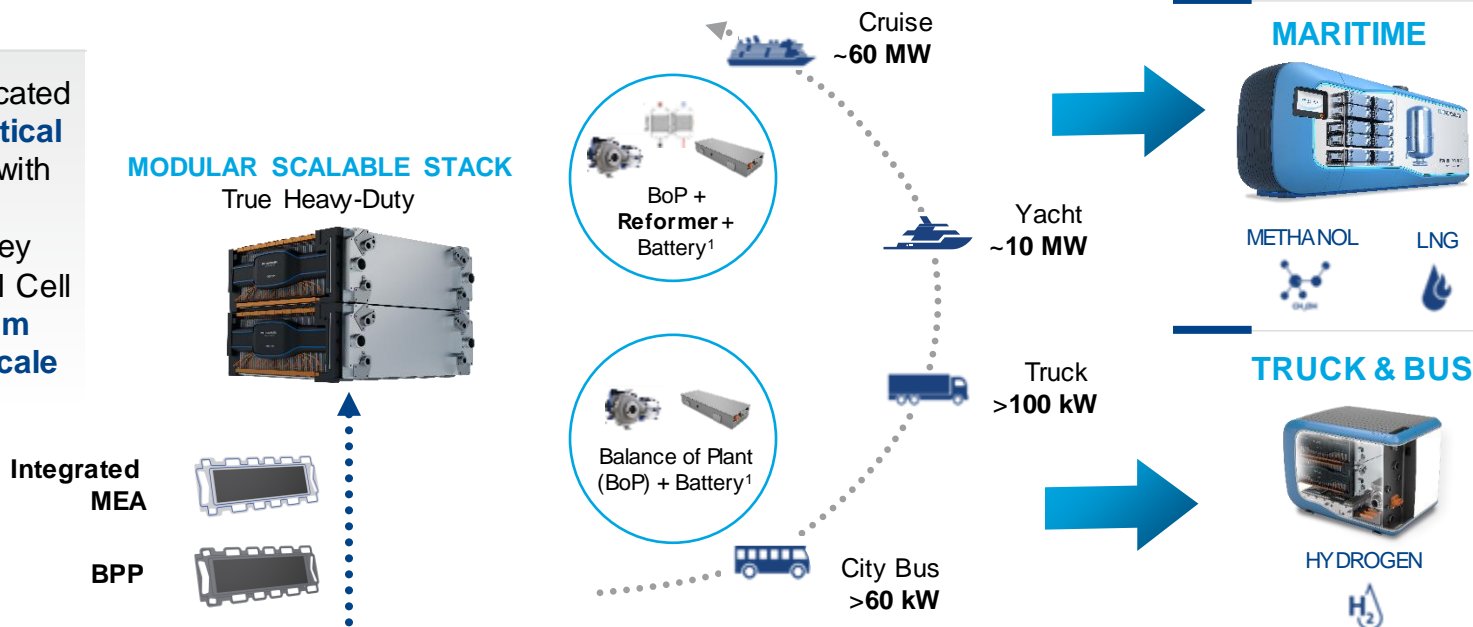
**CO₂ neutral
vessels**

**Powered by Fuel Cell
and Batteries only**



Maximize Economies of Scale in Heavy-Duty Markets

Heavy-duty dedicated **strategy of identical parts** combined with **deep vertical integration** for key components Fuel Cell unleash **maximum economies of scale**



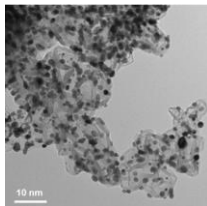
FEPS lifetime and efficiency optimized technology optimized for various heavy-duty segments like deep-sea vessels

Key Success Factors for True Heavy-Duty Fuel Cells

Freudenberg USPs

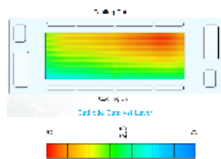
PROPRIETARY CATALYST PRODUCTION

Significantly better degradation results than leading market players
35.000 - 50.000 h lifetime expected



STACK DESIGN COMPETENCE FOR ADVANCED LIFETIME

Temperature range <6K and extremely low pressure drop to achieve true heavy-duty lifetimes and meet **highest efficiency** targets



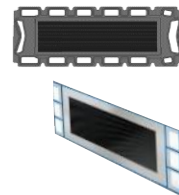
CERTIFICATION AND REGULATION COMPETENCE

Maritime Safety Concept fully in line with current IGF codes.
Type approval already achieved for MeOH100



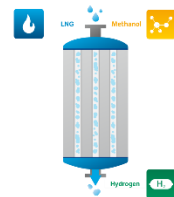
INTEGRATED MEA AND HEAVY-DUTY BPP

Durable and low-cost cell design validated - testing of new "SMARTR" generation already started



MARITIME TECHNOLOGY: INTEGRATED FUEL REFORMING

Efficient gas process proven:
CO values <10 ppm
Allows fuel flexibility for customers



PROCESS INNOVATIONS TO REDUCE COST

Implemented **pilot manufacturing line with 60 MW/a**
Including process innovation.
Transition of patented manufacturing process into roll-to-roll process ongoing





Thank you for
your attention!