CLEANTECH COMPETENCE

Maritime fuel cell hybrid propulsion systems

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PROTON MOTOR
Fuel Cells · Power Systems

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Who We Are

Proton Motor Fuel Cell GmbH is an complete energy solutions provider with A focus on developing and manufacturing LT-PEM fuel cell systems

- PEMFC development since 1994 (Magnet Motor),
- PM founded 1998 as independent company,
- Today 75 employees.
- Focus on providing complete energy solutions in maritime, transport and stationary applications

- Proton Motor Fuel Cell GmbH, Headquarters Puchheim
- Production plant, labs & offices on ca. 6000 m^2.
- Complete development cycle from feasibility studies to delivery on onsite training

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Proton Motor History

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Start development of Fuel Cell Technology

1994

Bayernbus set into operation

2000

Foundation Proton Power Systems PLC

2006

World first Triple Hybrid City Bus

2009

EPS System installed in Bachhausen

2012

Cooperation with Deutsche Bahnbau Gruppe

2015

1998

Foundation Proton Motor Fuel Cell GmbH

2001

World first Fuel Cell Fork Lift

2008

Fuel Cell Ship “Alsterwasser” in operation

2011

Road approval Newton with HyRange®

2015

Integration of Spower GmbH

2016

Presentation of FC REEV vehicle

Maritime Customer Application: FCS Alsterwasser

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ZEMSHIPS Project, Hamburg

- Zero Emission Fuel Cell Ship
- Capacity for approx. 100 passengers
- ZEMSHIPS project partner: ATG, Linde, German Lloyd, Stadt Hamburg, Proton Motor
- Proton Motor was responsible for the complete propulsion system of the ship
- In use since summer 2008 → in approx. 4’000 operating hours more than 50’000 passengers were transported *(01/2014)*
- 1.7 kg hydrogen consumption per operation hour

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Hybrid Setup & Power Management

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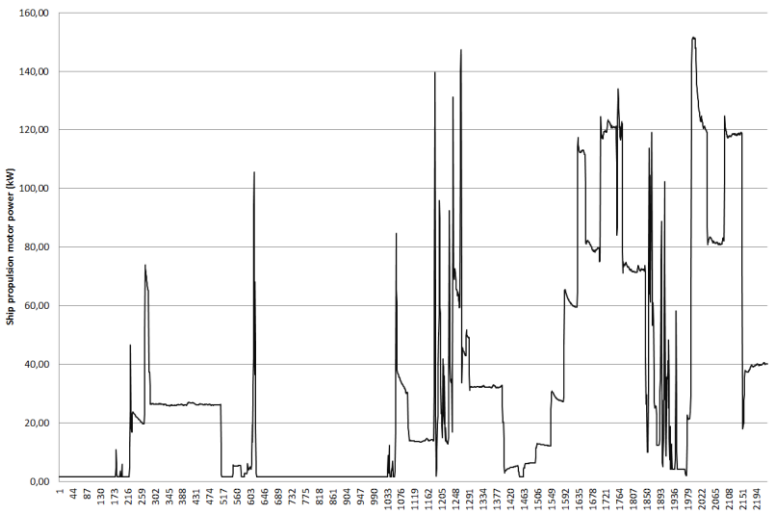
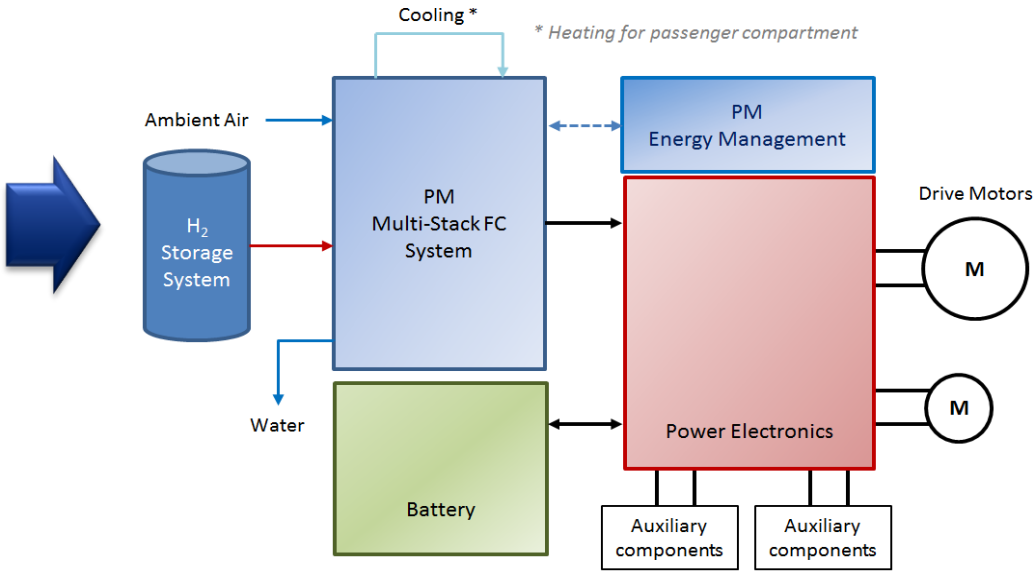
- Determine the real power demands to form the basis for the hybridisation concept





Area of Operation	Fuel cell System	Battery
Alster	Base load (20 - 25 kW)	Provides peak load, serves as buffer; backup for safe return in case of failure of both FC systems
Alster-Canals	Base load (10 - 20 kW)	Provides peak load, serves as buffer; backup for safe return in case of failure of both FC systems

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Safety Concept – Theoretical Basis

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PACKAGING AND SYSTEM LAYOUT

Avoiding H_2 Leakage

- Welding instead of screwing
- Depressurizing high and mid pressure pipes if not in use
- Clearing mid and low pressure pipes if not in use
- Double-walled pipes

Ex-Zone Concept

- Sectional classification in ship
- Forced air ventilation of areas with possibility of H_2 leakage
- Monitoring gas concentration

CONTROL

Micro Controller and CVMU's

- Keep system in normal parameters
- Normal shut-down if first level switching points are reached
- Prevent system from getting damaged
- Prevent hydrogen from leaving the system

SAFETY CIRCUIT

Hard Wired Safety Circuit

- Switches for temperature, pressure and flow
- Emergency shut-down if switching points are reached
- Preventing system from getting damaged
- Preventing hydrogen from leaving the system

PRD's

Pressure Relief Devices

- Safety valves
- Melting fuses
- Preventing the system from getting damaged
- Releasing hydrogen to environment if set pressure points or temperatures of melting fuse are reached

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Ship Layout

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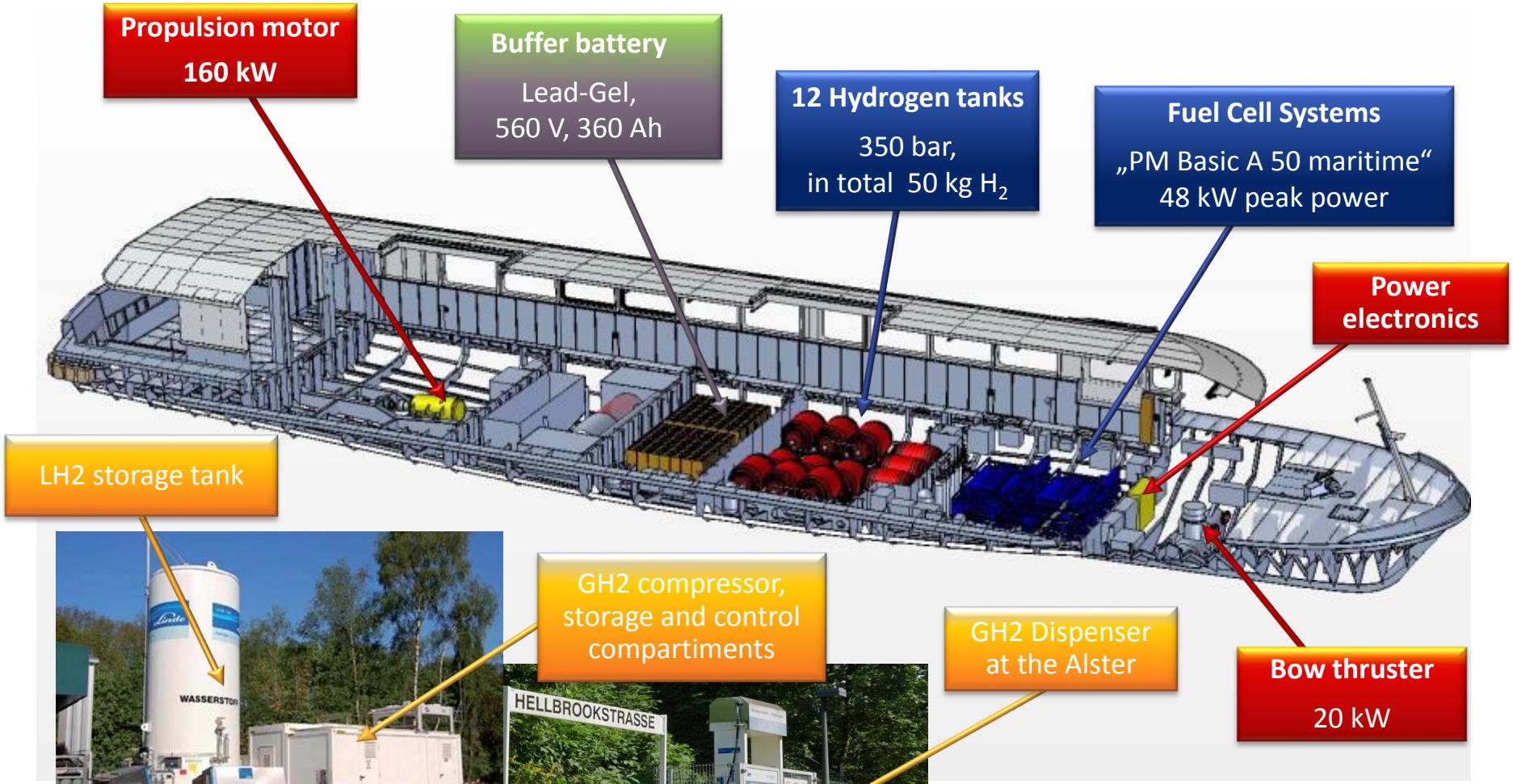
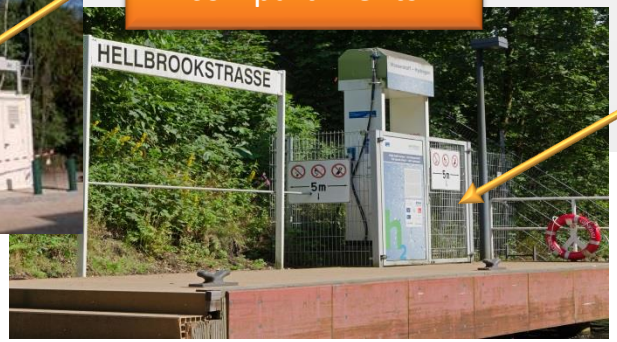


CAD drawing: Schiffstechnik Buchloh

Source: Linde Group



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Technology & Products

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PEM-Stacks

PM200 PM400

Automotive – Stationary – Maritime

Developed by Proton Motor

Manufactured in Germany

Power Range

PM200: 2…16 $kW_{elect.}$

PM400: 15…75 $kW_{elect.}$

PM Module

S 5 / 8 S25

Stationary applications

UPS applications

Parallel operation possible

Power Range

S 5/8: 1,1…8,9 $kW_{elect.}$

S 25: 4,0…30 $kW_{elect.}$

HyRange®

HyRange®

Transport applications

Plug-In Hybrid

Parallel operation possible

Power Range

HyRange®: 15…75 $kW_{elect.}$

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PM 400 Stack Module

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Stationary
Automotive
Maritime

Interfaces

Fuel Cell Power [kW]	15	22.5	30	37.5	45	52.5	60	67.5	75
Electrical System									
Power Range [kW]	2.0–15.0	2.9–22.5	3.9–30	4.8–37.5	5.8–45	6.8–52.5	7.7–60	8.7–67.5	9.7–75
Current Range [A]	0–500								
Voltage Range [V DC]	30–55	45–83	60–110	75–137	90–165	105–192	120–220	135–248	150–275
EL System Efficiency [%]	51–69								
Hydrogen System									
Hydrogen Quality	ISO 14687-2 / SAE J2719								
H2 Supply Pressure [bar_g]	1.2–8								
Hydrogen Consumption (max) [kg/h]	< 0.92	< 1.37	< 1.82	< 2.27	< 2.72	< 3.18	< 3.63	< 4.08	< 4.53
Dimensions									
Width x Height [mm x mm]*	434 x 277								
Length [mm]	452	542	632	722	812	902	992	1082	1172
Volume [l]	29	38	47	56	65	71	78	86	101
Tare weight [kg]	42	50	56	65	71	78	86	93	100

Environmental Conditions	
Ambient Temperature [°C]	-40 to +45
Operating Altitude* [m]	< 2,000
Humidity ** [% r.H.]	< 95
Lifetime [op. hrs.]	> 10,000

Others	
Conformity	CE, EN 62282-2
Protection Class	IP65

* without de-rating
** non condensing

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PM 400 Stack Module 30 kW

Electric Power Output	3.9 - 30 kW
System Efficiency	54% @ 180 A
Voltage Range	0…110 V_{DC}
Current Range	0…500 ADC
Operation Temperature	-30°C…+45°C
Ambient Temperature	-45°C…+60°C
Communication	CAN v2.0A
Conformity	CE, 79/2009/EC, 72/245/EEC, ECE100-01

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Thank you for your attention!

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