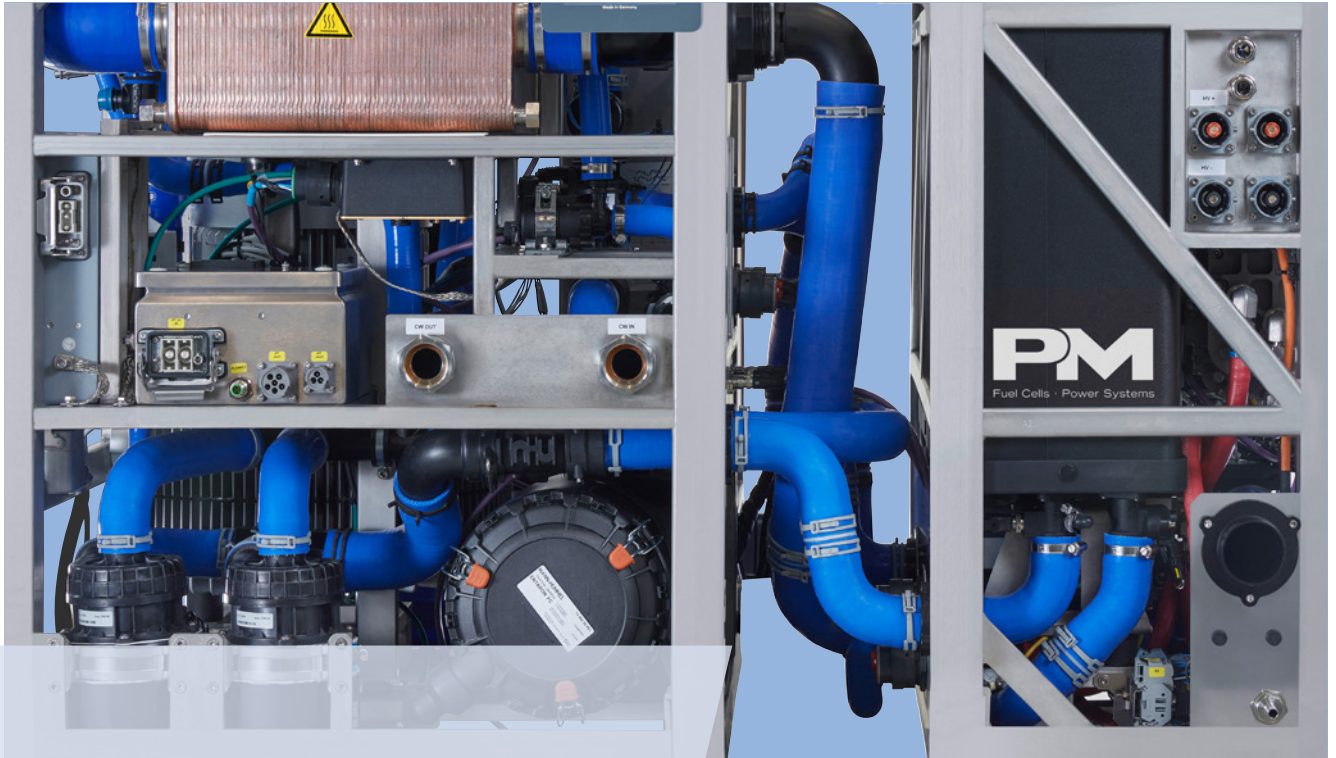




Fuel Cells · Power Systems

Proton Motor
Fuel Cell Stacks and Systems

Cleantech Competence



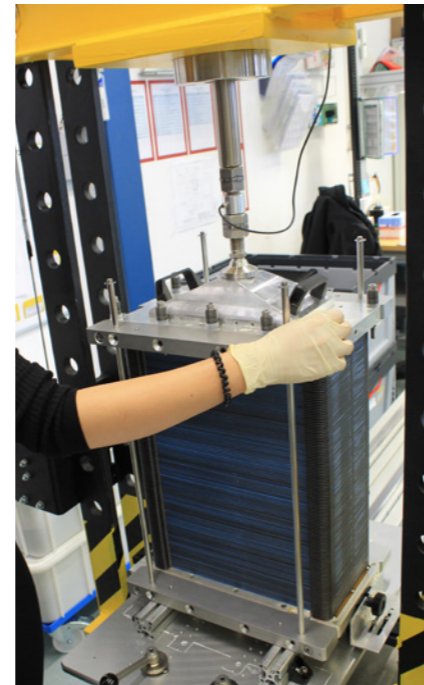
**Maritime
Fuel Cell Solutions**

**Zero
Emission**

**100%
Energy**

About Proton Motor Fuel Cell GmbH

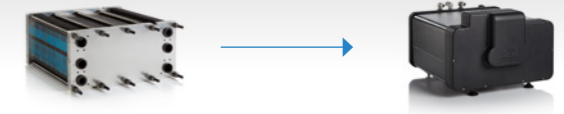
With more than 20 years of experience, Proton Motor is one of the leading experts in the field of fuel cell technology. In Puchheim near Munich, Proton Motor develops, tests and manufactures low-temperature PEM fuel cells. The company's expertise in this area starts with the individual cell and extends through the fuel cell stack to operable systems.



Proton Motor Fuel Cell Solutions – What we do

FUEL CELL TECHNOLOGY

In house development & manufacturing.
Only for use in fuel cell systems by Proton Motor



Monitoring
& Control

Primary
Cooling Circuit

Hydrogen
Supply Unit

Air Supply
Unit

Power
Electronics

FUEL CELL SYSTEMS

Available for customers,
e.g. OEM's, integrators, manufacturers



Mechanical Design

Voltage adaption
with power
electronics
(DC/DC)

Secondary cooling
circuit or plate heat
exchanger for
heat utilization

Monitoring System
& Communications
(Data Logging &
online diagnostics
possible)

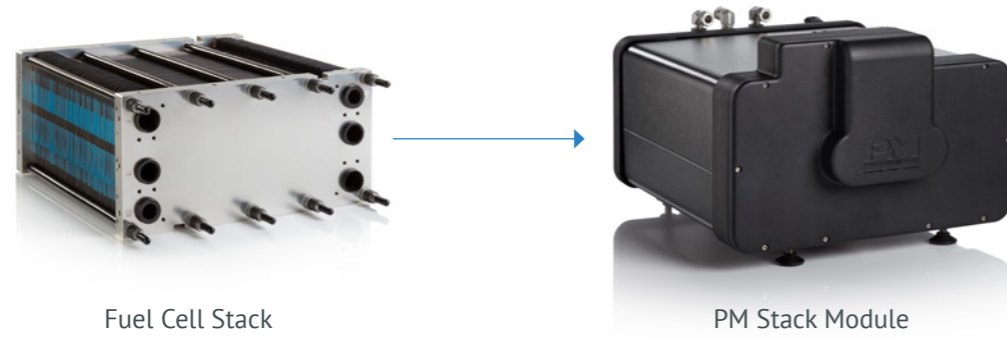
UNIQUE SOLUTIONS



FUEL CELL TECHNOLOGY BY PROTON MOTOR

Fuel Cell Stack Modules PM200 & PM400

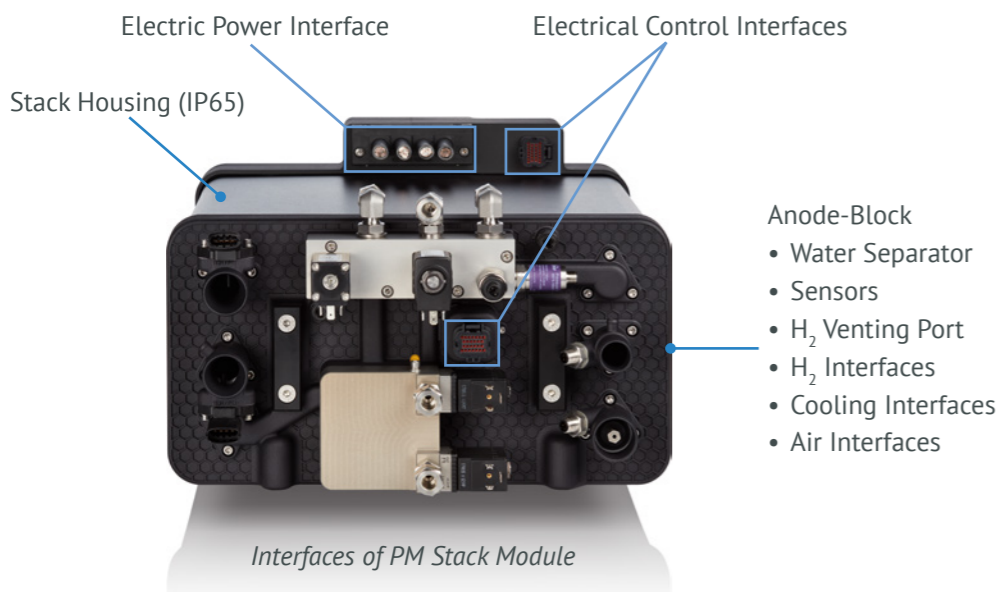
Based on two different fuel cell surface areas, Proton Motor manufactures two different stack models, called **PM200** and **PM400**. Both stack models can be realized in different power ranges by stacking a different number of cells.



Depending on the version, a **PM200** or a **PM400** fuel cell stack is explosion-proof encased inside the **PM Fuel Cell Stack Module**. In addition, a PM Stack Module includes electrical, process and signal interfaces by means of a media adapter plate and an electrical module. The design of the PM Stack Module allows a simplified integration of the fuel cell into a Proton Motor Fuel Cell System and is therefore the heart piece of Proton Motor's technology.

MAIN BENEFITS:

- Horizontal & vertical installation
- Highest integration of media and electric BoP (Balance of Plant)
- Highest modular FC-stacks



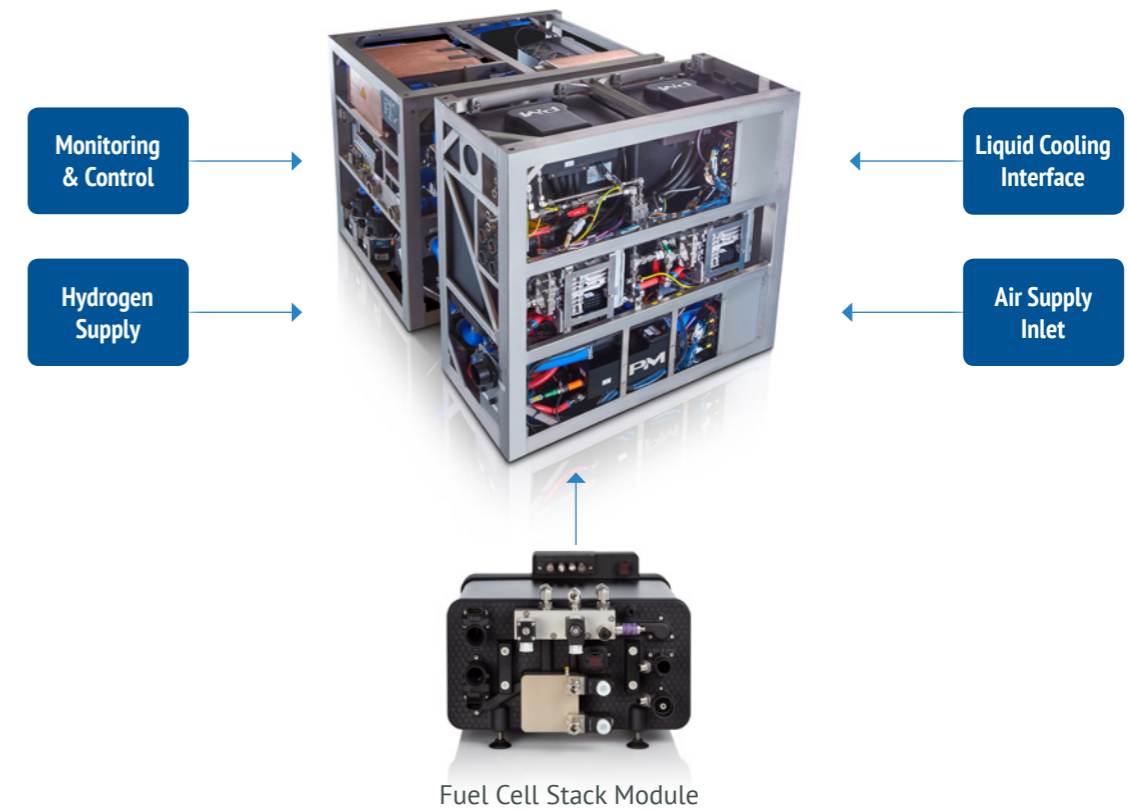
The entire fuel cell technology, from the single cell to the PM Stack Module, is developed, tested and manufactured by Proton Motor. Therefore, one of Proton Motor's major core competencies is the operation management of fuel cells. In order to guarantee the best possible performance, the PM Stack Modules are sold only with peripheral components, as so-called fuel cell systems.

FUEL CELL SYSTEMS BY PROTON MOTOR

To generate electricity and heat our Fuel Cell Stack Modules must be supplied with hydrogen and oxygen from air. At the same time, the heat generated must be dissipated to protect the fuel cell from overheating and thus from damage. Therefore, various peripheral components are required for the operation.

The peripheral components of our fuel cell systems are matched to the power size of the PM Stack Module that must be supplied. With use of sensors for monitoring the operating parameters, an internal control system ensures an optimum operation of all components.

Illustration of the system assemblies on the example of the HyShip



MAIN BENEFITS:

- Zero emissions
- Long lifetime due to graphite bipolar plates
- Silent operation
- Maintenance concept with fuel cell substitute
- Refurbishment of fuel cell stack possible
- Developed and manufactured in Germany
- European supply chain



Ferry



Passenger Ship

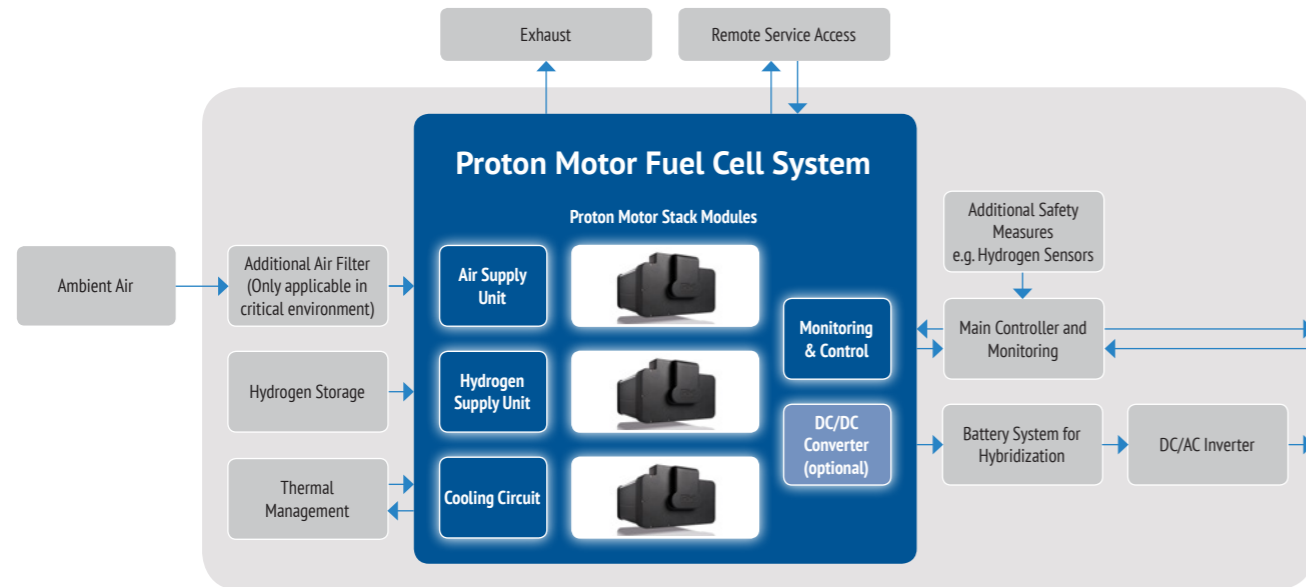


Leisure Boat

Application Areas

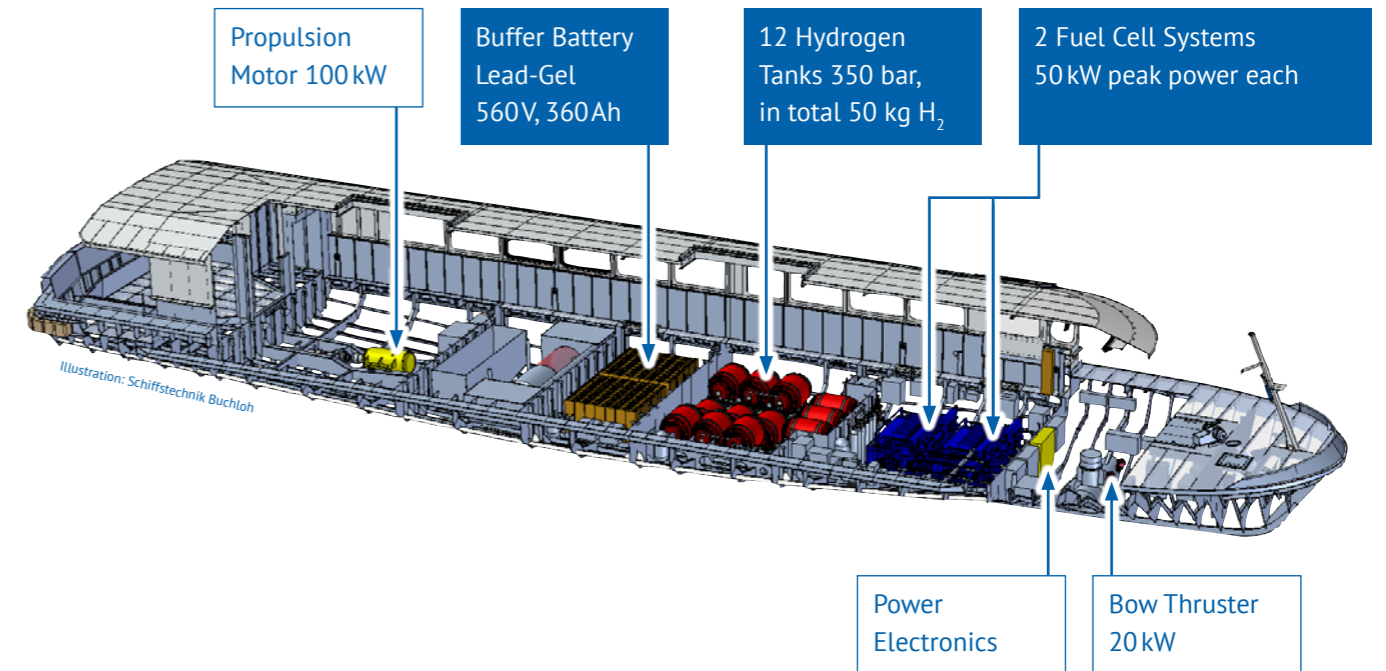
Our fuel cell systems are designed for multiple maritime applications. Their design allows easy integration into the target application.

Electrical Powertrain with Fuel Cell System

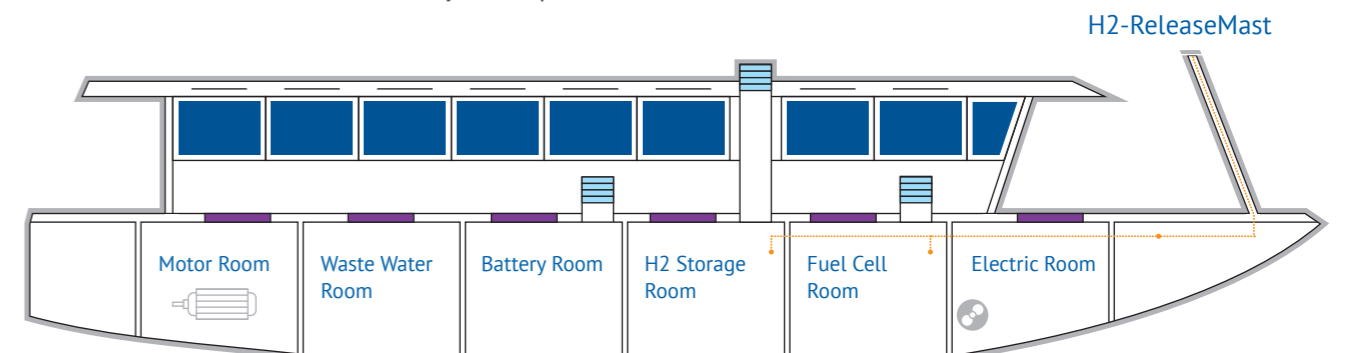


■ Scope of Supply HyShip

Integration Example and Ex-Zone Konzept



Ex-Zone Safety Concept according to rules of Germanischer Lloyd – simplified Illustration



- Ventilation Outlet
- Gas Tight Ports to Passenger Area
- Line for Pressure Relief Devices

MAIN BENEFITS:

- Sectional classification in ship
- Forced air ventilation of areas with possibility of H2 leakage
- Monitoring gas concentration

UNIQUE SOLUTIONS MARITIME



FCS Alsterwasser (World's 1st Zero Emission Fuel Cell Ship) ZEMSHIPS Project, Hamburg

- Capacity 100 passengers
- Partners: AIG, Linde, German Lloyd, City of Ahmburg, Proton Motor
- Proton Motor was responsible for FC propulsion system integration & approval
- In operation from 2008 till 2014
- More than 4,000 operating hours, more than 50,000 passengers



FINCANTIERI Marine Vessel ZEUS „Zero Emission Ultimate Ship“

- FC system with Metal Hybrid Storage
- FC system combine with battery
- Two fully redundant FC systems
- Hydrogen Capacity: 50 kg (850 kWh_{el})
- FC Power Range: 20 – 144 kW_{el}
- AUX. Consumers: max. 11 kW_{el}

UNIQUE SOLUTIONS AUTOMOTIVE AND RAIL



Garbage Truck E-TRUCKS Europe

- FC Power 43 kW
- H2 Storage: 20/30 kg, 350 bar
- Battery: 136 kWh
- Delivery: 6 Systems in 202



Rail Milling Train LINSINGER MG11 Hydrogen

- FC Power 2x107kW
- H2 Storage: To be announced, 350 bar
- Battery: To be announced
- Delivery: 2nd Qu. 2021



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